ORIGINAL ARTICLE

Assessment of Handgrip Strength and Its Clinical and Hematological Correlates of Inflammation among Adults with Pulmonary Tuberculosis: A Cross-sectional Study from a Tertiary Care Center of Western India

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Abstract

Background: Pulmonary tuberculosis (TB) is a significant contributor to illness and chronic functional decline in developing countries. Although treated aggressively through powerful antibiotics, the after-effect of the disease and treatment often has a detrimental impact on overall health, especially muscle function of the person affected. This study aimed at assessing the handgrip strength and its association with common clinical and routine laboratory parameters tested.

Materials and methods: This was a cross-sectional study with a predetermined sample size of 72 participants. Sociodemographic data, symptoms, and complete blood chemistry (CBC) findings were noted. Handgrip strength was measured by a rather inexpensive and validated Camry handheld digital dynamometer, which determined handgrip strength in pounds after adjusting for the individual's age, sex, and weight.

Results: Among the total number of study subjects, 49% were females and 51% were males. Out of the total study population, 29 were newly diagnosed, while 43 were treated for the disease. Symptoms of the disease ($p < 0.001$) and poor clinical findings like tachycardia ($p < 0.001$), raised temperature ($p = 0.011$), low mid-arm circumference ($p < 0.05$), and abnormal chest auscultatory findings ($p = 0.002$) were reported more among newly diagnosed patients. There was no difference between handgrip strength or inflammatory indices among the two groups ($p > 0.05$). The respective calf circumference and monocyte count were significant factors determining handgrip strength.

Discussion: This study accounts for the introduction of a new concept of assessment of muscle function among patients and survivors of TB as an indicator of disease improvement and to prognosticate outcomes and quality of life.

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Introduction

Pulmonary tuberculosis (TB) has been proven to be a significant contributor to illness in low- and middle-income countries. With a steadily rising prevalence, India alone accounts for one-fifth of the global burden of this disease. Once afflicted, it is known to result in an alarming 27% mortality among those individuals without access to appropriate and timely medical care.[1] With the advent of the National Tuberculosis Elimination Program (NTEP), active case finding has been emphasized upon greatly with door-to-door surveillance, especially after the COVID-19 pandemic.[2] The introduction of the new and improved directly observed treatment under supervision (DOTS and DOTS plus) has also been instrumental in rendering the affected population sputum negative, thereby controlling the rising tide of resistant cases.[3]

Symptoms in pulmonary TB can be classified as constitutional (fever, weight loss, anorexia) and locoregional (cough, breathlessness, and hemoptysis), which predilect the affected individual to a chronic debilitating state.[4] One of the many chronic complications is that of sarcopenia.[5] Sarcopenia has also been proven to act as a predisposing factor to acquiring primary TB, producing reactivation of a latent infection, and easing systemic dissemination of the involved organism.[6]

Sarcopenia, or declining muscle function *per se*, is not commonly reported. This is primarily attributed to the fact that the predominant symptoms of disease are discerning enough to make the patient feel better upon their resolution, and additionally to the accompanying nutritional deficits either as a result of disease-induced anorexia or a chronically developed catabolic state. The Asian Working Group for Sarcopenia (AWGS) 2019 contends that diagnosing sarcopenia requires measurements of both muscle quality and quantity.[7]

The Asian Working Group for Sarcopenia 2019 recommends using either dual-energy X-ray absorptiometry (DEXA) or multifrequency bioelectrical impedance analysis (BIA), both height-adjusted, for measuring muscle mass in diagnosing sarcopenia.[8] In day-to-day practice within resource-limited settings, the use of calibrated anthropometry devices has also been recommended for the same.[9] The gold standard for measuring handgrip strength is the JAMAR® hydraulic hand dynamometer (model J00105, Lafayette Instrument Company, United States of America). Although sensitive, financial constraints often restrict its utility to certain research facilities.[10] This study was conducted using the relatively inexpensive Camry digital handgrip dynamometer (model EH101, Zhongshan Camry Electronic Co., Ltd., China), which has been validated for its use in clinical settings.[11,12]

Circulating markers of sarcopenia have also been reviewed extensively. Sarcopenic patients, on average, have a high blood ratio of oxidized to reduced glutathione, accumulation of protein adducts, and an exaggerated innate immune response compared to their age-matched nonsarcopenic counterparts.[13]

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The detection of these markers, including erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), although accurate, is dependent on advanced instrumentation and molecular techniques, thereby limiting their utility in daily practice. In a country like India, with a majority of patients having economic hardships, these ancillary diagnostics deter the patient's will to receive any treatment at all. Complete blood chemistry (CBC)–derived inflammatory markers like neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), systemic inflammatory immune index (SIII), systemic inflammatory response index (SIRI), and monocyte-to-lymphocyte ratio (MLR) have proven association with poor outcomes in hospitalized patients.[14] Among individuals with solid organ malignancies, high levels of MLR and SIII are significant prognostic markers.[15] The calculation of these indices is simple, quick, and well suited for busy outpatient settings as is the case in most regions of India.

Literature pertaining to the clinical assessment of sarcopenia among individuals suffering from or treated for pulmonary TB in resource- and time-limited settings is deficient, especially in India,[3] a country where the prevalence of the disease is high (24,22,000 persons affected annually).

This study aims to assess handgrip strength as a marker of muscle function and a component of sarcopenia among TB patients. It also aims to utilize commonly prescribed tests such as CBC to derive inflammatory markers along with clinical parameters and study their relation to handgrip strength among both newly diagnosed as well as treated pulmonary TB patients.

Materials and Methods

This was a cross-sectional study conducted at a single tertiary care center, Smt Kashibai Navale Medical College and General Hospital, Pune, Maharashtra, India, within the period of 1 year (December 2022–December 2023). Written informed consent was obtained from the patients in their vernacular language. Ethical approval was obtained from the Institutional Ethics Committee of Smt Kashibai Navale Medical College prior to commencement of the study (approval number: SKNMC/Ethics/App/2022/863).

Sample Size Determination

The sample size required to run a linear regression analysis to predict handgrip strength (continuous) with the hematological parameters of inflammation (SIII, SIRI, NLR, PLR, MLR) (continuous) with four adjusting variables was 72 patients. The alpha error rate assumed is 5%, with a power of 90%. This sample size is calculated to detect a moderate coefficient of determination for the entire model ($R^2 = 0.2$, Cohen's $f^2 = 0.25$).[16,17]

Patient Recruitment

The following patients were included:

- Patients 18–65 years of age, in the outpatient department or admitted to the inpatient department of the Department of Respiratory Medicine, Smt Kashibai Navale Medical College and General Hospital.
- Patients diagnosed with pulmonary or extrapulmonary primary TB by GeneXpert and confirmed by culture of samples.

The following patients were excluded:

- Secondary or reactivated TB.
- Skeletal and articular TB.
- Tuberculous meningitis or neural TB.
- Critically ill patients.
- Active or prior HIV infection.
- Active ischemic heart disease.
- Clinical evidence of heart failure.
- Clinical evidence of liver cirrhosis.
- Severe chronic obstructive pulmonary disease (FEV_1 <70%).
- Active malignancy with concurrent chemotherapy.
- Neuromuscular disorders.
- Thyroid disorders.
- Uncontrolled diabetes mellitus (HbA1c >7%).
- Psychiatric illnesses incapacitating the patient' ability to provide consent or perform the required tests.

Data Collection

Data was collected as follows:

- Demography and preliminary details.
- Age in years, outpatient or inpatient ID, sex, education, and occupation were documented.

History and Physical Examination

Symptoms and their duration, history of substance abuse, and comorbidities. Body mass index (BMI) was calculated as weight in kg/height in m^2, and additional components of the modified Bandim TB score.

- Axillary temperature, measured with a digital thermometer in a dry portion of the axilla.
- Anemic conjunctiva, assessed at the lower palpebral conjunctiva in daylight.
- Tachycardia (>90 beats per minute), assessed manually and digitally on a monitor with chest leads connected.
- Abnormal lung auscultatory findings, examined by a senior pulmonologist, lung fields auscultated anteriorly (supraclavicular, supramammary, mammary, axillary, and infraaxillary regions) and posteriorly (suprascapular, scapular, interscapular, and infrascapular regions).
- Mid-upper arm circumference (MUAC) in centimeters, measured using an elastic measuring tape at the midpoint of an imaginary line joining the acromion of the scapula to the olecranon process of the ulna. Calf circumference was documented in cm using an elastic measuring tape at the widest portion of the calf with the lower limb muscles relaxed.
- Details of treatment were noted with respect to the regimen being used for treatment (drug-sensitive or drug-resistant TB therapy).

Nutritional Assessment

A standardized questionnaire, Mini Nutritional Assessment short-form (MNA-SF), was utilized to objectively assess nutritional status.[18]

Grip Strength

Upper arm grip strength was measured with the patient sitting upright comfortably on a chair or the bed, the arm to be assessed held at 90° flexion at the elbow joint. A smooth but firm grip was used to squeeze the bar as much as possible and release. The reading was noted, and the process was repeated twice to obtain an average of three readings. Based upon the chart provided along with the dynamometer, the grip strength was classified as weak or normal for age, sex, and weight.

Hematological indices of inflammation were calculated as follows:

Systemic Inflammatory Immune Index = Neutrophil lymphocyte ratio × Platelet Count (10^9/L)/Lymphocyte Count (10^9/L)

Systemic Inflammatory Response Index = Neutrophil lymphocyte ratio × Monocyte Count (10^9/L)/Lymphocyte Count (10^9/L)

Statistical Analysis

Continuous data were summarized as medians (interquartile ranges), while categorical data were summarized as frequencies (percentages). Continuous data were assessed for normality by visualizing histograms and Q–Q plots. Evaluation of the association between two categorical variables was performed using Pearson's Chi-squared test or Fisher's exact test as appropriate,

and between two continuous variables was performed using Spearman's rank correlation test. Evaluation of the difference between two continuous groups was performed using the Wilcoxon rank-sum test.

Results

Among the total number of study subjects (n = 72), 49% were females (n = 35), and 51% were males (n = 37). The study population was stratified into two groups based on treatment status (treated vs newly diagnosed), and both groups were age-matched. Sociodemographic features are mentioned in Table 1.

Table 1: Sociodemographic characteristics of the study participants

Characteristic	*No. of patients*
Education	
Literate	69 (95.8%)
Illiterate	3 (4.2%)
Occupation	
Employed	44 (61%)
Unemployed	28 (39%)
Comorbidities	
Yes	17 (23.6%)
No	55 (76.4%)
Diabetes mellitus	6 (8.3%)
Hypertension	7 (9.7%)
Thyroid disorders	4 (5.6%)
History of OR active substance use	
Yes	28 (39%)
No	44 (61%)
Type of substance used	
Alcohol	8 (11.1%)
Tobacco chewing	13 (18.2%)
Tobacco smoking	7 (9.7%)

Number of patient, N = 72

Table 2 summarizes the findings on history which were assessed. Symptoms of the disease were reported more frequently among the newly diagnosed patients (p < 0.001). Fever, cough, fatigue, night sweats, and fluctuation in body weight were documented more among newly diagnosed patients as opposed to treated patients (p < 0.001), along with the alarming symptom of hemoptysis, which followed a similar trend (p = 0.036). Figure 1 provides a pictorial representation of the symptoms among the two groups.

On physical examination, a lower value of MUAC (right arm, p = 0.024; left arm, p = 0.020), an increased body temperature (p = 0.011), tachycardia (p < 0.001), and abnormal lung auscultation findings (p = 0.002) were reported among the group of participants who were newly diagnosed (Table 3). A similar observation was made with the nutritional assessment scores (p < 0.0001), with lower mean scores obtained by newly diagnosed patients. The majority of the study participants were right-handed (91.6%). Among these, 96.6% of newly diagnosed patients (n = 28) and 83.7% of treated patients (n = 36) had a weak grip strength in their right hand (p = 0.089), while 89.7% of newly diagnosed patients (n = 26) and 72.1% of treated patients (n = 31) had a weak grip strength in their left hand (p = 0.072). The dominant handgrip strength, however, did not differ significantly between the two groups (p > 0.9).

Table 4 describes the various laboratory hematological parameters among the two groups, wherein the red cell distribution width (RDW) was significantly higher among the treated group (p = 0.044) as compared to that of the newly diagnosed patients. The value of the SIII, although higher in the newly diagnosed patient group, was not statistically significant (p = 0.3). The NLR and the PLR showed similar statistical trends among the two groups.

Assessment of clinicohematological correlates of handgrip strength (Table 5) showed bilateral calf circumference values (p = 0.000), MUAC of the right arm (p = 0.009), and MUAC of the left arm (p = 0.012) to have a positive association. The presence of anemia also correlated similarly with handgrip strength (p = 0.021).

A robust linear regression model was utilized to ascertain the risk factors of poor handgrip strength. The association between the inflammatory parameter SIII and dominant handgrip strength (Fig. 2), after adjusting for age, sex, BMI, and treatment status, was not significant (β = –0.22, 95% CI: –0.48 to 0.04, R^2 = 0.9769, p = 0.11). Conversely, a stepwise regression analysis performed revealed the respective calf circumference and monocyte count to be significant predictive factors of changes in the grip strength of the concerned hand (p = 0.000) (Table 6).

Discussion

The management of pulmonary TB is arduous and multifactorial, with a considerable degree

Table 2: Clinical findings among newly diagnosed and treated participants

Characteristic	*Total, (N = 72)*[1]	*Newly diagnosed, (N = 29)*[1]	*Treated, (N = 43)*[1]	*p-value*[2]
Height (cm)	158.0 (155.0, 160.5)	158.0 (156.0, 160.0)	158.5 (154.9, 161.1)	0.9
Body weight (kg)	60 (50, 68)	59 (55, 61)	61 (46, 70)	0.4
BMI (kg/m^2)	23.7 (21.1, 26.3)	23.7 (21.6, 25.0)	24.8 (19.5, 27.7)	0.3
Fever	42 (58%)	26 (90%)	16 (37%)	<0.001***
Cough	46 (64%)	28 (97%)	18 (42%)	<0.001***
Fatigue	49 (68%)	13 (45%)	36 (84%)	<0.001***
Anorexia	41 (57%)	13 (45%)	28 (65%)	0.088
Night sweats	32 (44%)	21 (72%)	11 (26%)	<0.001***
Chest pain	16 (22%)	7 (24%)	9 (21%)	0.7
Dyspnea	28 (39%)	10 (34%)	18 (42%)	0.5
Back pain	1 (1.4%)	0 (0%)	1 (2.3%)	>0.9
Hemoptysis	6 (8.3%)	5 (17%)	1 (2.3%)	0.036*
Total number of symptoms	3.00 (3.00, 4.00)	4.00 (4.00, 5.00)	3.00 (2.00, 3.50)	<0.001***
Duration of symptoms (weeks)	12 (8, 20)	16 (8, 20)	12 (7, 16)	0.5
Change in body weight (kg)	3.0 (–8.0, 6.0)	–9.0 (–10.0, –7.0)	5.0 (4.0, 7.0)	<0.001***

[1]Median (IQR), n (%); [2]Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test; *p < 0.05; ***p < 0.001

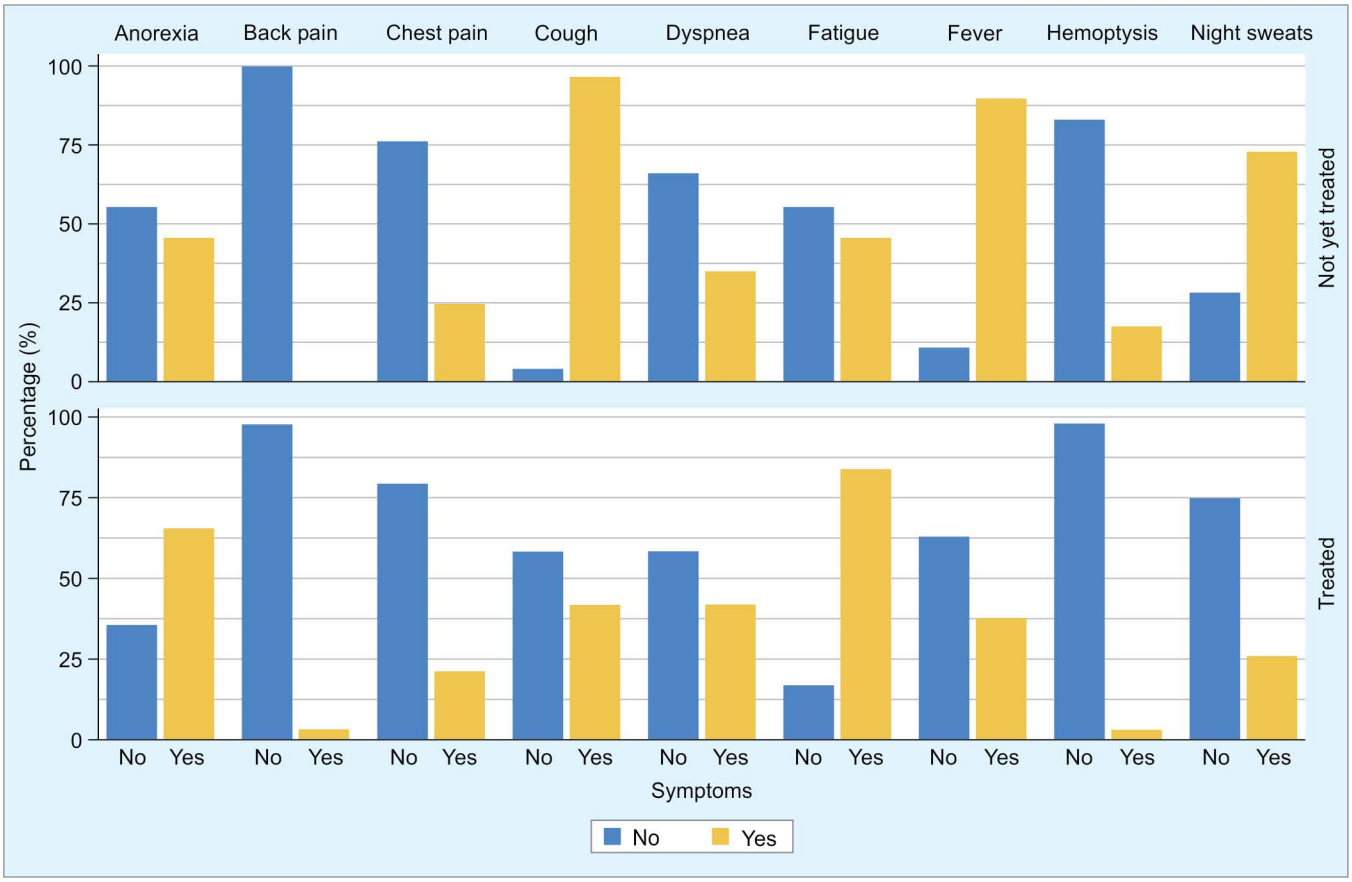

Fig. 1: Bar plot of symptoms among both newly diagnosed and treated individuals. The bar plot shows the prevalence of each symptom among the two groups, namely, the newly diagnosed and treated participants. A higher number of symptoms was noted among the newly diagnosed patients ($p < 0.001$)

Table 3: Physical examination findings among newly diagnosed and treated participants

Characteristic	*Total, (N = 72)*[1]	*Newly diagnosed, (N = 29)*[1]	*Treated, (N = 43)*[1]	*p-value*[2]
Dominant hand				
Left	7 (9.7%)	2 (6.9%)	5 (12%)	
Right	65 (90%)	27 (93%)	38 (88%)	
Grip strength in right hand	67 (42, 75)	70 (40, 75)	53 (43, 75)	0.563
Grip strength in left hand	65 (42, 77)	71 (42, 76)	51 (42, 77)	0.589
Grip strength in dominant hand	65 (42, 75)	71 (40, 75)	52 (42, 75)	>0.9
Calf circumference (right)	29.00 (26.93, 30.00)	28.40 (27.00, 30.00)	30.00 (26.85, 30.80)	0.3
Calf circumference (left)	29.05 (26.98, 30.05)	28.00 (27.00, 30.00)	29.60 (26.70, 30.85)	0.3
MUAC (right)	20.00 (18.93, 21.00)	19.30 (18.00, 20.00)	20.00 (19.55, 21.30)	0.024*
MUAC (left)	20.00 (18.90, 21.00)	19.00 (18.10, 20.30)	20.10 (19.20, 21.50)	0.020*
Tachycardia (>90 bpm)	45 (63%)	26 (90%)	19 (44%)	<0.001****
Lung auscultation				0.002**
Abnormal (crepts, wheeze, no sound)	34 (47%)	20 (69%)	14 (33%)	
Normal	38 (53%)	9 (31%)	29 (67%)	
Temperature (>37°C)	39 (54%)	21 (72%)	18 (42%)	0.011*

[1]Median (IQR), *n* (%); [2]Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test; *$p < 0.05$; **$p < 0.01$; ****$p < 0.0001$

of dependence upon patient compliance with therapy and nutritional rehabilitation. Although antitubercular therapy functions well to provide bacteriological clearance, the resultant disease process, as well as adverse effects of medications involved, lead to a state of persistent inflammation. Hence, despite complete clinicopathological or clinicoradiological cure, the physical state of the affected individual continues to deteriorate.[19]

The overall prevalence of weak dominant handgrip strength was 85.7% in males and 91.8% in females ($p = 0.238$). This finding was similar to that in the national cohort study conducted by Yang et al.[20] It was concluded in this 8-year longitudinal follow-up study that women were at 20% (age-adjusted OR = 1.20, 95% CI: 0.98–1.47) higher risk of developing sarcopenia than men. However, TB by itself predisposes

Table 4: Laboratory studies among newly diagnosed and treated participants

Characteristic	*Total, (N = 72)*[1]	*Newly diagnosed, (N = 29)*[1]	*Treated, (N = 43)*[1]	*p-value*[2]
Anemia (Hb)	62 (86%)	26 (90%)	36 (84%)	0.7
Neutrophil count (cells/mm^3)	5,456 (4,291, 6,515)	5,997 (4,480, 6,644)	5,132 (3,954, 6,352)	0.3
Lymphocyte count (cells/mm^3)	1,343 (932, 1,731)	1,160 (895, 1,653)	1,420 (953, 1,823)	0.5
Platelet count (cells/mm^3)	3,56,000 (2,99,650, 3,99,924)	3,45,000 (2,86,000, 3,68,000)	3,67,000 (3,03,000, 4,00,000)	0.12
Monocytes (cells/mm^3)	488 (329, 618)	489 (336, 624)	487 (328, 615)	0.7
RDW	17.00 (15.38, 18.53)	17.00 (14.00, 18.00)	17.80 (15.75, 19.00)	0.044*
BTB score	7.00 (6.25, 8.00)	7.00 (6.00, 8.00)	9.00 (9.00, 9.00)	0.2
Missing data	42	0	42	
SIII	1,451 (1,111, 1,864)	1,495 (1,316, 1,794)	1,346 (1,019, 1,913)	0.5
NPLR	0.026 (0.021, 0.036)	0.025 (0.022, 0.036)	0.026 (0.020, 0.035)	0.9
PLR	322 (216, 16,274)	299 (230, 471)	359 (209, 21,028)	0.4
NLR	4.06 (3.40, 5.35)	4.28 (3.55, 6.16)	3.84 (3.30, 4.79)	0.14
SIRI	13 (9, 17)	12 (9, 16)	14 (9, 17)	0.3

[1]Median (IQR), *n* (%); [2]Fisher's exact test; Wilcoxon rank sum exact test; Wilcoxon rank sum test; *$p < 0.05$

Table 5: Clinicohematological correlates of handgrip strength

		Handgrip strength (right)	*Handgrip strength (left)*
Calf circumference (right)	*r*	0.417**	0.434**
	p	0.000****	0.000****
Calf circumference (left)	*r*	0.403**	0.415**
	p	0.000****	0.000****
MUAC (right)	*r*	0.306**	0.309**
	p	0.009**	0.008**
MUAC (left)	*r*	0.288*	0.295*
	p	0.014*	0.012*
Neutrophil count in %	*r*	0.075	0.068
	p	0.534	0.572
Lymphocyte count in %	*r*	0.065	0.067
	p	0.588	0.577
Platelet count	*r*	–0.084	–0.059
	p	0.484	0.620
Monocyte count	*r*	0.180	0.192
	p	0.130	0.106
RDW	*r*	0.042	0.033
	p	0.728	0.785
SIII	*r*	–0.020	–0.009
	p	0.868	0.937
	N	72	72
SIRI	*r*	0.119	0.127
	p	0.318	0.288
PLR	*r*	-0.093	-0.079
	p	0.436	0.510
MLR	*r*	0.171	0.170
	p	0.151	0.155
NLR	*r*	0.053	0.043
	p	0.661	0.722

*$p < 0.05$; **$p < 0.01$; ****$p < 0.0001$

males to developing sarcopenia even after treatment (OR 3.44, 95% CI: 1.79–6.68), as shown by the derivations from the Korea National Health and Nutrition Examination Survey by Choi et al.[21]

Increased number of symptoms of both the disease and constitutional symptoms, with poor clinical examination findings, were also documented among the newly diagnosed patients in our study. Low BMI may be an innate host trait associated with TB infection and might also increase the risk of sarcopenia in the future.[22] In our study, we found BMI positively correlating with handgrip strength ($p = 0.007$) and low calf

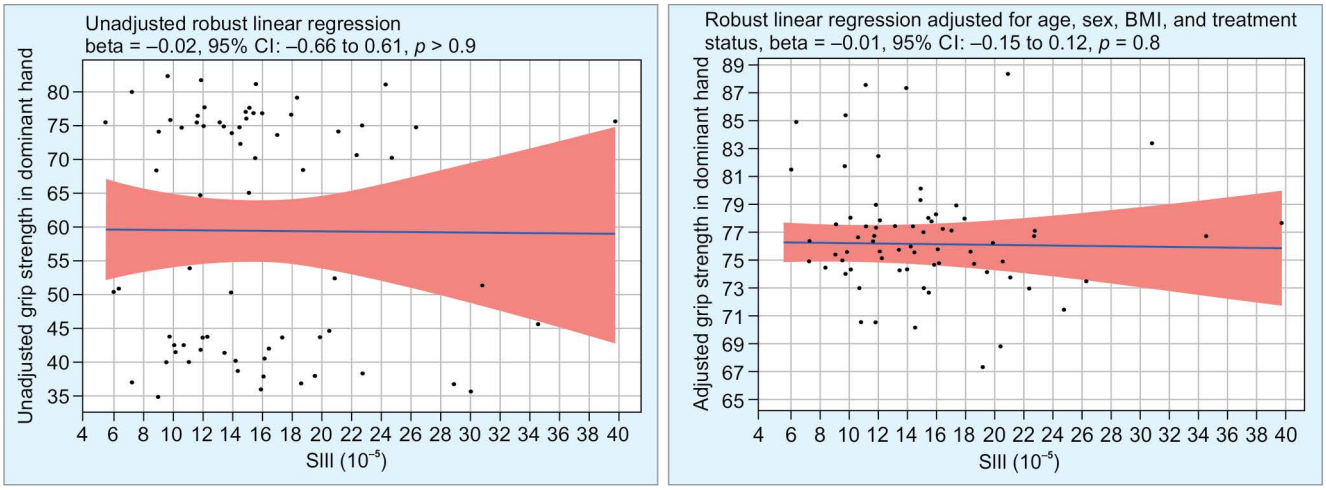

Fig. 2: Unadjusted and adjusted robust linear regression results for association of SIII with grip strength in dominant hand. The association between the inflammatory parameter SIII and dominant handgrip strength, after adjusting for age, sex, BMI, and treatment status, was not significant ($\beta = -0.22$, 95% CI: –0.48 to 0.04, $R^2 = 0.9769$, $p = 0.11$)

Table 6: Factors affecting handgrip strength

Model		*B*^	*Std error*^	*Beta*[I]	*t*	*Significance*	*R square*	*p-value*
Grip strength (in pounds) in left hand								
1	Constant	–1.367	16.111		–0.085	0.933	17.20%	0.000****
	Calf circumference (left)	2.126	0.557	0.415	3.818	0.000		
2	Constant	–26.035	17.468		–1.490	0.141	26.40%	0.000****
	Calf circumference (left)	2.516	0.545	0.491	4.613	0.000		
	Monocyte count	0.027	0.009	0.312	2.929	0.005		
Grip strength (in pounds) in right hand								
1	Constant	–0.580	15.747		–0.037	0.971	17.40%	0.000****
	Calf circumference (right)	2.091	0.545	0.417	3.837	0.000		
2	Constant	–23.298	17.101		–1.362	0.178	25.70%	0.000****
	Calf circumference (right)	2.451	0.536	0.489	4.573	0.000		
	Monocyte count	0.025	0.009	0.298	2.789	0.007		

^Unstandardized coefficients; [I]Standardized coefficients; ****$p < 0.0001$

circumference as a strong risk factor for developing poor handgrip strength.

Anemia is an ignored parameter by virtue of erythrocytosis being adversely affected by disease processes. In this study, we found anemia (hemoglobin value <9 gm/dL) correlating positively with mean grip strength in both hands (right hand: $p = 0.021$; left hand: $p = 0.025$) but did not differ significantly among newly diagnosed and treated patients ($p = 0.7$). This was similar to the findings in a nationwide cohort and cross-sectional study China Health and Retirement Longitudinal Study (CHARLS) conducted by Liu et al.[23] It was in this aforementioned study that it was determined that, on average, a per 1 gm/dL higher hemoglobin level was associated with 5% lower odds of sarcopenia (OR = 0.95, 95% CI: 0.90–0.9).

A significantly higher RDW was documented among treated patients ($p = 0.044$). RDW is a surrogate marker of inflammation, and inflammation is a factor that increases the heterogeneity in red cell size, such as the red blood cell circulation half-life and membrane deformability, and thereby the RDW.[24] This proves the persistence of residual inflammation even after treatment of the underlying disease, which further predisposes a decline in muscle function and leads to sarcopenia.

In the present study, we found comparable values of dominant handgrip strength among the treated as well as newly diagnosed groups of participants ($p > 0.9$). In a nationwide analysis of TB survivors, this is postulated to be a result of the fact that TB is a wasting disease.[21] Although patients report gain in weight during treatment, dynamic changes in body composition after treatment suggest that TB can lead to permanent loss of lean tissue and fat mass.[25] This can predispose these individuals to developing sarcopenia and the complications that follow.[26]

Analysis of a national health survey conducted by Guo et al.[27] found raised counts of neutrophils, monocytes, and total white cells to have a strong association with sarcopenia. Additionally, a strong association of sarcopenia with SIRI OR: 1.397 (1.188–1.645), SIII OR: 1.311 (1.122–1.533) was reported by this study. A similar observation was obtained in our study, in which a higher absolute monocyte count was derived as a strong risk factor for poor handgrip strength; however, SIII and SIRI did not exhibit an association pattern with handgrip strength.

Through these findings, our study highlights the importance of periodic clinical assessment of muscle function among patients with pulmonary TB as one of the possible ways to improve quality of life for both patients and survivors alike. Our study impresses upon

the utility of deriving data from tests that are routinely conducted among all patients, which is well suited for a vast majority of those from low-income backgrounds. As part of DOTS-plus, the personnel in charge of therapeutic supervision can be educated further about means of quality-of-life assessment, which can improve not only outcomes but also survival among these individuals.

A greater sample size, however, would have permitted the extrapolation of the results of this study to a wider population. The present study was cross-sectional in nature; a prospective design would have allowed better comparison and outcome assessment, given that muscle function and its decline are dynamic entities. Furthermore, assessment of physical performance would have provided a changed perspective on this concept.

Conclusion

Tuberculosis as a disease poses a great challenge to affected individuals, caregivers, and treating doctors alike. With widespread effects of the disease and intense treatment regimens, the definition of disease clearance often synonymizes with clinical improvement. India, a significant contributor to the global burden of the disease, finds itself deficient in documentation supporting outcome and quality assessment among afflicted persons and how it can improve the same. Poor muscle function, a component of sarcopenia, is known to worsen survival quality and outcomes if hospitalized among any individual, irrespective of the disease. Periodic examination of these factors with laboratory parameters already assessed can provide a time-efficient, cost-effective, and thorough insight into amenable variables and therefore alleviate patient care and life.

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