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PATTERN OF CORTISOL LEVELS IN NEWLY DIAGNOSED PATIENTS WITH TUBERCULOSIS

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Abstract: **Background: Tuberculosis (TB) induces systemic inflammation and stress, which may affect adrenal gland function and alter serum cortisol levels. However, data on cortisol dynamics in TB patients within sub-Saharan Africa are limited. This study aimed to evaluate the pattern of serum cortisol levels among newly diagnosed pulmonary TB patients and explore associations with disease severity and glycaemic status.**

Methods: A descriptive cross-sectional study was conducted among 171 newly diagnosed adult pulmonary TB patients attending the DOTS clinic at the University of Port Harcourt Teaching Hospital, Nigeria. Sociodemographic and clinical data were collected through structured questionnaires. Fasting morning blood samples were analyzed for serum cortisol using Enzyme Linked Immunosorbent Assay (ELISA). Cortisol levels were categorized as low (<5 µg/dL), normal (5–25 µg/dL), or high (>25 µg/dL). TB severity was assessed using the Bandim TB severity scoring system. Associations between cortisol levels, disease severity, and dysglycaemia were evaluated using descriptive and inferential statistics.

Results: Most participants (86.5%) had normal cortisol levels, while 12.9% had hypercortisolaemia and 0.6% had hypocortisolaemia. The mean serum cortisol level was 14.32 ± 6.87 µg/dL. Classification of TB severity showed that 71.9% had moderate disease and 16.4% had severe disease. Although no statistically significant association was found between cortisol category and TB severity (p = 0.30), cortisol levels tended to be higher in patients with moderate disease and declined in severe TB cases. Participants with diabetes exhibited higher cortisol levels compared to those with prediabetes, indicating a possible link between cortisol elevation and glucose dysregulation.

Conclusion: While most TB patients demonstrated normal cortisol levels, a considerable proportion exhibited elevated levels, particularly among those with moderate disease and comorbid diabetes. Cortisol levels tended to decline with increasing TB severity, potentially reflecting progressive adrenal dysfunction. These findings suggest the need for integrating adrenal function monitoring into TB management, particularly for patients with metabolic comorbidities.

Keywords: **Tuberculosis, Cortisol, Adrenal dysfunction, TB severity, Hypercortisolaemia, Dysglycaemia, Nigeria.**

1. INTRODUCTION

Tuberculosis (TB) remains a significant global health concern, with the World Health Organization (WHO, 2023) estimating 10.6 million new cases and 1.3 million deaths in 2022.[1] Despite advancements in diagnostic modalities and therapeutic interventions, TB continues to be a major cause of illness and death in low- and middle-income nations, especially in sub-Saharan Africa[2]. In addition to its respiratory involvement, TB is a multisystem disease capable of triggering complex physiological and biochemical alterations, including disturbances in endocrine function[3].

Cortisol, a glucocorticoid hormone secreted by the adrenal cortex, is crucial in mediating the body's stress response, regulating immune activity, and maintaining metabolic balance[4]. It serves as a primary output of the hypothalamic-pituitary-adrenal (HPA) axis, which becomes activated during infectious and inflammatory processes[5,6]. In TB, persistent inflammation and prolonged immune stimulation can disrupt normal cortisol synthesis. Both elevated and reduced cortisol levels have been documented in TB cases, each with potential implications for disease trajectory, immune competence, and treatment outcomes[7,8]

Mycobacterium tuberculosis can involve the adrenal glands via haematogenous dissemination, and TB remains one of the leading causes of adrenal insufficiency in resource-limited settings where its prevalence is high[7]. In the early 20th century, adrenal TB accounted for nearly 69.7% of all adrenal insufficiency cases[8]. Adrenal hypofunction typically occurs when over 90% of the gland is damaged, with early stages characterised by bilateral gland enlargement due to stress-related inflammation, progressing to calcification and atrophy in the inactive phase[9]. Active TB disease often presents with immune–endocrine imbalance, leading to impaired cell-mediated immunity and elevated circulating cortisol concentrations. The persistent inflammatory state stimulates pro-inflammatory cytokines such as tumour necrosis factor-α[10], which can diminish adrenal cortisol production, resulting in adrenal insufficiency. Furthermore, rifampicin, a core anti-TB agent, has been reported to lower cortisol levels by accelerating its metabolism and clearance[11], although some studies, such as that by Magee et al., observed no adverse effect on adrenal function with rifampicin use[9].

Reports on the prevalence of adrenal insufficiency in TB vary widely, ranging from 0% to 40%[12]. Mugusi et al. found a prevalence of 32% among 50 hospitalised TB patients in Tanzania[13], similar to the 34% reported by Soule in South Africa[10] and the 39% recorded by Barnes et al. in a cohort of 90 TB patients[8]. In contrast, Odeniyi et al. observed a lower prevalence of 23% in 44 Nigerian adults with TB[14], noting no significant difference in basal cortisol between TB patients and healthy controls. Laway et al. documented reduced basal and stimulated cortisol levels in active TB patients[15], while Sarin et al. reported a prevalence of adrenal hypofunction of 16%[16]. Conversely, Bozza et al.[17] and Baker et al.[18] noted elevated plasma cortisol in active TB cases. Post et al., however, found no evidence of adrenal insufficiency among 50 newly diagnosed hospitalised TB patients[19], a finding similar to that of Barnes et al., who reported normal basal cortisol in 61% of TB patients at diagnosis[8], and York et al., who also observed no biochemical evidence of adrenal insufficiency in active TB[20].

Past research has shown inconsistent cortisol patterns in TB, with some studies reporting elevated basal levels attributed to prolonged stress and inflammatory activation, while others describe suppressed adrenal function, possibly due to immune-mediated HPA axis suppression or direct adrenal destruction by Mycobacterium tuberculosis[21]. These discrepancies may be shaped by disease stage, nutritional deficiencies, co-morbidities such as HIV, and pharmacological effects of anti-TB treatment.

In Nigeria, where TB persists as a major public health challenge, limited research has explored cortisol dynamics in affected patients. Greater insight into cortisol behaviour in this population may enhance understanding of TB pathophysiology, improve clinical surveillance, and inform integrated patient management. This study therefore seeks to assess cortisol level patterns among pulmonary TB patients receiving care at the University of Port Harcourt Teaching Hospital (UPTH), Nigeria, and to investigate potential associations with key demographic and clinical variables.

2. METHODS

2.1 Study Design and Setting

This descriptive cross-sectional study was carried out at the Directly Observed Treatment, Short-course (DOTS) Clinic of the University of Port Harcourt Teaching Hospital (UPTH) in Rivers State, Nigeria. UPTH serves as a leading tertiary healthcare facility catering to both urban and rural communities within the Niger Delta region.

2.2 Study Population

The study population included adult patients aged 18 years and above who had a recent diagnosis of pulmonary tuberculosis (≤6 months) and had not initiated anti-TB treatment. Diagnosis was established through sputum smear microscopy or GeneXpert MTB/RIF assay. Participants were enrolled consecutively from the DOTS clinic. Exclusion criteria comprised a history of endocrine disorders, recent use of corticosteroids, confirmed HIV/AIDS, pregnancy, severe systemic disease, or unwillingness to provide informed consent.

2.3 Sample Size Determination

The minimum sample size for this study was calculated using Kish's formula for sample size estimation in populations greater than 10,000:

$n = (Z^2 \times p \times q) / d^2$

Where:

n = required sample size for large populations

Z = standard normal deviate at 95% confidence level (1.96)

p = estimated prevalence of diabetes mellitus among tuberculosis patients, set at 15.1% (0.151) based on findings from a similar study by Lawson et al.[22] (Abuja, Nigeria)

$q = 1 - p = 0.849$

d = desired precision or margin of error = 0.05

Substituting the values:

$n = (1.96^2 \times 0.151 \times 0.849) / (0.05)^2$

$n = (3.8416 \times 0.128199) / 0.0025 = 0.4926 / 0.0025 = 197$

Since the total population of newly diagnosed TB patients at the University of Port Harcourt Teaching Hospital (UPTH) in the previous year was estimated at 707 (obtained from hospital records), a finite population correction was applied:

$Nf = n / [1 + (n/N)] = 197 / [1 + (197/707)] = 197 / 1.2786 \approx 154$

To account for an anticipated 10% attrition (non-response rate), the adjusted final sample size was:

$154 + (10\% \text{ of } 154) = 154 + 15.4 \approx 169$

The study therefore adopted a final sample size of 171 participants, allowing for adequate power and potential exclusions.

2.4 Data Collection

Data collection was conducted using a structured, interviewer-administered questionnaire that obtained information on socio-demographic characteristics (age, sex, education, occupation, marital status).

2.5 Sample Collection and Laboratory Analysis

Venous blood samples were obtained from each participant between 8:00 and 9:30 AM, following an overnight fast, to reduce the impact of diurnal fluctuations in cortisol secretion. Serum cortisol concentrations were determined using a commercially available enzyme-linked immunosorbent assay (ELISA) kit, in accordance with the manufacturer's instructions. The reference ranges applied were: Normal: 5–25 µg/dL, Hypocortisolaemia: <5 µg/dL, and Hypercortisolaemia: >25 µg/dL. All analyses were carried out in the Chemical Pathology Laboratory of UPTH under standard quality control protocols.

2.5.1 TB Severity Classification

The Bandim TB score as adapted from Rudolf et al[23] was used to classify tuberculosis severity using ten simple clinical indicators, producing a score from 0–10 that reflects systemic and pulmonary disease burden. Scores 0–5 indicate mild disease, 6–7 moderate disease, and 8–10 severe disease, with increasing values associated with greater inflammation, malnutrition, functional decline, and higher mortality risk during treatment.

2.6 Data Management and Statistical Analysis

Data entry was performed in Microsoft Excel and analysis was conducted using SPSS Statistics version 25 (IBM, USA). Descriptive statistics were applied to summarize demographic and clinical characteristics. Mean cortisol concentrations were compared between groups using independent t-tests or one-way ANOVA, while associations between categorical variables were assessed using chi-square or Fisher's exact tests. Multivariate logistic regression analysis was employed to determine independent predictors of abnormal cortisol levels. Statistical significance was set at $p < 0.05$.

2.7 Ethical Considerations

Ethical approval for the study was obtained from the Health Research Ethics Committee of the University of Port Harcourt Teaching Hospital. Written informed consent was obtained from each participant after providing a detailed explanation of the study purpose, procedures, potential risks, and benefits. Data confidentiality was ensured through anonymization, and all participants with abnormal cortisol levels were referred to the endocrinology unit for further evaluation.

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3. RESULTS

Table 1 presents the background characteristics of the 171 TB patients enrolled. The majority were male (53.8%), while females comprised 46.2%. The predominant age group was 30–39 years (39.8%), followed by 18–29 years (27.5%). The mean age was 30.03 ± 8.89 years. A substantial proportion had tertiary education (64.3%), while 27.5% had secondary and 8.2% had only primary education. Most participants were married (59.1%) and a significant number were engaged in unskilled occupations (50.3%), with 36.8% in skilled/professional roles.

Table 1: Socio-demographic Characteristics of patients

Characteristics	Frequency (n = 171)	Percent (%)
Sex		
Male	92	53.8
Female	79	46.2
Age Bracket (in years)		
18 – 29	47	27.5
30 – 39	68	39.8
40 – 49	42	24.6
50 – 59	14	8.2
Mean age ± SD	30.03± 8.89	
Education level		
Primary	14	8.2
Secondary	47	27.5
Tertiary	110	64.3
Marital status		
Single	66	38.6
Married	101	59.1
Widow/widower	4	2.3
Occupation		
Skilled/professional	63	36.8
Unskilled	86	50.3
Others	22	12.9

The proportion of participants with high serum basal cortisol level and low serum basal cortisol levels constituted 4 (2.34%) and 7 (4.09%) of the sample population respectively with a mean serum cortisol level of 14.32 ± 6.87 as shown in table 2.

Table 2: Cortisol Level of study population

Characteristics	Frequency (n=171)	Percent (%)
Serum Cortisol		
Low Cortisol	7	4.09
Normal	160	93.57
High Cortisol	4	2.34
Mean Serum cortisol	14.32 ± 6.87	

Classification of TB severity by Bandim score identified 123 (71.9%) participants as having moderate and 28 (16.4%) as having severe disease as shown in Table 3.

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Table 3: TB Severity Staging (Bandim score)

Characteristics	Frequency (n=171)	Per cent (%)
Severity level		
Mild (SC I)	20	11.7
Moderate (SC 11)	123	71.9
Severe (SC 111)	28	16.4

SC 1- Severity class 1, SC 11- Severity class 11, SC 111- severity class 3

The association between serum cortisol and TB severity showed no significant difference in the proportion of persons with normal, high or low cortisol levels among persons with mild, moderate and severe TB as shown in Table 4.

Table 4: Association of serum cortisol with TB disease severity

Cortisol category	TB Disease severity			
	Mild n=20, (%)	Moderate n=123, (%)	Severe n=28,(%)	Fishers Exact (p-value)
Low	2(10.0)	5(4.1)	0(0.0)	0.30
Normal	16(80.0)	117(95.1)	27(96.4)	
High	2(10.0)	1(0.8)	1(3.6)	

4. DISCUSSION

The majority of the study participants had normal cortisol levels. This is similar to studies done by Barnes et al who also documented normal cortisol levels in the majority of his study participants.[8] The normal cortisol level seen in this study may be due to the fact that most of the participants had a short duration of TB implying that the TB infiltration to the adrenal gland was suboptimal therefore not able to cause any significant adrenocortical impairment by leaving sufficient adrenal tissue capable of sustaining basal cortisol secretion.[14] However, some of the participants in this study were seen with hypercortisolaemia. This was consistent with finding by Bozza et al[17] and Baker et al[18] who also documented increased cortisol levels in their study participants similar to those included in the current study. The increase in cortisol levels may be accounted for by the enlargement of the adrenal gland which characterises the active phase of TB disease. There is consequent increase in the secretion of cortisol by the adrenal gland and resultant development of reactionary hyperglycaemia.[24] The hypothalamic pituitary adrenal axis stimulation by cytokines may also result in an increased ACTH and cortisol secretion. With progression of the disease into the chronic phase, there is atrophy of the adrenal gland which characterises this phase of TB disease. This results in reduced secretion of cortisol from the atrophied gland leading to hypocortisolaemia.[14] This was seen in a small proportion of the study participants and was consistent with the findings by Odeniyi et al in Lagos.[14]

The relationship between serum cortisol and TB severity in this study reveals a significant association between serum cortisol and TB severity. The highest mean cortisol level was seen in patients with moderate TB disease (Bandim score SC 2). The level though high, was still within the normal range. Baker and colleagues demonstrated in their study the increased conversion of cortisone, an inactive metabolite, to cortisol in patients with PTB.[18] However, there was a decrease in cortisol levels as TB disease progressed to severe forms in this study. This may be accounted for by the atrophy of the adrenal gland seen in progressive TB disease leading to a decrease in cortisol secretion. This was consistent with findings by Odeniyi and his colleagues [14]who also documented adrenal insufficiency in persons diagnosed of tuberculosis not more than 6 months. There is thus, a negative correlation between serum cortisol and TB severity from this study. As the severity of TB disease increased, cortisol level decreased.

5. CONCLUSION

This study found that the majority of newly diagnosed pulmonary tuberculosis patients had normal serum cortisol levels, while a smaller proportion exhibited hypercortisolaemia and a very limited number demonstrated hypocortisolaemia. Although no statistically significant association was found between cortisol levels and TB severity classifications, the trend showed decreasing cortisol levels with increasing TB severity. These findings underscore the importance of endocrine assessment in TB patients and suggest that routine cortisol monitoring may aid in the identification of individuals at risk for adrenal insufficiency or stress-induced hyperglycaemia during TB progression.

REFERENCES

[1] World Health Organization. Global tuberculosis report 2023. Geneva: World Health Organization; 2023.

[2] Naggirinya AB, Mujugira A, Meya DB, Biraro IA, Mupere E, Worodria W, et al. Functional adrenal insufficiency among tuberculosis-human immunodeficiency virus co-infected patients: a cross-sectional study in Uganda. BMC Res Notes 2020;13(1):224.

[3] Parivakkam Mani A, Shanmugapriya K, Deepak Kanna K, Yadav S. Assessment of lipid profile in patients with pulmonary tuberculosis: an observational study. Cureus 2023;15(5): e39244.

[4] Kelestimur F. The endocrinology of adrenal tuberculosis: the effects of tuberculosis on the hypothalamo–pituitary–adrenocortical function. J Endocrinol Invest 2004;27(4):380–386.

[5] Díaz A, Bongiovanni B, D'Attilio L, Santucci N, Dídoli G, Fernández R del V, et al. The clinical recovery of tuberculosis patients undergoing specific treatment is associated with changes in the immune and neuroendocrine responses. Pathog Dis 2017;75(7)

[6] Kibirige D, Owarwo N, Kyazze AP, Morgan B, Olum R, Bongomin F, et al. Prevalence, clinical features, and predictors of adrenal insufficiency in adults with tuberculosis or HIV: a systematic review and meta-analysis. Open Forum Infect Dis 2024;11(4): ofae098.

[7] Laway BA, Khan I, Shah BA, Choh NA, Bhat MA, Shah ZA. Pattern of adrenal morphology and function in pulmonary tuberculosis: response to treatment with antitubercular therapy. Clin Endocrinol (Oxf) 2013;79(3):321–325.

[8] Barnes DJ, Naraqi S, Temu P, Turtle JR. Adrenal function in patients with active tuberculosis. Thorax 1989;44(5):422–424.

[9] Magee MJ, Salindri AD, Kyaw NTT, Auld SC, Haw JS, Umpierrez GE. Stress hyperglycemia in patients with tuberculosis disease: epidemiology and clinical implications. Curr Diab Rep 2018;18(9):71

[10] Kibirige D. Endocrine dysfunction among adult patients with tuberculosis: an African experience. Indian J Endocrinol Metab 2014;18(3):288–294.

[11] Cooper MS, Stewart PM. Corticosteroid insufficiency in acutely ill patients. N Engl J Med 2003;348(8):727–734.

[12] Odeniyi IA, Fasanmade OA, Ajala MO, Ohwovoriole AE. Adrenocortical function in Nigerian patients with pulmonary tuberculosis (PTB). Afr J Med Med Sci 2011;40(1):33–38.

[13] Mugusi F, Swai AB~~M~~, Turner SJ, Alberti KG~~MM~~, McLarty DG. Hypoadrenalism in patients with pulmonary tuberculosis in Tanzania: an undiagnosed complication? Trans R Soc Trop Med Hyg 1990;84(6):849–851.

[14] Sarin BC, Sibia K, Kukreja S. Study of adrenal function in patients with tuberculosis. Indian J Tuberc 2018;65(3):241–245.

[15] Bozza V, D'Attilio L, Didoli G, Santucci N, Nannini L, Bogue C, et al. The adrenal steroid response during tuberculosis and its effects on the mycobacterial-driven IFN-γ production of patients and their household contacts. Ann N Y Acad Sci 2009;1153:247–255.

[16] Baker RW, Walker BR, Shaw RJ, Honour JW, Jessop DS, Lightman SL, et al. Increased cortisol: cortisone ratio in acute pulmonary tuberculosis. Am J Respir Crit Care Med 2000;162(5):1641–1647.

[17] Post FA, Soule SG, Willcox PA, Levitt NS. The spectrum of endocrine dysfunction in active pulmonary tuberculosis. Clin Endocrinol (Oxf) 1994; 40(3):367–371.

[18] York EL, Enarson DA, Nobert EJ, Fanning FA, Sproule BJ. Adrenocortical function in patients investigated for active tuberculosis. Chest 1992;101(5):1338–1341.

[19] Neogi S, Mukhopadhyay P, Sarkar N, Datta PK, Basu M, Ghosh S. Overt and subclinical adrenal insufficiency in pulmonary tuberculosis. Endocr Pract 2021;27(6):601–606.

[20] Mabuza LH, Sarpong DF. Indicators of adrenal insufficiency in TB-suspect patients presenting with signs and symptoms of adrenal insufficiency at three South African hospitals in Pretoria. Open Public Health J 2020;13:178–187.

[21] Vinnard C, Blumberg EA. Endocrine and metabolic aspects of tuberculosis. Microbiol Spectr 2017;5(1): 10.1128/microbiolspec.tnmi7-0035-2016.

[22] Lawson L, Yassin MA, Thacher TD, Olatunji OO, Lawson JO, Akingbogun TI, et al.. Clinical presentation of adults with pulmonary tuberculosis with and without HIV infection in Nigeria. Scand J Infect Dis 2008;40(1):30-35.

[23] Rudolf F, Joaquim LC, Vieira C, Bjerregaard-Andersen M, Andersen A, Erlandsen M, Sodemann M, Andersen PL, Wejse C. The Bandim tuberculosis score: reliability and comparison with the Karnofsky performance score. Scand J Infect Dis 2013 ~~Apr~~;45(4):256-264.