



Contents lists available at [www.gsjpublications.com](http://www.gsjpublications.com)

## Journal of Global Scientific Research in Medical and Dental Sciences

journal homepage: [www.gsjpublications.com/jourgsr](http://www.gsjpublications.com/jourgsr)



# Nutritional Status of Newly Diagnosed Tuberculous Patients at the National Tuberculosis Institute in Baghdad

Noor Basim Jabbar<sup>1</sup>, Jawad Kadhim Al-Diwan<sup>2</sup>

<sup>1</sup>Public Health Department, Ministry of Health, Baghdad, Iraq.

<sup>2</sup>Department of Family and Community Medicine, College of Medicine, University of Baghdad, Baghdad, Iraq.

### ARTICLE INFO

Received: 2 Sep 2023,  
Revised: 3 Sep 2023,  
Accepted: 9 Sep 2023,  
Online: 27 Sep 2023

#### Keywords:

Nutritional Tuberculosis, Patients Tuberculosis.

### ABSTRACT

**Background:** Tuberculosis (TB) is an infectious disease that mainly affects people in developing countries. It is affected by nutritional status. The aim of this study was to determine the prevalence of malnutrition and the effect of associated sociodemographic and clinical variables on the nutritional status among adult TB patients. **Methodology:** A convenient sample of 100 newly diagnosed adult Tuberculous patients whether pulmonary or extrapulmonary who attended the General Tuberculosis Institute in Baghdad governorate from October 2022 to January 2023 was taken. Their nutritional status was measured by BMI. **Result:** Out of the total patients included in the study, (53%) were males and (47%) were females. More than half of patients had a normal BMI (55%), while 19% had undernutrition which is mainly seen in the pulmonary type, and 26% were overweight and obese which is seen in the extrapulmonary type. High educational level, high socioeconomic status, eating frequent meals (>3/day), not having anemia, and not having significant weight loss appear to be protective against malnutrition in tuberculous patients. **Conclusion:** Tuberculosis and malnutrition with dual effects so every TB patient needs a baseline nutritional assessment prior to the start of treatment. Also important to improve nutritional knowledge by counseling on a balanced diet and increasing awareness about the risk factors of undernutrition and its consequences for tuberculous patients and their family members.

## 1. Introduction

Tuberculosis (TB) is an infectious disease caused by Mycobacterium Tuberculosis, It can affect almost any organ of the body which is called extrapulmonary TB but pulmonary TB which affects the lungs is the most common form (1,2). TB is the top cause of death from a single infectious agent and the 13th leading cause of death worldwide (3). According to WHO, an estimated 1.6 million people died from TB and

approximately 10.6 million people fell ill with it worldwide but TB is curable and preventable (4). TB is a chronic disease that mainly affects lower socioeconomic status, more than 80% of patients with TB and > 95% of TB deaths occur in low- and middle-income countries, particularly Asia and sub-Saharan Africa countries, where extreme hunger and poverty are endemic and overwhelming public health issues (5,6). In Iraq,

Corresponding author:

E-mail addresses: [dr.noorbasim2013@gmail.com](mailto:dr.noorbasim2013@gmail.com)

doi: [10.5281/jgsr.2023.8379189](https://doi.org/10.5281/jgsr.2023.8379189)

2523-9376/© 2023 Global Scientific Journals - MZM Resources. All rights reserved.

the prevalence of TB is estimated at 24/100000 population, and the mortality is estimated at 2.1/100000 population (7).

Malnutrition refers to excesses or deficiencies in nutrient intake. The two burdens of malnutrition include both undernutrition and overweight and obesity (8). Many states like genetics, eating or metabolic disorders, medication side effects, and infections like tuberculosis predispose to being underweight (9,10).

The association between TB and malnutrition is bidirectional, TB predisposes the patient to malnutrition (11) or exacerbates the already existing undernutrition by; decreasing appetite through altering the appetite regulatory hormones, increasing metabolic demand, and causing nutrient and micronutrient malabsorption. These changes which are caused by the disease process could lead to emaciation and may cause low BMI. As hormones normalize during treatment, appetite is restored and nutritional status improved (12-15).

Malnutrition also increases the risk of developing active TB by 6 to 10 folds (16). since undernutrition among TB patients weakens the human immune system and selectively compromises cell-mediated immunity, which is the principal defense against Mycobacterium tuberculosis and this can result in latent TB developing into active infection and worsen the treatment outcomes (17,18,19). Severe undernutrition at diagnosis is associated with an increased risk of death two-fold therefore, undernutrition needs to be treated in concert with the treatment of infection (20).

Although the relationship between TB and malnutrition has been recognized long ago, there are few studies about it in Iraq. There is also limited insight into the effect of socioeconomic factors on the nutritional status of TB patients in Iraq. This study was therefore designed to assess the nutritional status and document the prevalence of malnutrition among newly diagnosed adult TB patients and to assess the impact of the socioeconomic characteristics of newly diagnosed TB patients on their nutritional status at the time of registration.

## 2. Methodology

A convenient sample of 100 newly diagnosed Tuberculous patients whether pulmonary or extrapulmonary aged 15 years and above who attended the General Tuberculosis Institute in Baghdad governorate for the period between October and December 2022 were included in the study after obtaining approval from the Institute, and from each participant prior to the start of the study.

At enrolment, a direct interview with the patients was done, and information on basic socio-demographic data was collected, a detailed history and full examination were done

The height of the patients was measured while standing erect without shoes and recorded in centimeters; weight was measured on a digital weight scale with minimal clothing on and recorded in kilogram. The same instruments were used to take the measurements and were calibrated each morning to ensure the validity of the results.

Body mass index (BMI) was used to assess nutritional status. BMI was computed as = weight (in kilogram)/ (height in meter) <sup>2</sup>. According to the World Health Organization (WHO), a BMI less than 18.5 KG/M<sup>2</sup> was considered underweight, 18.5–24.9 was considered normal weight, 25.0–29.9 was considered overweight, and 30.0 and more was considered obese.

Significant weight loss was considered when the patient lost 5% of body weight over 6–12 months (21).

The blood samples were collected by laboratory technologists to measure the hemoglobin concentration and recorded in gram/deciliter. According to the WHO, anemia is defined as hemoglobin (Hb) levels <12.0 g/dL in women and <13.0 g/dL in men (22).

### **Statistical analysis:**

IBM SPSS program (version 23) was used for data entry and analysis. Descriptive statistics was used in the form of frequencies and percentages for categorical data, represented by figures and tables. For qualitative variables, the chi-square test was

used. The significance level was set at a p-value of 0.05.

### 3. Results

A total of 100 patients were included in the study. The mean age was 40.53±12.751 years, giving male to female ratio of 1.13.

**Table 1: The characteristic features of the sample**

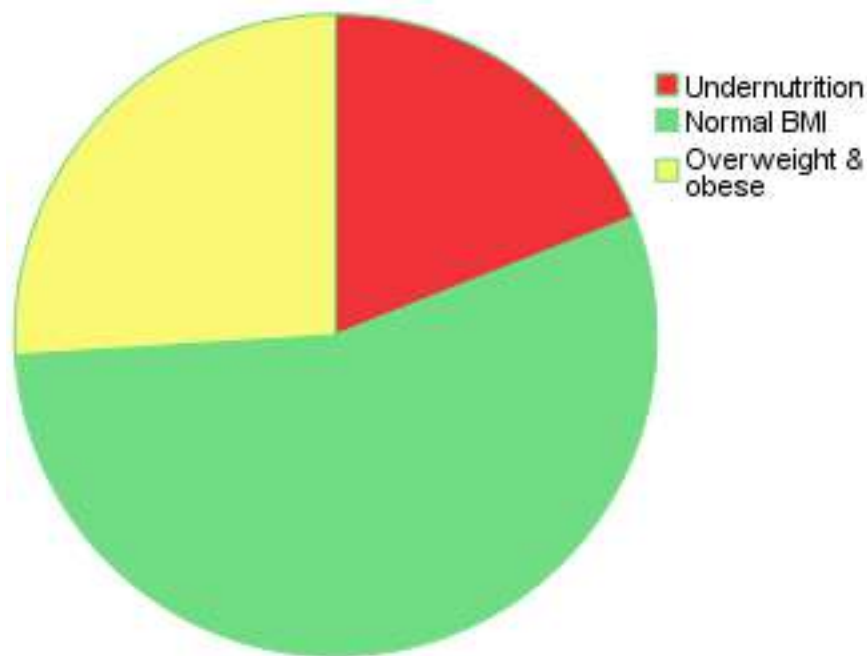
Variables	No.	%	
Age	15-30 years	24	24
	31-45 years	42	42
	>45 years	34	34
Sex	Male	53	53
	Female	47	47
Occupation	Employed	22	22
	Unemployed	49	49
	Self-employed	29	29
Education	Illiterate	21	21
	Primary School	40	40
	Secondary school	26	26
	> Secondary school	13	13
Marital status	Single	18	18
	Married	73	73
	Divorced/Widow	9	9
Smoker	Yes	34	34
	No	66	66
Alcoholic	Yes	4	4
	No	96	96
Crowding Index	≤ 2	46	46
	> 2	54	54
Total	100	100.0	

Pulmonary TB was found in 37 (37%) of patients and extrapulmonary TB was found among 63 (63%) of patients. About 29% of patients had a comorbid disease, and 59% had a loss of appetite. The frequency of food intake/ day was > 3 meals among 58%. 37% of patients were anemic, and 53% lost 5% or more of their weight as shown in Table 2.

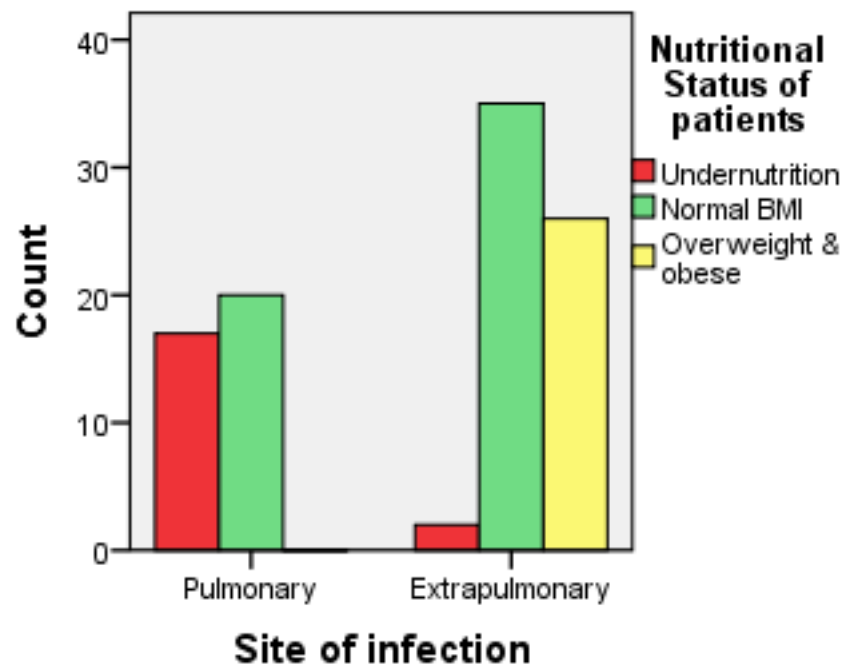
**Table 2: Clinical features of the studied sample**

Variables		No.	%
Site Of Infection	Pulmonary TB	37	37
	Extrapulmonary TB	63	63
Comorbid disease	Yes	29	29
	No	71	71
Loss of appetite	Yes	59	59
	No	41	41
Frequency of food intake/ day	≤ 3 meals	42	42
	>3 meals	58	58
Anemia	Yes	37	37
	No	63	63
Weight loss	< 5%	47	47
	≥ 5%	53	53
Total		100	100

Figures 1 and 2 show; the nutritional status of patients having tuberculosis which shows that 19% were undernutrition, 26% were overweight and obese, and 55% had normal BMI as shown in Figure 1, while Figure 2 shows the nutritional status of tuberculosis patients according to the site of infection, the under nutritional status seen mainly in pulmonary type.



**Figure 1: Nutritional status of tuberculous patients**



**Figure 2: Nutritional status of tuberculosis patients according to the site of infection**

Normal body mass index (BMI) was associated significantly with participants with higher than secondary school education and with a crowding index of equal or less than 2, p 0.02, 0.001 respectively. (Table 3).

**Table 3: Distribution of sociodemographic features of patients according to their nutritional status**

Variables		Nutritional Status						P value
		Underweight		Normal BMI		Overweight & Obese		
		No.	%	No.	%	No.	%	
Age	15-30	8	33.3	11	45.8	5	20.8	0.33
	31-45	7	16.7	24	57.1	11	26.2	
	>45	4	11.8	20	58.8	10	29.4	
Sex	Male	9	17.0	33	62.3	11	20.8	0.28
	Female	10	21.3	22	46.8	15	31.9	
Occupation	Employed	4	18.2	14	63.6	4	18.2	0.71
	Unemployed	11	22.4	24	49.0	14	28.6	
	Self-employed	4	13.8	17	58.6	8	27.6	
Education	Illiterate	8	38.1	9	42.9	4	19.0	0.02
	Primary School	9	22.5	17	42.5	14	35.0	
	Secondary school	1	3.8	19	73.1	6	23.1	
	> Secondary school	1	7.7	10	76.9	2	15.4	
Marital status	Single	6	33.3	5	27.8	7	38.9	0.13
	Married	11	15.1	45	61.6	17	23.3	
	Divorced/Widow	2	22.2	5	55.6	2	22.2	
Smoker	Yes	4	11.8	24	70.6	6	17.6	0.07
	No	15	22.7	31	47.0	20	30.3	
Alcoholic	Yes	1	25.0	2	50.0	1	25.0	0.95
	No	18	18.8	53	55.2	25	26.0	
Crowding Index	≤ 2	2	4.3	27	58.7	17	37.0	0.001
	> 2	17	31.5	28	51.9	9	16.7	

Normal body mass index (BMI) was associated significantly with patients; complaining of extrapulmonary TB, not having loss of appetite, eating more than 3 meals/ day, not having anemia, and having weight loss of less than 5% of body weight in the last 3-6 months. (Table 4).

**Table 4: Distribution of clinical features of patients according to their nutritional status**

Variables		Nutritional Status						P value
		Underweight		Normal BMI		Overweight & Obese		
		No.	%	No.	%	No.	%	
Site of infection	Pulmonary	17	45.9	20	54.1	0	0.0	<0.001
	Extrapulmonary	2	3.2	35	55.6	26	41.3	
Comorbid diseases	Yes	8	27.6	16	55.2	5	17.2	0.24
	No	11	15.5	39	54.9	21	29.6	
Loss of appetite	Yes	16	27.1	31	52.5	12	20.3	0.03
	No	3	7.3	24	58.5	14	34.1	
Frequency of food intake/day	≤ 3 meals	17	40.5	18	42.9	7	16.7	<0.001
	>3 meals	2	3.4	37	63.8	19	32.8	
Anemia	Yes	17	45.9	12	32.4	8	21.6	<0.001
	No	2	3.2	43	68.3	18	28.6	
Weight loss	<5 %	2	4.3	36	76.6	9	19.1	<0.001
	≥ 5%	17	32.1	19	35.8	17	32.1	

**4. Discussion**

Malnutrition was observed in 19% and this number must be considered as Iraq witnessed an economic change. It is well known that malnutrition is associated (manifestation or a cause) with tuberculosis. This finding is consistent with that in Indonesia (87%) (23), India (66%) (24), Sri Lanka (51%) (25), Ghana (51%) (26), Uganda (46%) (27), Ethiopia (39.7%) (28). The discrepancy between the nations may be related to socioeconomic and sociocultural inequalities; behavioral and lifestyle differences, and also due to differences in sample size.

This study showed no significant association between age, sex, occupation, marital status, and

being a smoker or alcoholic with malnutrition among tuberculous patients and this goes in line with the study done by Gurung et al. (29).

High-educated tuberculous patients were the lowest group affected by malnutrition, this finding was similar to a study done in India (30), and also WHO stated that education is a protective factor against malnutrition (31).

High socioeconomic status (low crowding index) (32) was a protective factor against malnutrition and this may be explained by the availability of a hygienic and healthy living environment among them.

The results showed that most patients with extrapulmonary TB had normal BMI (68.2%), and this finding does not go with a study done in Nepal (33) and goes in line with Ernawati et al. who said that mainly pulmonary type contributes to poor nutritional status because the disease process affects the immune system (34).

There is no significant association between the presence of comorbid diseases in TB patients and nutritional status and this is against Aljohaney et al. (35).

Taking more than 3 meals per day was a protective factor against malnutrition, this can be explained by that frequent meals make the patient take adequate dietary intake and hence sufficient calories to maintain weight, and these findings disagree with a study done in Kenya which state meal frequency showed an increased risk of having low BMI (36).

This study revealed that 39% of TB patients were anemic this is due to the effect of TB on red blood cell production like decreasing the erythrocyte lifespan, poor erythrocyte iron incorporation, and decreased sensitivity to the supply of erythropoietin (37), and this number is lower than the global prevalence of anemia in tuberculosis, which ranges from 44–89.1% (38). Normal BMI was found to be significant with patients not complaining of anemia and this is similar to the concept of a study done in Brazil (39); and differs from a study conducted by Nagu et al. who found 86% were anemic (40).

Most individuals with active TB are in a catabolic state and experience weight loss (41). This can be caused by several factors, including reduced food intake due to loss of appetite, nausea, and abdominal pain; nutrient losses from vomiting and diarrhea, and metabolic alterations caused by the disease (42,43), In our study, patients with less percentage of weight loss were less likely to have undernutrition.

## 5. Conclusion

Tuberculosis and malnutrition with dual effects. A vicious circle appears from them. The nutritional status of TB patients was affected by educational level, socioeconomic status, site of infection, frequency of meals, anemia, and weight loss.

## 6. References

- [1]. Jindal SK, Aggarwal AN, Gupta D, Agarwal R, Kumar R, Kaur T, et al. Indian study on the epidemiology of asthma, respiratory symptoms, and chronic bronchitis in adults (INSEARCH). *Int J Tuberc Lung Dis.* 2012; 16:1270-7.
- [2]. Guideline: Nutritional care and support for patients with tuberculosis. World Health Organization 2013. Available at: [http://www.who.int/elena/titles/full\\_recommendations/tb\\_nutrition/en/](http://www.who.int/elena/titles/full_recommendations/tb_nutrition/en/)
- [3]. WHO. Global tuberculosis report 2021. Available online: <https://www.who.int/publications/i/item/global-tuberculosis-report-2021>.
- [4]. World Health Organization Tuberculosis (TB). World Health Organization Tuberculosis: Key Fact. [(accessed on 27 October 2022)];2022 Available online: <https://www.who.int/en/news-room/fact-sheets/detail/tuberculosis>.
- [5]. Khazaei HA, Rezaei N, Bagheri GR, Dankoub MA, Shahryari K, Tahai A, et al. Epidemiology of tuberculosis in southeastern Iran. *Eur J Epidemiol.* 2005;20(10):879–83.
- [6]. USAID Nutrition and Tuberculosis: A Review of the Literature and Considerations for TB Control Programs. [(accessed on 15 November 2019)]; Available online: [https://www.researchgate.net/publication/48909164\\_Nutrition\\_and\\_Tuberculosis\\_A\\_Review\\_of\\_the\\_Literature\\_and\\_Considerations\\_for\\_TB\\_Control\\_Programs](https://www.researchgate.net/publication/48909164_Nutrition_and_Tuberculosis_A_Review_of_the_Literature_and_Considerations_for_TB_Control_Programs)
- [7]. World Health Organization. Global tuberculosis report 2022: WHO/CDS/TB/202. Geneva: WHO; 2022.
- [8]. World Health Organization. Home/Health Topics/Malnutrition Available online: [https://www.who.int/health-topics/malnutrition#tab=tab\\_1](https://www.who.int/health-topics/malnutrition#tab=tab_1).
- [9]. Bernstein M, Munoz N. Nutrition for the older adult: Jones & Bartlett Learning; 2019. [Google Scholar](#)
- [10]. Kumar R, Abbas F, Mahmood T, Somrongthong R. Prevalence and factors associated with underweight children: a population-based subnational analysis from Pakistan. *BMJ Open.* 2019;9(7):e028972. [Article PubMed PubMed Central Google Scholar](#)
- [11]. Bhargava A, Oxlade O, Menzies D. Undernutrition and the incidence of tuberculosis in India: national and subnational estimates of the population attributable fraction related to undernutrition. *Nat Med J India.* 2014;27:4–9.
- [12]. WHO. *Nutritional Care and Support for Patients with Tuberculosis.* WHO Library Cataloguing; 2013.
- [13]. Geberemeskel T, Woldeyohannes D, Demisie M, Demisie M. Undernutrition and associated factors among adult tuberculosis patients in hossana town



- public health facilities, Southern Ethiopia. *J Trop Dis.* 2018;06(01). doi:10.4172/2329-891X.1000253
- [14]. Chang SW, Pan WS, Lozano Beltran D, et al. Gut hormones, appetite suppression and cachexia in patients with pulmonary TB. *PLoS One.* 2013;8(1):e54564. doi:10.1371/journal.pone.0054564
- [15]. Zheng Y, Ma A, Wang Q, et al. Relation of leptin, ghrelin and inflammatory cytokines with body mass index in pulmonary tuberculosis patients with and without type 2 diabetes mellitus. *PLoS One.* 2013;8(11):e80122. doi:10.1371/journal.pone.0080122
- [16]. Schaible U, Kaufmann S. Malnutrition and infection: complex mechanisms and global impacts. *PLoS Med.* 2007;4:e115.
- [17]. Lönnroth K, Jaramillo E, Williams BG, Dye C, Raviglione M. Drivers of tuberculosis epidemics: The role of risk factors and social determinants. *Soc Sci Med* 2009;68:2240–6.
- [18]. Padmapriyadarsini C, Shobana M, Lakshmi M, Beena T, Swaminathan S. Undernutrition and tuberculosis in India: Situation analysis and the way forward. *Indian J Med Res* 2016;144:11-20. Back to cited text no. 5 [PUBMED] [Full text].
- [19]. S. Pranay, J. Davis, L. Saag et al., "Undernutrition and tuberculosis: public health implications," *The Journal of Infectious Diseases*, vol. 219, no. 9, pp. 1356–1363, 2019.
- [20]. Semba RD, Darnton-Hill I, de Pee S. Addressing tuberculosis in the context of malnutrition and HIV coinfection. *Food Nutr Bull* 2010;31:S345-64. Back to cited text no. 2
- [21]. [https://harrisons.unboundmedicine.com/harrisons/view/Harrisons-Manual-of-Medicine/623744/all/Chapter 32: Unintentional Weight Loss](https://harrisons.unboundmedicine.com/harrisons/view/Harrisons-Manual-of-Medicine/623744/all/Chapter_32:_Unintentional_Weight_Loss)
- [22]. Corbett EL, Watt CJ, Walker N, Maher D, Williams BG, Raviglione MC, et al The growing burden of tuberculosis: Global trends and interactions with the HIV epidemic *Arch Intern Med.* 2003;163:1009–21 Cited Here | [View Full Text](#) | [PubMed](#) | [CrossRef](#)
- [23]. Pakasi T., Karyadi E., Dolmans W., vanderMeer J., vanderVelden K. Malnutrition and socio-demographic factors associated with pulmonary tuberculosis in Timor and Rote Islands, Indonesia. *Int. J. Tuberc. Lung. Dis.* 2009;13:755–759. [PubMed] [Google Scholar]
- [24]. Das S., Sen S., Debnath A., Basuthakur S., Saha P.K., Biswas C. A study of nutritional assessment of newly diagnosed tuberculosis patients in a tertiary care hospital of Tripura. *India Int. J. Res. Med. Sci.* 2018;6:1382–1387. doi: 10.18203/2320-6012.ijrms20181301. [CrossRef] [Google Scholar]
- [25]. Jayasuriya NA, Nanayakkara L, Iddamalagoda N, Derore K. Food security and nutrition among the tuberculosis infected patients. A case study among patients at the chest clinic in Sri Lanka. 2014.
- [26]. Appiah PK, Osei B, Amu H. Factors associated with nutritional status, knowledge and attitudes among tuberculosis patients receiving treatment in Ghana: A cross-sectional study in the Tema Metropolis. *PLoS One.* 2021;16(10 October):1–12. <https://doi.org/10.1371/journal.pone.0258033>
- [27]. Nambi E. Master's Thesis. Makerere University; Kampala, Uganda: 2015. [(accessed on 30 May 2019)]. Prevalence and Factors Associated with Malnutrition among Adult Tuberculosis Patients Attending the National Referral Tuberculosis Program Clinic at Mulago Hospital. Available online: <http://hdl.handle.net/10570/5691> [Google Scholar]
- [28]. Wondmieneh A, Gedefaw G, Getie A, Demis A. Prevalence of undernutrition among adult tuberculosis patients in Ethiopia: A systematic review and meta-analysis. *J Clin Tuberc Other Mycobact Dis.* 2021;22:100211. <https://doi.org/10.1016/j.ijctube.2020.100211>
- [29]. Gurung LM, Bhatt LD, Karmacharya I, Yadav DK. Dietary Practice and Nutritional Status of Tuberculosis Patients in Pokhara: A Cross Sectional Study. *Front Nutr.* 2018;5:63. doi: 10.3389/fnut.2018.00063. eCollection 2018. PubMed PMID: 30167434; PubMed Central PMCID: PMC6106647.[PubMed].
- [30]. Indupalli AS, Sirwar SB, Shaikh K. Nutritional status of tuberculosis cases registered under tuberculosis unit of Gulbarga city, North Karnataka, India. *International Journal of Bioassays.*2013;2(3):616-9
- [31]. Kassu A, Yabutani T, Mahmud ZH, et al. Alterations in serum levels of trace elements in tuberculosis and HIV infections. *Eur J Clin Nutr.* May 2006; 60(5):580-586.
- [32]. Melki IS, Beydoun HA, Khogali M, Tamim H, Yunis KA; National Collaborative Perinatal Neonatal Network (NCPNN). Household crowding index: a correlate of socioeconomic status and interpregnancy spacing in an urban setting. *J Epidemiol Community Health.* 2004 Jun;58(6):476-80.
- [33]. Sreeramareddy CT, Panduru KV, Verma SC, Joshi HS, Bates MN. Comparison of pulmonary and extrapulmonary tuberculosis in Nepal- a hospital-based retrospective study. *BMC Infect Dis.* 2008;8:8.
- [34]. Ernawati, K., Ramdhagama, N. R., Ayu, L. A. P., Wilianto, M., Dwianti, V. T. H., & Alawiyah, S. A. (2018). Perbedaan Status Gizi Penderita Tuberculosis Paru antara Sebelum Pengobatan dan Saat Pengobatan Fase Lanjutan di Johar Baru, Jakarta Pusat. *Majalah Kedokteran Bandung*, 50(2), 74–78. <https://doi.org/10.15395/mkb.v50n2.1292>
- [35]. Aljohaney AA. Mortality of patients hospitalized for active tuberculosis in King Abdulaziz University

- Hospital, Jeddah, Saudi Arabia. *Saudi Med J*. 2018;39(3):267–72. <https://doi.org/10.15537/smj.2018.3.22280>
- [36]. Nthiga I, Mbithe D, Mugendi BJ, Wambui T. The nutritional status of pulmonary tuberculosis patients aged 25-44 years attending tuberculosis clinic at Lodwar county and referral hospital, Turkana county, Kenya. *Int J Food Sci Nutr* 2017;2:119-22. Back to cited text no. 18
- [37]. Davis SL, Littlewood TJ. The investigation and treatment of secondary anaemia. *Blood Rev*. 2012;26(2):65–71
- [38]. Gelaw Y, Getaneh Z, Melku M. Anemia as a risk factor for tuberculosis: a systematic review and metaanalysis. *Environ Health Prev Med*. 2021;26(1):1–15. <https://doi.org/10.1186/s12199-020-00931-z>
- [39]. Lins TB, Soares Ede M, dos Santos FM, Mandacaru PM, Pina T, de Araujo Filho JA. Mycobacterium tuberculosis and human immunodeficiency virus coinfection in a tertiary care hospital in Midwestern Brazil. *Le infezioni in medicina*. 2012;20(2):108–16.
- [40]. Nagu J, Spiegelman D, Hertzmark E, Aboud S, Makani J, Matee MI, et al. Anemia at the initiation of tuberculosis therapy is associated with delayed sputum conversion among pulmonary tuberculosis patients in Dar-esSalaam, Tanzania. *PLoS O*
- [41]. Dodor E. Evaluation of nutritional status of new tuberculosis patients at the effia-nkwanta regional hospital. *Ghana Med. J*. 2008;42(1):22-8. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2423338/>, accessed 3 September 2013.
- [42]. Metcalfe N. A study of tuberculosis, malnutrition and gender in Sri Lanka. *Trans. R. Soc. Trop. Med. Hyg*. 2005;99(2):115-9.
- [43]. Podewils LJ. Impact of malnutrition on clinical presentation, clinical course, and mortality in MDRTB patients. *Epidemiol. Infect*. 2011;139:113-20.
- [44]. Ahmed, H. S., Hasson, R. N., Mohammed, R. I. (2023). Molecular Study of Mycobacterium Tuberculosis Infection in TB Centers , Ninava. *Journal of Global Scientific Research*. 8(1): 2799-2809.