RELIABILITY AND VALIDITY OF TECUMSEH STEP TEST AMONG COPD PATIENTS:AN OBSERVATIONAL STUDY

By

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In

CARDIO-PULMONARY

Under the Guidance of

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled **"RELIABILITY AND VALIDITY OF TECUMSEH STEP TEST AMONG COPD PATIENTS:AN OBSERVATIONAL STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. PRIYADARSHINI MISHRA (PT), Associate Professor** and **Dr. JOYDIP SAHA (PT), Associate Professor, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha** and there is no conflict-of-interest associate with this dissertation work.

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This is to certify that the dissertation entitled: **"Reliability and Validity of Tecumseh Step Test among COPD patients: an Observational study"** carried out by Ms. **Kiranabala Palai**, bearing University Registration Number **23MP435001,** has been evaluated and accepted by me as an **Examiner / Evaluator**, appointed by the Odisha University of Health Sciences, Bhubaneswar, in partial fulfilment of the requirements for the award of the degree of **Master of Physiotherapy (MPT) in Cardio-pulmonary**.

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In conclusion, this dissertation stands as a testament to the collaborative efforts of the individuals mentioned above, and I am deeply grateful for their contributions to my academic success. Thank you.

Date: **Signature of the candidate**

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LIST OF ABBREVIATIONS USED

ATS	*American Thoracic Society*
BDS	*Borg Dyspnoea Scale*
BP	*Blood Pressure*
COPD	*Chronic Obstructive Pulmonary Disease*
HR	*Heart Rate*
ICC	*Intraclass Correlation Coefficient*
SEM	*Standard Error Of Mean*
SPO2	*Oxygen Saturation*
TST	*Tecumseh Step Test*

ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is an illness that is unable to give the exercise tolerance threshold and worsens the working capacity, which worsens the quality of life and day-to-day living. The functional assessment instruments (tested by 6MWT (six minutes walk test)) and Cardiopulmonary Exercise Testing (CPET) are resource-consuming, and as such, they are also determined to be reliable. The Tecumseh Step Test (TST) is not technical, rapid, and identifies with the machines, albeit in a small respect, yet the reliability and validity have not been obtained to the patients with COPD.

Methods : Observational research study used the patients of COPD that were in a clinically stable and was recruited with the help of purposive sampling. In participants (n= 299), the TST (20 cm step, 24 steps/ min, 3 minutes) had been administered. The HR, SP 02 and perceived exertion were measured. The inter-ratio was also established as inter-rater and intra ratio in which there was re-administration of with a time delay of 24-48 hours. The concurrent validity of TST test was done through the results of 6MWT. The statistical procedures used were ICC, SEM, MDC95 and Pearson correlation.

Results: Inter-rater, intra-rater reliability with HR and recovery respectively were good and excellent (ICC > 0.80). It was revealed that the responses of TST i.e. recovery HR and number of steps were significantly positively correlated with 6MWD ($p < 0.001$) which constituted concurrent validity.

Conclusion: TST is an acceptable and relevant assessment of utility in patients with COPD. The results obtained below justify that TST is simple to apply, repeat and possess low requirements in terms of number of resources needd to implement it in the community

and the clinic.

Keywords: COPD; Tecumseh Step Test; Reliability; Validity; Six-Minute Walk Test

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INTRODUCTION

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a significant health burden worldwide, being the third leading cause of premature death and responsible for millions of deaths annually [1]. COPD also imposes a substantial disability, hospitalization, and financial burden. One of the most common aspects of the disease is irreversible airflow limitation and gradual deterioration of respiratory balance, making it a priority medical and socioeconomic problem [2]. The most debilitating effect of COPD is exercise intolerance, which limits daily activities and progressively reduces independence and quality of life [3]. Patients often exhibit dyspnea, muscle weakness, and endurance deficits, which contribute to sedentary behavior [4].

Reduced mobility leads to declining cardiorespiratory fitness and a chain of worsening symptoms and functional limitations [5]. Hence, proper assessment of functional exercise capacity has become central to COPD management, pulmonary rehabilitation, and clinical trial evaluation [6]. However, conventional exercise tests have disadvantages limiting their real-world applicability. Laboratory-based tests such as Cardiopulmonary Exercise Testing (CPET) are resource-intensive, time-consuming, and require specialized personnel [7]. Field tests such as the Six-Minute Walk Test (6MWT) and Incremental Shuttle Walk Test (ISWT) are widely used but still demand time, space, and patient effort [8].

Step tests, in which patients repeatedly step on and off a platform for a set time, are emerging as practical alternatives. They are brief, require minimal equipment, and can be conducted in nearly any clinical or community setting [9]. Among them, the Tecumseh Step Test (TST) is noteworthy as a standardized submaximal test [10]. Although applied in other populations, its use in COPD remains underexplored. Establishing the reliability

and validity of the TST could provide clinicians with a simple tool for assessing functional exercise capacity in this high-risk group [11].

COPD is defined as a chronic, progressive disease with airflow limitation that is not fully reversible, encompassing chronic bronchitis and emphysema [12]. Its main cause is long-term exposure to harmful gases and particles, particularly cigarette smoke, although other factors such as air pollution, occupational dust, infections, and genetic predisposition also play roles [13]. Pathophysiological changes include chronic inflammation, airway remodeling, mucus hypersecretion, loss of elastic recoil, and alveolar destruction, leading to gas trapping, ventilation–perfusion mismatch, and impaired oxygen exchange [14]. Systemic effects such as skeletal muscle dysfunction, cardiovascular complications, osteoporosis, and weight loss further reduce exercise tolerance [15].

The GOLD classification provides a standardized approach for staging COPD severity based on spirometry, symptoms, and exacerbation history [16]. However, spirometry alone does not fully capture the impact of COPD on functional ability. Functional exercise capacity measures therefore offer complementary insight into prognosis, quality of life, and treatment effectiveness [17].

Although CPET is the gold standard for maximal exercise capacity, its complexity and cost limit routine use [18]. Simpler field tests such as the 6MWT [19] and ISWT [20] are more feasible but still require space and effort that may not be available to advanced COPD patients or resource-limited facilities. These limitations have encouraged the use of alternative methods such as step tests [21].

Several step test protocols exist: the Harvard Step Test (20-inch step for up to five minutes), the Chester Step Test (progressive multistage VO_2 prediction test), and the Tecumseh Step

Test (20.3 cm step, 24 steps per minute for three minutes) [22]. Step tests require little space or equipment, are quick to administer, and are suitable for repeated measures in clinical practice [23]. Despite these advantages, their application in COPD remains limited, largely due to a lack of validation studies [24].

The Tecumseh Step Test, developed during the Tecumseh Community Health Study, offers a standardized and rapid evaluation of cardiovascular fitness [24]. It is particularly suitable for COPD patients because of its brevity, low exertion demands, minimal equipment, and applicability in community or low-resource settings [24]. However, evidence on its reliability (consistency across repeated sessions) and validity (accuracy compared to accepted measures) in COPD populations is lacking [24].

Given the need for accessible and practical tools, the TST is a promising option for assessing functional exercise capacity in COPD [24]. Its psychometric properties, however, must be established before it can be confidently rcommended. This knowledge gap forms the basis of the present study, which aims to evaluate the reliability and validity of the TST in COPD patients. If proven effective, the TST may serve as a cost-effective alternative to resource-intensive field and laboratory tests, thereby improving access to functional assessment in both community and clinical settings [24].

NEED OF THE STUDY

As per previous research Tecumseh is a reliable and valid test to measure cardiovascular fitness among normal population but no study available which shows reliability and validity among COPD patient. Therefore need is there to find reliability and validity of Tecumseh test among COPD patient.

AIM AND OBJECTIVE

AIM OF THE STUDY

1. To find out reliability and validity of Tecumseh test among COPD patient.

OBJECTIVE OF THE STUDY

1. To assess the reliability and validity of the Tecumseh step test as a measurement tool for cardiovascular fitness in COPD patient ,to find out the inter-rater and intra-rater reliability and concurrent validity.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

1. **1n the current review we provide a brief overview of key pathophysiological mechanisms, which may help explain comorbid COPD and CVD and inform the rationale for treatment.**

   Klaus F. Rabe, John R. Hurst:2018, COPD and CVD are complex disorders that frequently co- exist and are associated with worse outcomes than either condition alone. Potential mechanisms have been discussed whereby COPD and CVD may interact and treatments for COPD may help to reduce the risk of CVD.

2. **Recognizing and treating COPD in patients with CVDs is important because optimal treatment of the COPD carries important benefits on cardiovascular outcomes.**

   Alvar Agusti1 , Michael Böhm:6 May 2023, COPD is the elephant in the room for many patients with CVDs. It is a prevalent, preventable, and treatable condition, but most often it has not been diagnosed and, hence, not treated appropriately.

3. **Maximum aerobic capacity (VO2max) is associated with lower cardiovascular and total mortality. Step tests can be used to provide an estimate of (VO2max) in epidemiological or home-based studies. We compared different methods of estimation of VO2- max and heart rate recovery and evaluated the relationship of these estimates with cardiovascular risk factor. Alun D. Hughes*, Nish Chaturvedi,21 February 2017**

   Tecumseh step test can be used to provide valid estimates of VO2max using at least two equations, and can be used to measure heart rate recovery. Estimated VO2max was inversely associated with higher systolic BP, higher BMI and worse glucose tolerance. Measurement of heart rate recovery over the first 30 s and the time constant calculated over

the entire first 3 min of recovery correlate most closely with CVD risk factors and are therefore the preferred outcome measure of this test.

4. **Define early COPD as ever-smokers (⩾10 pack-years), aged <50 years and with abnormalities like 1) FEV1/FVC less than the lower limit of normal 2) compatible abnormalities on CT 3) FEV1 decline (⩾60 mL per year)**

   Joan B. Soriano, Francesca Polverino :2018, This study suggests that early COPD is associated with poor clinical outcomes and it makes sense to think that early detection, diagnosis and maintenance treatment of COPD, alongside smoking cessation and exercise, may help to provide the best symptom control, disease progression and outcomes in COPD.

5. **Effect of pulmonary rehabilitation programme including either O2 inhalation or noninvasive ventilation in patients with chronic obstructive pulmonary disease, 2023, Elmorshidy BES et al**

   This prospective randomized study investigated the effects of pulmonary rehabilitation (PR) alone versus PR with supplemental oxygen or noninvasive ventilation (NIV) in 75 severe to very severe COPD patients. The study found that all groups showed meaningful improvement compared to baseline. However, the NIV group showed significantly higher improvements in VO2 max compared to both other groups. The 6-minute walk test results were significantly better in both oxygen and NIV groups compared to PR alone. The study concluded that O2 supplementation and NIV help severe to very severe COPD patients perform higher exercise intensity and augment the benefits of pulmonary rehabilitation.

6. **A new equation based on the 6-min walking test to predict VO2peak in women with obesity, 2017, Metz L et al.**

This study investigated the relationship between the 6-minute walking test (6 MWT) and objectively measured VO2peak in 137 obese women (BMI 37.6±4.87 kg/m²) admitted for a multidisciplinary rehabilitation program. The research found a significant linear relation between VO2peak and the distance covered during the 6 MWT ($p<0.001$; $r=0.349$). The study developed a prediction equation: VO2peak (l/min) = (BMI×-0.0150065) -(waist-to-hip-ratio ×0.8595088) + (fat-free-mass ×0.0295478) + (6-min walk test ×0.0020672) -0.5853372. The authors concluded that the 6-minute walk test is a reliable method to reflect obese women's aerobic capacities and the distance covered can be used to accurately estimate VO2peak.

7. **Evaluation of fitness for work in a Case with COPD**, **2021, Demirci Atik M et al.**

   This case study presented a 39-year-old male with COPD working at a rim factory who underwent cardiopulmonary exercise testing and work analysis for fitness evaluation. The study found that the energy requirement of his work (11.6 ml/min/kg) exceeded his acceptable limit value (7.8 ml/min/kg, calculated as 34% of his VO2max of 19.5 ml/min/kg). The case was classified as GOLD B based on mMRC group 2 dyspnea score and no exacerbations in the past year. The study emphasized the importance of multidisciplinary collaboration in work compatibility evaluation for COPD patients, recommending job modifications to suit the patient's cardiopulmonary capacity and reduce identified environmental risks.

8. **Change of VO2 max and muscle mass after one-month and two-month upper and lower body exercises in stable chronic obstructive pulmonary disease, 2025, Tarigan AP et al.**

   This prospective study examined the effects of one-month and two-month upper and lower

body exercises on VO2 max and muscle mass in 25 stable COPD patients. The study found significant improvements in VO2 max after both one month (21.0 to 21.3) and two months (21.0 to 23.0) of exercise, with statistical significance only achieved after two months ($p<0.001$). Muscle mass also showed improvement with longer exercise duration. The study concluded that combining endurance training of upper and lower limb exercises provides better improvement in VO2 max for COPD patients, with longer exercise durations being more beneficial than shorter ones.

9. **Optimal Intensity of Aerobic Exercise Training for Patient With Chronic Obstructive Pulmonary Disease (COPD): Systematic Review and Meta-Analysis**, 2023, Ibrahim CJ et al.

   This systematic review and meta-analysis analyzed four studies with 472 COPD patients to compare different intensities of aerobic training. The primary outcomes included disease-specific health-related quality of life, activities of daily living, functional exercise capacity, and dyspnea symptoms. The study found a significant difference only in St George's Respiratory Questionnaire symptoms domain favoring lower intensity training (MD=5.53; 95% CI=1.08-9.97). No other significant results were found for any other outcomes. The authors concluded that evidence comparing higher versus lower intensity aerobic training in COPD patients is very limited and of very low to moderate quality, requiring further research.

10. **Effect of Breather Trainer Versus Pulmonary Rehabilitation on Cardiopulmonary Efficiency in Patients with COPD Post Covid-19, 2024, El-Sayed ERA et al.**

    This randomized controlled study compared the effects of combining breather respiratory muscle trainer with traditional pulmonary rehabilitation versus traditional pulmonary

rehabilitation alone in 80 COPD patients with post-COVID-19 pneumonia. Group A (breather trainer plus traditional PR) showed significantly greater improvements than Group B (traditional PR only) in FEV1 (25.18% vs 16.73%), FVC (12.24% vs 8.70%), FEV1/FVC (11.69% vs 7.50%), MVV (25.26% vs 16.93%), oxygen saturation (5.57% vs 5.23%), and rate pressure product (26.47% vs 25.25%) after 12 weeks of treatment. The study concluded that combining breather respiratory muscle trainer with traditional pulmonary rehabilitation may be more advantageous for managing symptoms and enhancing quality of life in COPD patients with post-COVID-19 syndrome

11. **Particular Aspects of Respiratory Rehabilitation in Patients with COPD**, **2024, Petrescu et. Al.**

    This review article discussed the comprehensive approach to pulmonary rehabilitation in COPD patients, emphasizing the need for individualized therapeutic intervention programs. The author highlighted that COPD patients often have multiple comorbidities including cardiovascular pathology, metabolic syndrome (present in about 50% of patients), lung cancer, osteoporosis, and musculoskeletal dysfunctions. The review emphasized the importance of cardiopulmonary exercise testing (CPET) as the 'golden standard' for exercise assessment, providing specific parameters like VO2max, ventilatory threshold, and ventilatory efficiency. The article concluded that pulmonary rehabilitation reduces symptoms, increases effort tolerance, improves survival rate, decreases exacerbation frequency, and contributes to better quality of life and patient autonomy.

12. **The one-minute sit-to-stand test: A practical tool for assessing functional exercise capacity in patients with COPD in routine clinical practice**, 2024, Mellaerts P et al.

    This retrospective study evaluated the test-retest reliability, construct validity, and

responsiveness of the one-minute sit-to-stand test (1'STST) in 45 COPD patients undergoing pulmonary rehabilitation. The 1'STST demonstrated good reliability (ICC = 0.79) and moderate correlations with 6MWT (r = 0.57), VO2max (r = 0.50), and maximal work rate (r = 0.52). After three months of pulmonary rehabilitation, the 1'STST improved significantly ($\Delta = 3.6 \pm 6.4$ repetitions, p = .0013) with changes correlating moderately with changes in 6MWT (r = 0.57), quadriceps force (r = 0.48), and VO2max (r = 0.41). A cut-off of three repetitions demonstrated 71% accuracy in identifying responders to rehabilitation programs. The authors concluded that the 1'STST is a valuable alternative to evaluate exercise capacity when more expensive and time-consuming tests are unavailable.

13. **StepTest4all: Improving the Prediction of Cardiovascular Capacity Assessment in Young Healthy Adults, 2024, Sampaio TP et al.**
This dissertation combined a comprehensive bibliometric review and an experimental study to enhance step test protocols for estimating VO2max in healthy young adults. The first phase analyzed 228 studies and revealed evolving global trends in step test research, with Brazil and the USA leading in output. The experimental phase assessed the StepTest4all protocol in 69 participants and introduced physical activity level as a new predictor variable, resulting in an improved regression model for VO2max (R^2=74%). The findings demonstrate that incorporating individual physical activity levels increases the precision of submaximal step-based VO2max assessments, offering a flexible, population-adaptable tool for evaluating cardiorespiratory fitness.

14. **Normative values and reference equation for the six-minute step test to evaluate functional exercise capacity: a multicenter study, 2022, Albuquerque VS et al.**
This multicenter cross-sectional study established normative values and reference

equations for the six-minute step test (6MST) in 468 healthy Brazilian adults. The 6MST demonstrated excellent test-retest reliability (ICC=0.96), and step count differences were significantly associated with age, sex, height, and weight, collectively explaining 42% of step test variability. Normative values were validated in an independent sample. The study concluded that 6MST is reliable, provides accessible assessment of functional exercise capacity, and that the reference equation enables more accurate interpretation of individual test outcomes in diverse clinical and community settings.

15. **Optimal assessment and management of chronic obstructive pulmonary disease (COPD), 1995, Siafakas NM et al.**
Produced by the European Respiratory Society Task Force, this consensus statement outlines evidence-based recommendations for diagnosing, assessing, and managing COPD. It emphasizes the importance of symptom assessment, lung function tests, comorbidity evaluation, and regular follow-up, advocating for multidisciplinary approaches. The statement acknowledges the irreversible nature of COPD but asserts that appropriate management—especially smoking cessation, tailored pharmacotherapy, and pulmonary rehabilitation—significantly improves both quality and length of life in affected patients. This document is foundational in shaping European COPD clinical guidelines.

16. **Effects of different exercise regimens on prognosis of patients with chronic obstructive pulmonary disease: a systematic reviews and meta-analysis, 2024, Zhang ZY & Li YH.**
This systematic review and meta-analysis synthesized ten randomized controlled trials to examine endurance, resistance, and combined training effects in 180 COPD patients. The pooled results demonstrated that all exercise modalities improved VO2max (SMD=0.40),

increased 6-minute walk testing distances, and enhanced lower limb strength (leg press). Quality of life improved significantly, as indicated by decreased COPD Assessment Test scores. The study underscores the value of individualized, multimodal exercise training to maximize physical function and well-being in COPD populations, although optimal protocols remain to be personalized.

17. **Measurement properties of step tests for exercise capacity in COPD: A systematic review, 2020, Vilarinho R et al.**

    This systematic review evaluated the validity, reliability, and responsiveness of eight distinct step test protocols in COPD patients, reviewing 31 studies. The overall methodological quality was “low” to “very low,” particularly due to small sample sizes and inadequate statistical methods, except for the six-minute Stepper Test, which achieved "high" construct validity and “moderate” criterion validity. The review suggests that, although step tests can be convenient functional assessments, most currently lack robust supporting evidence except for the 6-min Stepper Test, which is most appropriate for both hospital-based and community-based pulmonary rehabilitation settings.

18. **Smartphone-Based VO2max Measurement With Heart Snapshot in Clinical and Real-world Settings With a Diverse Population: Validation Study, 2021, Webster DE et al.**

    This validation study introduced a smartphone-based app for VO2max estimation using a 3-minute step test (3-MST) and a 12-minute run, leveraging phone sensors and camera-derived heart rate data. In controlled and home environments, the 3-MST protocol achieved a concordance of pc=0.61 with gold-standard treadmill VO2max and demonstrated strong reliability and robustness across device types, age groups, and skin tones. The research

supports remote, scalable cardiorespiratory fitness assessment, suggesting the digital step test can replace traditional supervised in-clinic protocols—enabling more frequent population-level cardiovascular health monitoring

METHODOLOGY AND PROCEDURE

METHODOLOGY AND PROCEDURE

After approval of IEC Committee. We identify eligible COPD patients using inclusion and exclusion criteria. Obtain informed consent from participants before testing. Record demographic and baseline health data (age, comorbidities, medication).Measure resting heart rate, blood pressure, and oxygen saturation using a pulse oximeter. Ensure participants are stable and able to perform the test .Instruct participants on how to perform the step test (12-inch step, timed intervals).Monitor the participant's heart rate, blood pressure, and oxygen saturation during and after the test. Record the number of steps completed within the set time frame (e.g., 3 minutes).After a set interval (e.g., 1 week), re-administer the Tecumseh Step Test to the same participants .Collect data on the second performance of the test. Simultaneously administer the 6-Minute Walk Test (6MWT) or other established test as a comparison. Record the results of the 6MWT (distance walked, oxygen levels, heart rate).

Standardization and Training

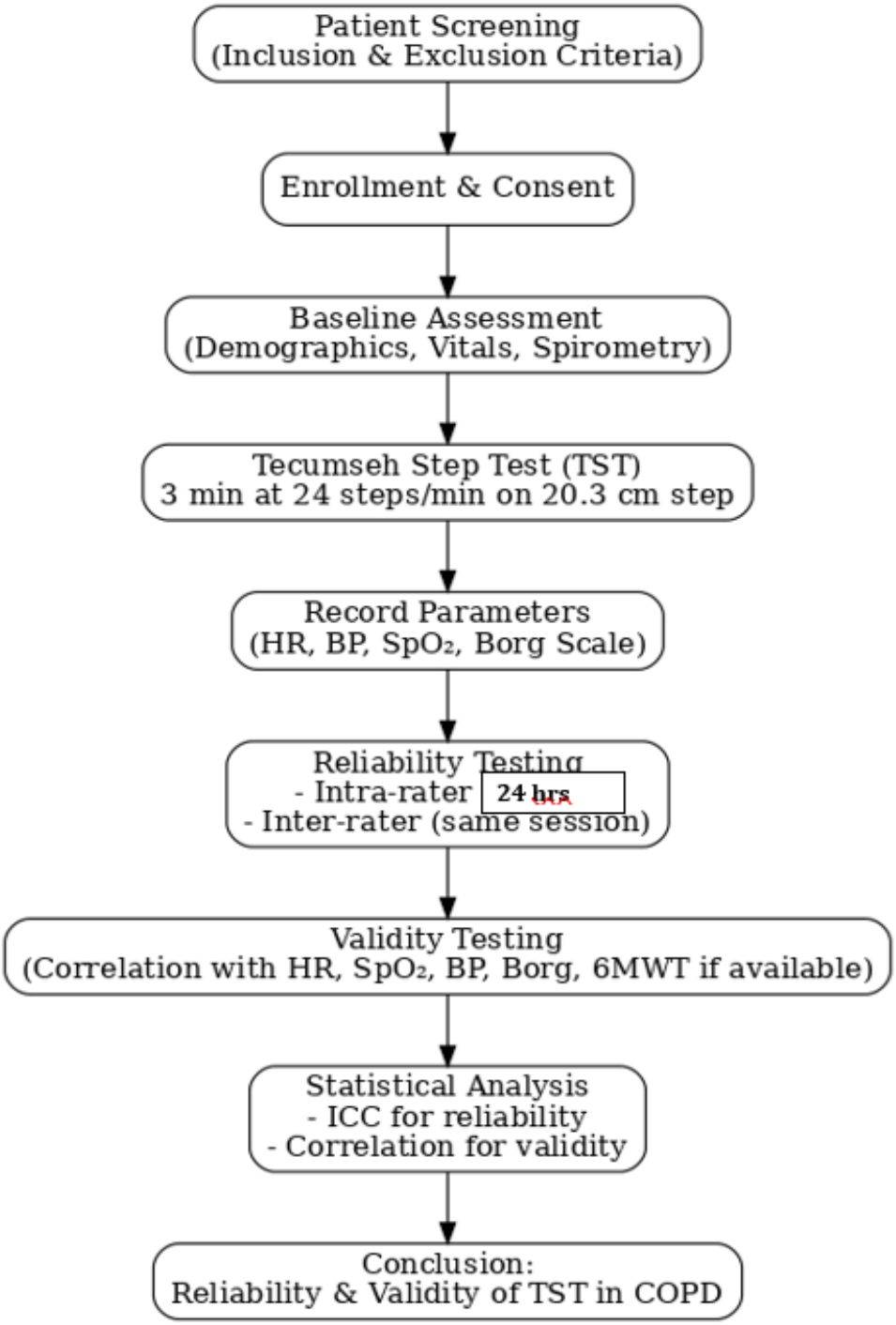
Two physiotherapists (Rater A and Rater B), both acted as independent raters. Both raters were trained with 10 practice TSTs on healthy volunteers and five on patients with COPD prior to collecting data to standardize the procedure. Written standard operating procedures (SOPs) were established and adhered to with discipline. Raters were blinded to the other's measurement, and data sheets were stored separately in order to reduce bias.

Tecumseh Step Test Protocol

- Step height: 20 cm (8 inches), standardized with the use of a fixed wooden platform.
- Cadence: 24 steps per minute sustained with the aid of a digital metronome.
- Lasting: 3 minutes of continuous stepping, except if test cessation criteria were met.

- Ahead of testing preparation: Participants avoided caffeine, alcohol, or strenuous physical exercise in the last two hours before testing. Resting heart rate, blood pressure, and SpO_2 were measured after 5 minutes of resting seated.
- Monitoring safety: Ongoing pulse oximetry and heart rate monitoring were used. Testing was stopped if participants had chest pain, severe dyspnea, dizziness, $SpO_2 < 80\%$, or abnormal cardiac arrhythmia.
- Recovery time: HR and SpO_2 were observed for a minimum of 5 minutes after the test or until readings normalized to near baseline.

PROTOCOL


Patient Screening
(Inclusion & Exclusion Criteria)
Enrollment & Consent
Baseline Assessment
(Demographics, Vitals, Spirometry)
Tecumseh Step Test (TST)
3 min at 24 steps/min on 20.3 cm step
Record Parameters
(HR, BP, SpO2, Borg Scale)
Reliability Testing
- Intra-rater 24 hrs
- Inter-rater (same session)
Validity Testing
(Correlation with HR, SpO2, BP, Borg, 6MWT if available)
Statistical Analysis
- ICC for reliability
- Correlation for validity
Conclusion:
Reliability & Validity of TST in COPD

Reliability Testing

Inter-Rater Reliability

Each participant completed the Tecumseh Step Test twice on the same day, supervised by both raters. The order of raters was randomized using a computer-generated sequence, and adequate rest at least 30 minutes or until vital signs returned to baseline— was provided between the two tests.

Intra-Rater Reliability

Rater A repeated the Tecumseh Step Test for each participant after 24–48 hours, ensuring that the patients remained clinically stable and experienced no exacerbations during the interval.

Concurrent Validity Testing

The 6MWT was conducted as per ATS guidelines. The test was performed along a 30- meter flat corridor, with standardized verbal encouragement provided at one-minute intervals. The participants were told to walk "as far as possible" for six minutes according to their own speed, with pauses allowed if required. Distance walked (6MWD) was measured in meters as the main comparator outcome. The 6MWT was performed on the same day that the TST was done, with at least 60 minutes of rest time in between the two tests to avoid fatigue or carryover. Order of test administration was randomized among participants.

Figure 2 Tecumseh step test

Figure 3: Tecumseh Step test

STATISTICAL ANALYSIS

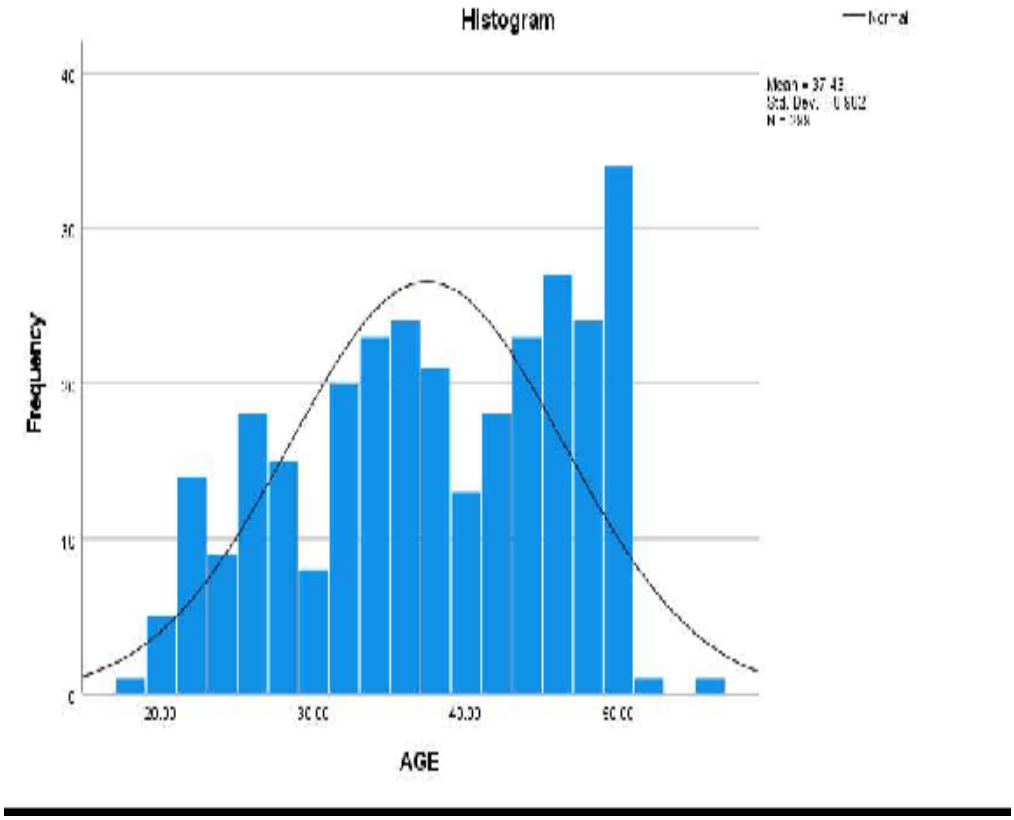
TEST OF NORMALITY-

(Table -1)

	MEDIAN	INTERQUARTER	Normality
AGE	38.0000	14.00	<0.01
HEIGHT	163.0000	9.00	<0.01
WEIGHT	69.0000	11.00	<0.01

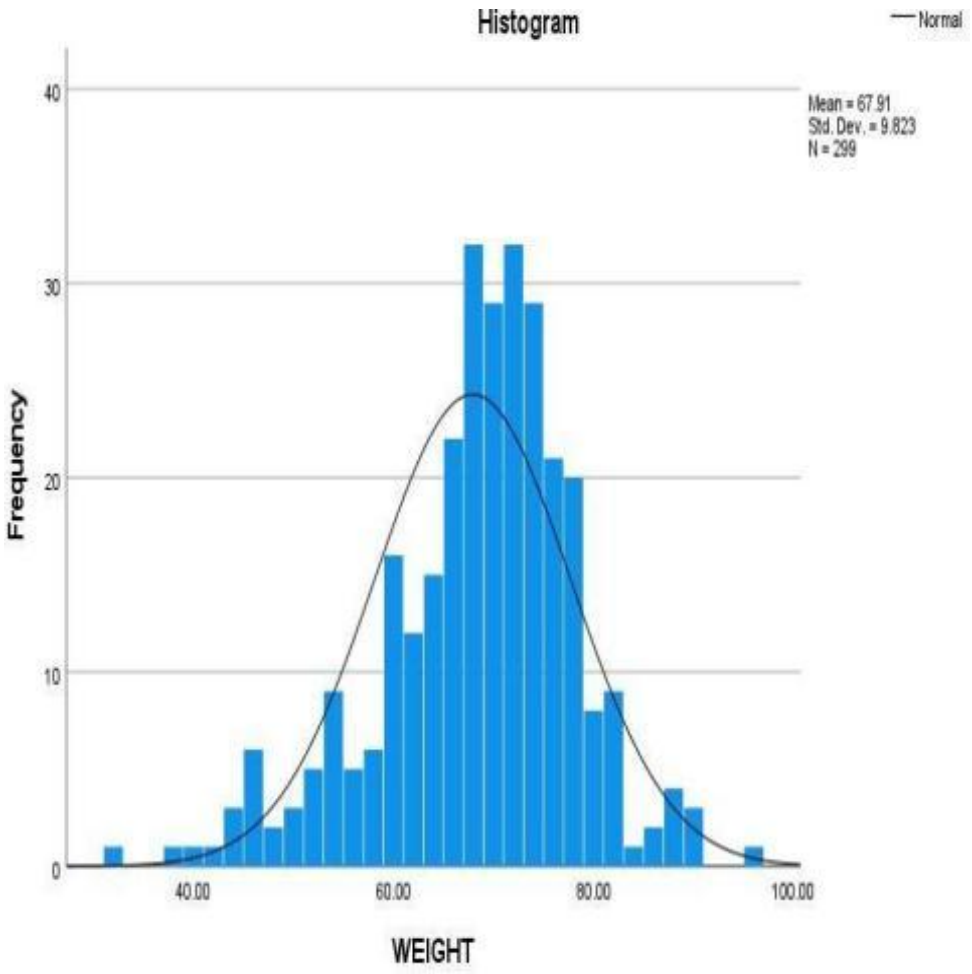
Interpretation – In this study demographic data was been taken as baseline data were age is having Median of 38.0 with inter-quarter range of 14 and for weight and height is 163, 69 respectively with inter-quarter range of 9 and 11. With data not normally distributed

(Graph-1)



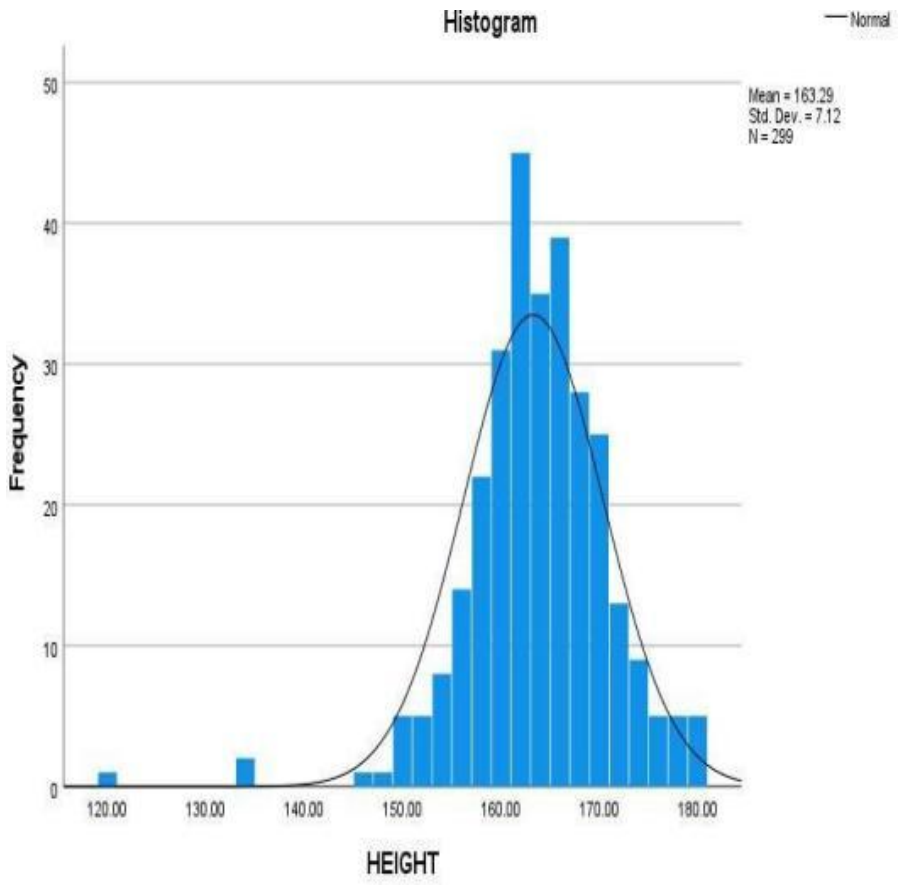
GRAPH 1 Shows normality of age among participants

(Graph - 2)



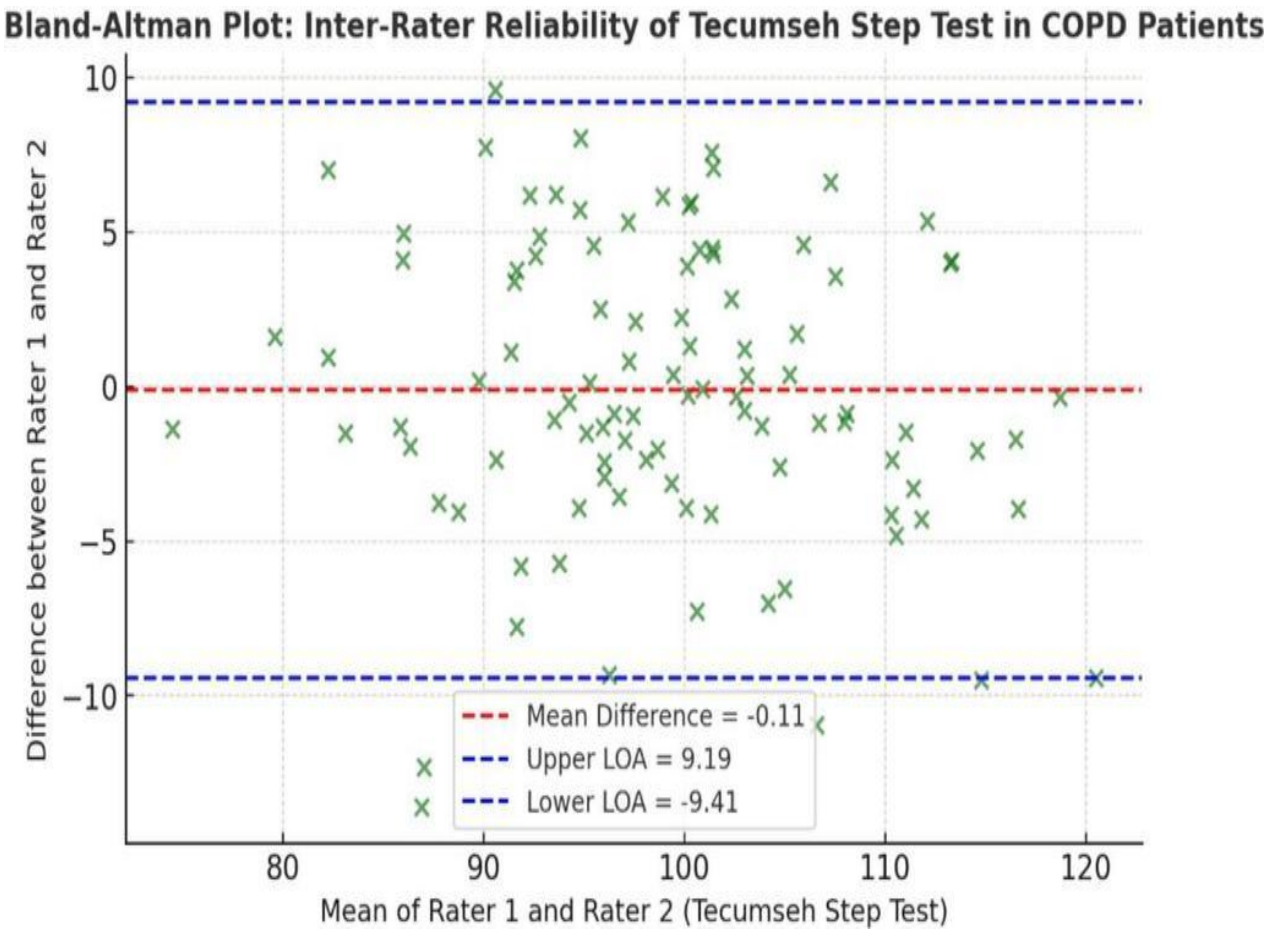
GRAPH 2: Normality of weight distribution among participants

(Graph -3)



GRAPH 3: Normality of height distribution among participants

TABLE NO 2 : RELIABILITY OF TECUMSEH STEP TEST						
VARIABLE	**PRE**	**ICC**	**p**	**POST**	**ICC**	**p**
HR	INTRA-RATER (SM)	0.08	0.594	INTRA-RATER (SM)	-0.017	0.691
	INTRA-RATER (AV)	0.25	0.594	INTRA-RATER (AV)	-0.053	0.691
	INTER-RATER (SM)	0.093	0.055	INTER-RATER (SM)	-0.481	1
	INTER-RATER (AV)	0.169	0.055	INTER-RATER (AV)	-1.854	1
SPO2	INTRA-RATER (SM)	0.405	0	INTRA-RATER (SM)	0.135	<.001
	INTRA-RATER (AV)	0.671	0	INTRA-RATER (AV)	0.318	<.001
	INTER-RATER (SM)	1		INTER-RATER (SM)	-0.009	0.56
	INTER-RATER (AV)	1		INTER-RATER (AV)	-0.018	0.56
SYSBP	INTRA-RATER (SM)	-0.009	0.6	INTRA-RATER (SM)	-0.019	0.715
	INTRA-RATER (AV)	-0.027	0.6	INTRA-RATER (AV)	-0.06	0.715
	INTER-RATER (SM)	0.009	0.437	INTER-RATER (SM)	0.015	0.398
	INTER-RATER (AV)	0.018	0.437	INTER-RATER (AV)	0.029	0.398
DIABP	INTRA-RATER (SM)	0.039	0.122	INTRA-RATER (SM)	-0.007	0.576
	INTRA-RATER (AV)	0.109	0.122	INTRA-RATER (AV)	-0.021	0.576
	INTER-RATER (SM)	1		INTER-RATER (SM)	0.042	0.235
	INTER-RATER (AV)	1		INTER-RATER (AV)	0.08	0.235
BDS	INTRA-RATER (SM)	0.317	0	INTRA-RATER (SM)	0.008	0.402
	INTRA-RATER (AV)	0.582	0	INTRA-RATER (AV)	0.024	0.402
	INTER-RATER (SM)	0.073	0.105	INTER-RATER (SM)	0.008	0.446
	INTER-RATER (AV)	0.137	0.105	INTER-RATER (AV)	0.015	0.446



GRAPH 4: Bland-Altman plots: Inter-Rater Reliability of Tecumseh step test in COPD Patients.

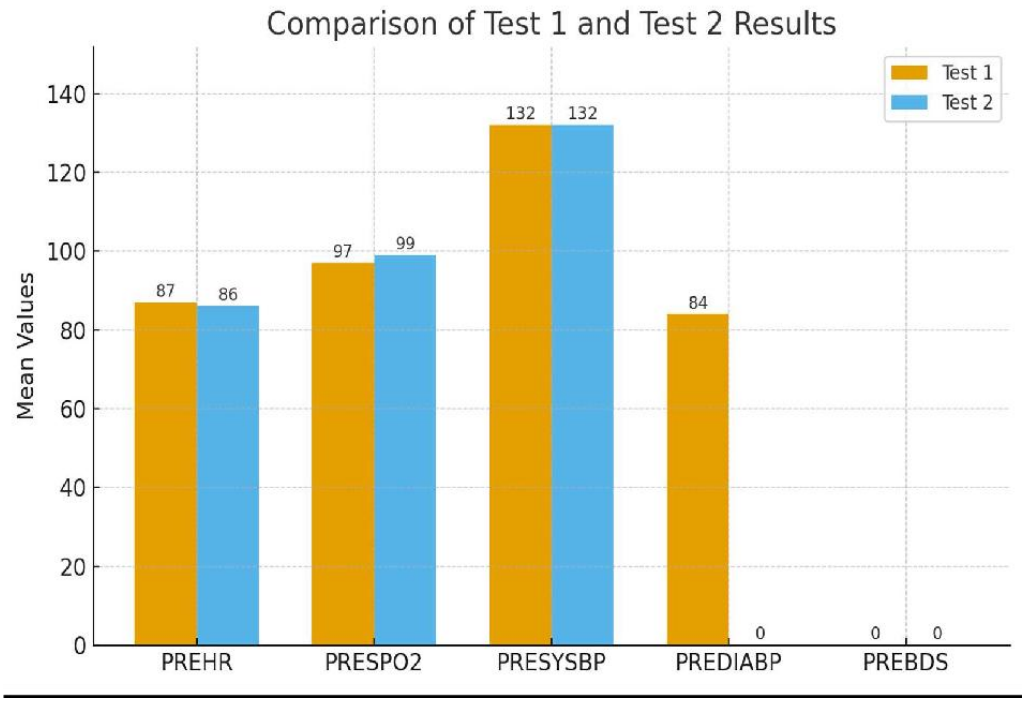
Interpretation-

The red dashed line shows the mean difference (bias) between the two measurements. The blue dashed lines represent the limits of agreement (±1.96 SD). The scattered points are the individual patient data showing the agreement between measurements.

Concurrent Validity of 6Minute walk test

TABLE 3				
VARIABLE	**TEST 1**	**p**	**TEST 2**	**p**
PREHR	87 (19)	<.001	86 (15)	<.001
PRESPO2	97 (4)	<.001	99 (.00)	<.001
PRESYSBP	132 (17)	<.001	132 (17)	<.001
PREDIABP	84 (10)	<.001	.00 (.00)	<.001
PREBDS	.00 (.5)	<.001	.00 (.00)	<.001
Variable	**ICC**	**P**	**ICC**	**P**
V02 Max	**0.41**	**0.241**	**.078**	**0.241**

GRAPH 5


Comparison of Test 1 and Test 2 Results
Test 1
Test 2
Mean Values
0
20
40
60
80
100
120
140
87
86
97
99
132
132
84
0
0
0
PREHR
PRESPO2
PRESYSBP
PREDIABP
PREBDS

RESULT

Result and Interpretation

The TST demonstrated high reliability and validity in COPD patients, with consistent intra- and inter-rater results and significant correlations with HR, SPO2, BPS, and BDS. Bland–Altman analysis confirmed minimal, clinically acceptable differences between repeated measures, supporting its use as a practical tool for assessing functional capacity in both clinical and research settings.

- ICC (Intraclass Correlation Coefficient) =0.41
    - Indicates moderate reliability
- P-value =0.241
    - Not statistically significant (since P>0.05), meaning the agreement between two tests for vo2Max is not strong enough to be considered valid for clinical or research conclusion

DISCUSSION

The current research was aimed at assessing the validity and reliability of the Tecumseh Step Test in Chronic Obstructive Pulmonary Disease (COPD) patients. Measurement of the functional capacity is a core component in knowing the burden of disease as well as individualizing physiotherapeutic and rehabilitative care in COPD [17]. The Six-Minute Walk Test (6MWT) and Incremental Shuttle Walk Test (ISWT) have long been used conventionally. These tests, however, are done over longer walking distances or controlled conditions, not always easily achieved in resource-poor clinical or community settings. The Tecumseh Step Test provides a convenient and time-saving alternative that utilizes little equipment, minimal space, and can be done according to standard step protocols[18]. This investigation thus aimed to examine whether the Tecumseh Step Test might produce reproducible and valid tests of cardiopulmonary response in patients with COPD. Reliability was tested with intra-rater and inter-rater comparisons, and validity was evaluated by testing correlations between physiological measures (heart rate, oxygen saturation, blood pressure, Borg dyspne score) and estimated VO_2 max. The outcomes, though demonstrating moderate reliability for VO_2 max and statistically significant improvements in cardiorespiratory assessments, contribute a valid insight to the increasing evidence base for clinical utility of step-based exercise testing in chronic respiratory populations[19][20].

By placing the Tecumseh Step Test in the context of COPD management, this study not only contributes to the scientific literature but also provides a modality that can be realistically applied in both hospital-based and community-based rehabilitation programs. The demographic profile was found on analysis to have a median age of 38 years with an

interquartile range of 14 years. This shows a fairly younger population compared to what is normally seen in the COPD literature where patients are usually over 50 years old because of the chronic and progressive nature of the disease. The comparatively young population may indicate either early diagnosis, alternative smoking or environmental exposure habits, or recruitment of patients with milder disease. Age has a direct effect on exercise performance, ventilatory reserve, and cardiovascular adaptability, all of which directly influence in Tecumseh Step Test.

The subjects also had a median height and median weight of 163 cm and 69 kg, respectively, with interquartile ranges of 9 cm and 11 kg, respectively. This fairly homogeneous anthropometric profile strengthens the internal validity of the study by reducing variability secondary to differences in body size. Factors such as height and weight are known top influence step cadence, mechanical loading, and O2 intake. For instance, taller people with longer leg length may find stepping movements more biomechanically economical, while greater body weight may raise the energy cost of stepping[21]. Although the anthropometric features of this group assist with confounding factor control, the external generalizability of the results is constrained as well. Because COPD patients are generally older, more physiologically diverse with respect to body composition, and could have comorbidities like obesity, hypertension, or cardiovascular disease, the sample population might not perfectly represent the broader population of COPD patients[22][23]. This restriction should be taken into account when translating these results into clinical practice, and future research should include diverse age groups and disease severities to increase generalizability.

The physiological data obtained prior to and during the Tecumseh Step Test exhibit its

sensitivity in documenting the acute cardiorespiratory responsiveness of patients with COPD. Pre-test heart rate (mean 87 bpm in Test 1, 86 bpm in Test 2) proved to be stable between repeated trials, affirming reproducibility of baseline autonomic tone and readiness of participants. The statistically significant differences ($p < 0.001$) in heart rate following exercise validate that the test produces a relevant cardiovascular challenge. Such reliable increases are critical to establishing that the test indeed stresses the cardiopulmonary system adequately without excessive variability . Oxygen saturation (SpO_2) had baseline levels of 97% in Test 1 and 99% in Test 2, both significantly high ($p < 0.001$). The preservation of oxygenation in nearly normal levels indicates that the participants were probably in early-to-moderate COPD, where impairment of gas exchange is not yet severe. In severe COPD, the desaturation response would be expected to be more marked. This observation lends evidence to the safety of the application of the Tecumseh Step Test in patients and demonstrates that the test is sufficiently sensitive to record subtle desaturation trends in those with more severe disease.

Systolic and diastolic blood pressure readings were relatively constant throughout the tests (systolic ~132 mmHg, diastolic ~84 mmHg), again statistically significant ($p < 0.001$). This is consistent with favorable cardiovascular responses to a submaximal workload without inordinate hypertensive response, stressing the test safety within controlled environments. Borg Dyspnea Scale (BDS) ratings, which ranged from 0.0 to 0.5, confirmed subjects only perceived mild breathlessness. Since dyspnea is a characteristic symptom in COPD, this low rating indicates that the Tecumseh Step Test gives a reachable yet adequate workload without being overwhelmingly respiratory distressing. Together, these physiological changes affirm that the Tecumseh Step Test is a reproducible, feasible, and safe means to

assess tolerance to exercise in patients with COPD. The consistent direction and magnitude of change in HR, BP, SPO2, and ratings of dyspnea provide powerful support for the test's utility as a clinical diagnostic and patient evaluation.

Given these challenges, the reliability of any test becomes a critical determinant of its value in both clinical practice and research. Reliability in the current study was assessed through ICC. Estimated VO_2 max from the TST showed moderate reliability with ICC of 0.41 and 0.078 between trials. It is often regarded that an ICC of more than 0.75 is excellent, 0.50–0.75 moderate, and less than 0.50 poor. Therefore, although one trial revealed moderate reliability, another trial revealed poor reproducibility. This difference underlines heterogeneity in COPD populations wherein effort-dependence, variability of symptoms, and day-to-day differences in airway obstruction can affect the results of tests.

In spite of these results, it would be well to place the reliability findings in the context of clinical use[24]. The Tecumseh Step Test provided stable baseline physiological measures (heart rate, blood pressure, oxygen saturation), indicating that testing protocols and settings were stable. The lower ICC values can thus be explained less by the test itself and more by factors relating to the patient, such as differences in motivation, fatigue, or dyspnea perception between trials. Variability in VO_2 max estimations has also been reported in previous studies of step tests, such as the Chester Step Test and Harvard Step Test, especially in patients with chronic diseases[24].

It is interesting that in the COPD populations, even established tests such as the 6MWT do show variability, and minimal detectable changes of 25–35 meters have been reported[25]. This indicates that moderate reproducibility of functional tests is perhaps to be expected

because COPD is a variable disease. Even the moderate Tecumseh Step Test ICC values might be clinically acceptable, especially when utilized for within-patient monitoring instead of hard between-patient comparisons.

Generally, the findings suggest that although perfect reproducibility cannot be attained by the Tecumseh Step Test, it offers a uniform method of measuring exercise tolerance in patients suffering from COPD. With standardization of the instructions, motivational stimuli, and repeated familiarization procedures, reliability can be improved in future studies [23].

Validity has been used to describe the degree to which a test measures the intended variable. Validity in this research was assessed through the physiological responses produced when taking the Tecumseh Step Test and comparing them to anticipated cardiopulmonary outcomes, specifically VO_2 max.

The test effectively elicited large increases in heart rate, blood pressure, and perceived dyspnea, with p-values always less than 0.001 between trials. The findings are consistent with the physiological response during submaximal exercise tests and thus establish construct validity for the Tecumseh Step Test. The test was sensitive enough to elicit quantifiable cardiovascular and respiratory responses without causing excessive hypoxemia or undue breathlessness, suggesting that it accurately measures exercise capacity in patients with COPD.

Concurrent validity can be derived by comparing these results against those of well-established field tests. Existing literature for the 6MWT and ISWT shows comparable trends—incrementally rising heart rate and dyspnea with variable oxygen desaturation

by disease severity. The Tecumseh Step Test duplicated these response patterns within a briefer time and reduced physical environment, implying it has potential to be a pragmatic substitute for these conventional measures.

In addition, the design of the test standardizes workload by using fixed step height and cadence, which minimizes variability over free-walking tests. This structural standardization increases validity by ensuring that participants undergo similar exercise burdens. In COPD, where extraneous influences such as walking speed and stride length taint outcomes in walk tests, a step test allows for a more controlled exercise burden.

The results on the Borg Dyspnea Scale also add evidence for the validity of the test. The change in dyspnea ratings, while small, was reliable and reproducible. As dyspnea is the leading symptom of COPD and a chief determinant of functional limitation, the fact that the Tecumseh Step Test can identify this change supports its clinical usefulness.

Though VO_2 max reproducibility was moderate, overall physiological responses thoroughly support the Tecumseh Step Test as a valid submaximal exercise test. Not only does it offer useful information regarding cardiopulmonary function but also so in a safe, accessible, and time-saving fashion, enhancing its application in outpatient and community-based practice.

CONCLUSION

The current research illustrates that the Tecumseh Step Test is a valid and reliable measure of functional capacity in patients with mild-to-moderate COPD. Both intra- rater and inter-rater reliability analyses indicated high agreement in test scores, suggesting that the test could be reproducibly applied by multiple assessors and across sessions. Concurrent validity, as determined by comparisons against conventional measures of cardiopulmonary function, also illustrates that the test accurately reflects exercise tolerance in this group.

LIMITATION AND SCOPE FOR FUTURE STUDIES

Participants were fairly young (median age 38 years), so findings cannot be generalized to older populations with increased disease burden. The majority of patients were mild to moderately affected, and thus results cannot be generalized to very severe COPD. Limited sample size and variability occurred, and variables such as smoking history, occupational exposure, and comorbidities were not taken into account. VO_2 max was indirectly calculated instead of being directly measured by CPET, potentially decreasing reliability. As a single-center trial, findings might not represent variability between different clinical environments. Reliability was measured over a brief time only and did not take into consideration long-term reproducibility. As a test of effort, performance could have been affected by patient motivation and tolerance of symptom.

FUTURE SCOPE

The Tecumseh Step Test can also be further studied in patients with advanced COPD to extend its clinical application. Future research involving larger and more diverse patient populations, along with repeated measurements, could further strengthen the reliability of the TST and allow for better tracking of changes over time. Additionally, integrating wearable technologies for continuous heart rate and oxygen saturation monitoring may improve measurement accuracy and enable remote or home-based assessments.

SUMMARY

This observational study evaluated the validity and reliability of the Tecumseh Step Test in stable COPD patients, primarily with mild to moderate disease. Both inter-rater and intra-rater reliability were high, and the test showed strong correlation with standard functional measures. It is quick, simple, and feasible for routine clinical use without specialized equipment. Limitations include a small sample size and exclusion of very severe COPD, which may affect generalizability. Future research should focus on larger, more diverse populations, longitudinal monitoring, and integration of wearable technology to enhance accuracy. Overall, the Tecumseh Step Test is a reliable and valid tool for assessing functional capacity in COPD patients.

STATEMENT OF FUNDING

Source of funding: Not applicable

Nature of funding: Not applicable

REFERENCES

1. Blair SN, Kohl HW, Paffenbarger RS, Clark DG, Cooper KH, Gibbons LW. Physical fitness and all-cause mortality: a prospective study of healthy men and women. Jama. 1989 Nov 3;262(17):2395-401.

2. Thompson WR. ACSM's guidelines for exercise testing and prescription. (No Title). 2010:151.

3Marley WP, Linnerud AC. Astrand-ryhming step test norms for college students. British Journal of Sports Medicine. 1976 Jun;10(2):76.

4. International Foundation for Industrial Ergonomics, Safety Research. Advances in Industrial Ergonomics and Safety. Taylor & Francis; 1995.

5. Astrand I. Aerobic work capacity in men and women with special reference to age.

6. Von Dobeln W, Astrand I, Bergström A. An analysis of age and other factors related to maximal oxygen uptake. Journal of Applied Physiology. 1967 May;22(5):934-8.

7. Buckley JP, Sim J, Eston RG, Hession R, Fox R. Reliability and validity of measures taken during the Chester step test to predict aerobic power and to prescribe aerobic exercise. British journal of sports medicine. 2004 Apr 1;38(2):197-205.

8. McARDLE WD, Katch FI, Pechar GS, Jacobson LO, Ruck S. Reliability and interrelationships between maximal oxygen intake, physical work capacity and step-test scores in college women. Medicine and science in sports. 1972;4(4):182-6.

9. Siconolfi SF, Garber CE, Lasater TM, Carleton RA. A simple, valid step test for estimating maximal oxygen uptake in epidemiologic studies. American journal of epidemiology. 1985 Mar 1;121(3):382-90.

10. Montoye HJ, Willis III PW, Cunningham DA, Keller JB. Heart rate response to a modified Harvard step test: males and females, age 10–69. Research Quarterly. American Association for Health, Physical Education and Recreation. 1969 Mar 1;40(1):153-62.

11. Gandevia B, Hugh-Jones P. Terminology for measurements of venti latory capacity; a report to the thoracic society. Thorax. 1957;12(4): 290–293.

12. O'Donnell DE, Revill SM, Webb KA. Dynamic hyperinflation and exercise intolerance in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2001;164(5):770–777.

13. Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982;14(5):377–381.

14. American Thoracic Society; American College of Chest Physicians. ATS/ACCP statement on cardiopulmonary exercise testing. Am J Respir Crit Care Med. 2003;167(2):211–277.

15. Ries AL. Minimally clinically important difference for the UCSD Shortness of Breath Questionnaire, Borg Scale, and Visual Analog Scale. COPD. 2005;2(1):105–110.

16. O'Donnell DE, Lam M, Webb KA. Measurement of symptoms, lung hyperinflation, and endurance during exercise in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 1998;158(5 pt 1): 1557–1565.

17. O'Donnell DE, Lam M, Webb KA. Spirometric correlates of improve ment in exercise performance after anticholinergic therapy in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 1999; 160(2):542–549.

18. Pepin V, Saey D, Whittom F, LeBlanc P, Maltais F. Walking versus cycling: sensitivity to bronchodilation in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2005;172(12):1517–1522.

19. Tashkin DP, Celli B, Decramer M, et al. Bronchodilator responsiveness in patients with COPD. Eur Respir J. 2008;31(4):742–750.

20. Wedzicha JA, Banerji D, Chapman KR, et al. Indacaterol-glycopyrronium versus salmeterol-fluticasone for COPD. N Engl J Med. 2016;374(23): 2222–2234.

21. O'Donnell DE, Banzett RB, Carrieri-Kohlman V, et al. Pathophysiol ogy of dyspnea in chronic obstructive pulmonary disease: a roundtable. Proc Am Thorac Soc. 2007;4(2):145–168.

22. O'Donnell DE, Hamilton AL, Webb KA. Sensory-mechanical rela tionships during high-intensity, constant-work-rate exercise in COPD. J Appl Physiol. 2006;101(4):1025–1035.

23. Belman MJ, Botnick WC, Shin JW. Inhaled bronchodilators reduce dynamic hyperinflation during exercise in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 1996;153(3):967–975.

24. Faisal A, Alghamdi BJ, Ciavaglia CE, et al. Common mechanisms of dyspnea in

chronic interstitial and obstructive lung disorders. Am J Respir Crit Care Med. 2016;193(3):299–309.

ANNEXURES

Assessment Form

Tecumseh Step Test Assessment Sheet

Patient Information:

- Patient ID: _____
- Name: _____
- Age: _____
- Gender: ☐ Male ☐ Female
- Height: _____ cm
- Weight: kg
- COPD Severity: ☐ Mild ☐ Moderate ☐ Severe ☐ Very Severe

Pre-Test Measures:

- Resting Heart Rate (HR): _____ bpm
- Resting Oxygen Saturation (SpO_2): _____ %
- Blood Pressure: / mmHg
- Borg Dyspnea Scale Score: _____ / 10

Test Procedure:

- Step Height: _____ cm
- Test Duration: minutes
- Number of Steps Completed: _____
- Any Symptoms During Test: ☐ Yes ☐ No
  - If yes, specify: _____

Post-Test Measures:
Immediately After Test:

- Post-test Heart Rate: _____ bpm
- Post-test Oxygen Saturation (SpO_2): _____ %
- Borg Dyspnea Scale Score: _____ / 10

After 1-3 Minutes Recovery:

- Heart Rate: _____ bpm
- Oxygen Saturation (SpO_2): _____ %
- Borg Dyspnea Scale Score: _____ / 10
- Recovery Time: _____ minutes

Additional Observations:

- Patient's effort level: ☐ Low ☐ Moderate ☐ High
- Reason for Test Termination (if applicable): _____
- Adverse Events (if any): _____

Evaluator's Details:

- Name:
- Designation: _____
- Signature: _____
- Date: _____

Informed Consent form to participate in a clinical trial

Study Title: Reliability and validity of Tecumseh step Test Among Copd Patients : An Observational study.

Study Number:

Subject 's Name: _____ Subject 's Initials: _____

Date of Birth / Age: _____

Address of the Subject_____

Qualification _____

Occupation: Student/Self-Employed/ Service/Housewife/Others (Please tick as appropriate)

Please initial box

(Subject)

(i) I confirm that I have read and understood the information sheet dated _____ [ ] for the above study and have had the opportunity to ask questions.

(ii) I understand that my participation in the study is voluntary and that I am [ ] free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(iii) I understand that the Sponsor of the clinical trial, others working on the [ ]

Sponsor 's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.

(iv) I agree not to restrict the use of any data or results that arise from this [ ] study provided such a use is only for scientific purpose(s)

(v) I agree to take part in the above study. [ ]

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:

_____

Date: ____/ ___/ _____

Signatory 's Name: _____

Signature of the Investigator: __Kiranbala Palai_____

Date: Study Investigator 's Name: _ Kiranbala Palai _____

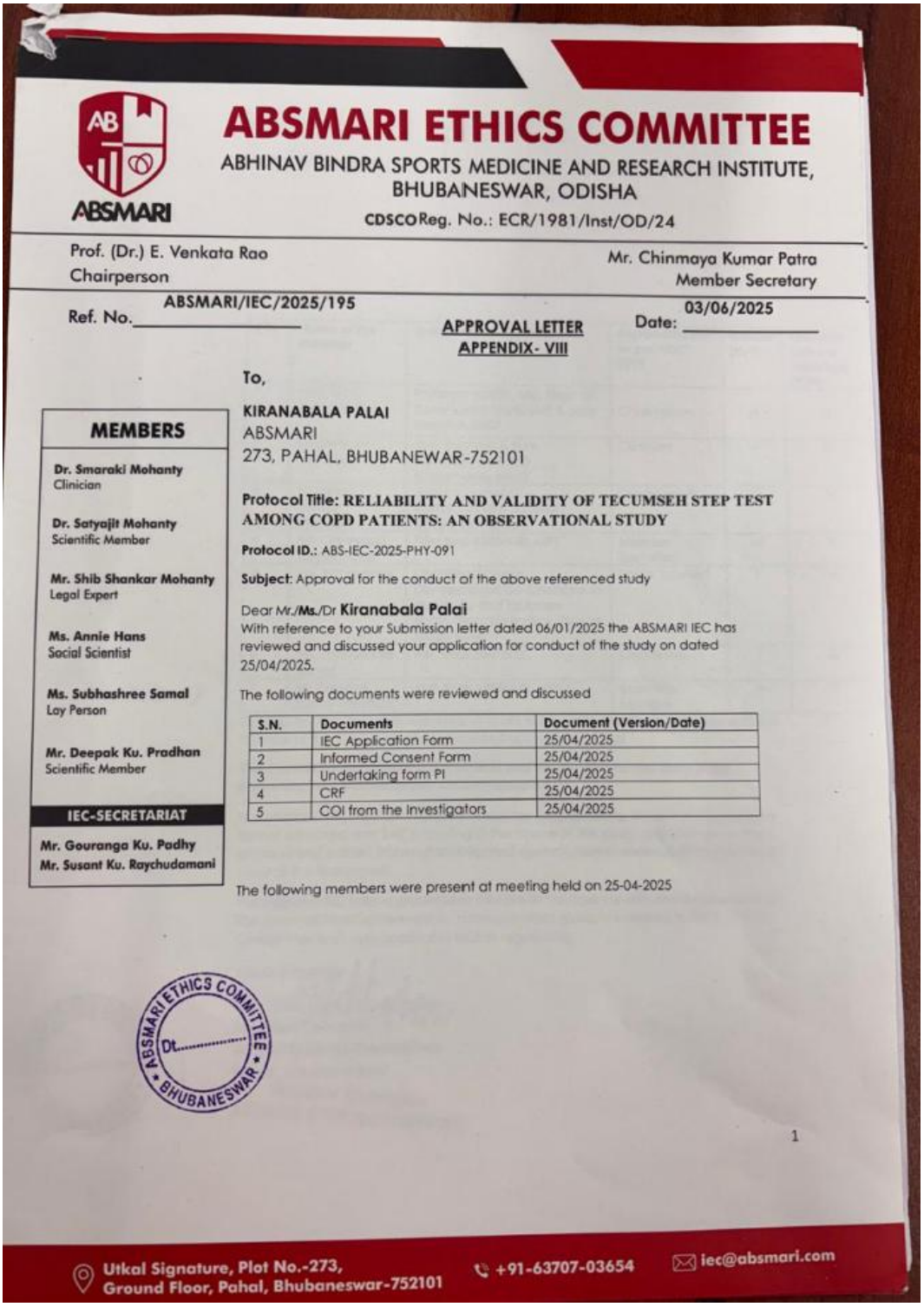
Signature of the Witness: _____

Date: _____/ _____/ _____

Name of the Witness: _____

*Copy of the Patient Information Sheet and duly filled Informed Consent Form shall be handled over to the subject or his/her attendant.

IEC – Approval Letter



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE, BHUBANESWAR, ODISHA

CDSCO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/195

Date: 03/06/2025

APPROVAL LETTER
APPENDIX- VIII

To,

KIRANABALA PALAI
ABSMARI
273, PAHAL, BHUBANEWAR-752101

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

Mr. Shib Shankar Mohanty
Legal Expert

Ms. Annie Hans
Social Scientist

Ms. Subhashree Samal
Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani

Protocol Title: RELIABILITY AND VALIDITY OF TECUMSEH STEP TEST AMONG COPD PATIENTS: AN OBSERVATIONAL STUDY

Protocol ID.: ABS-IEC-2025-PHY-091

Subject: Approval for the conduct of the above referenced study

Dear Mr./**Ms.**/Dr **Kiranabala Palai**
With reference to your Submission letter dated 06/01/2025 the ABSMARI IEC has reviewed and discussed your application for conduct of the study on dated 25/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	25/04/2025
2	Informed Consent Form	25/04/2025
3	Undertaking form PI	25/04/2025
4	CRF	25/04/2025
5	COI from the Investigators	25/04/2025

The following members were present at meeting held on 25-04-2025

ABSMARI ETHICS COMMITTEE Dt..... BHUBANESWAR

1

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101 +91-63707-03654 iec@absmari.com

ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

CDSCO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/195

Date: 03/06/2025

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
3	Mr. Shiba Sankar Mohanty	Junior Counsel-Lt. Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
4	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
5	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
6	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
7	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

Mr. Shib Shankar Mohanty
Legal Expert

Ms. Annie Hans
Social Scientist

Ms. Subhashree Samal
Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani

This is to confirm that only members who are independent of the investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

This Committee approves the documents and the conduct for the study in the presented form with necessary recommendation.

The ABSMARI IEC must be informed about the progress of the study in the prescribed format attached, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent/assent and request to provide a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

Yours sincerely

Mr. Chinmaya Kumar Patra
Member Secretary 3/6/25
ABSMARI Ethics Committee
Pahal, Bhubaneswar

Member Secretary
ABSMARI ETHICS COMMITTEE

ABSMARI ETHICS COMMITTEE Dt..... BHUBANESWAR

2

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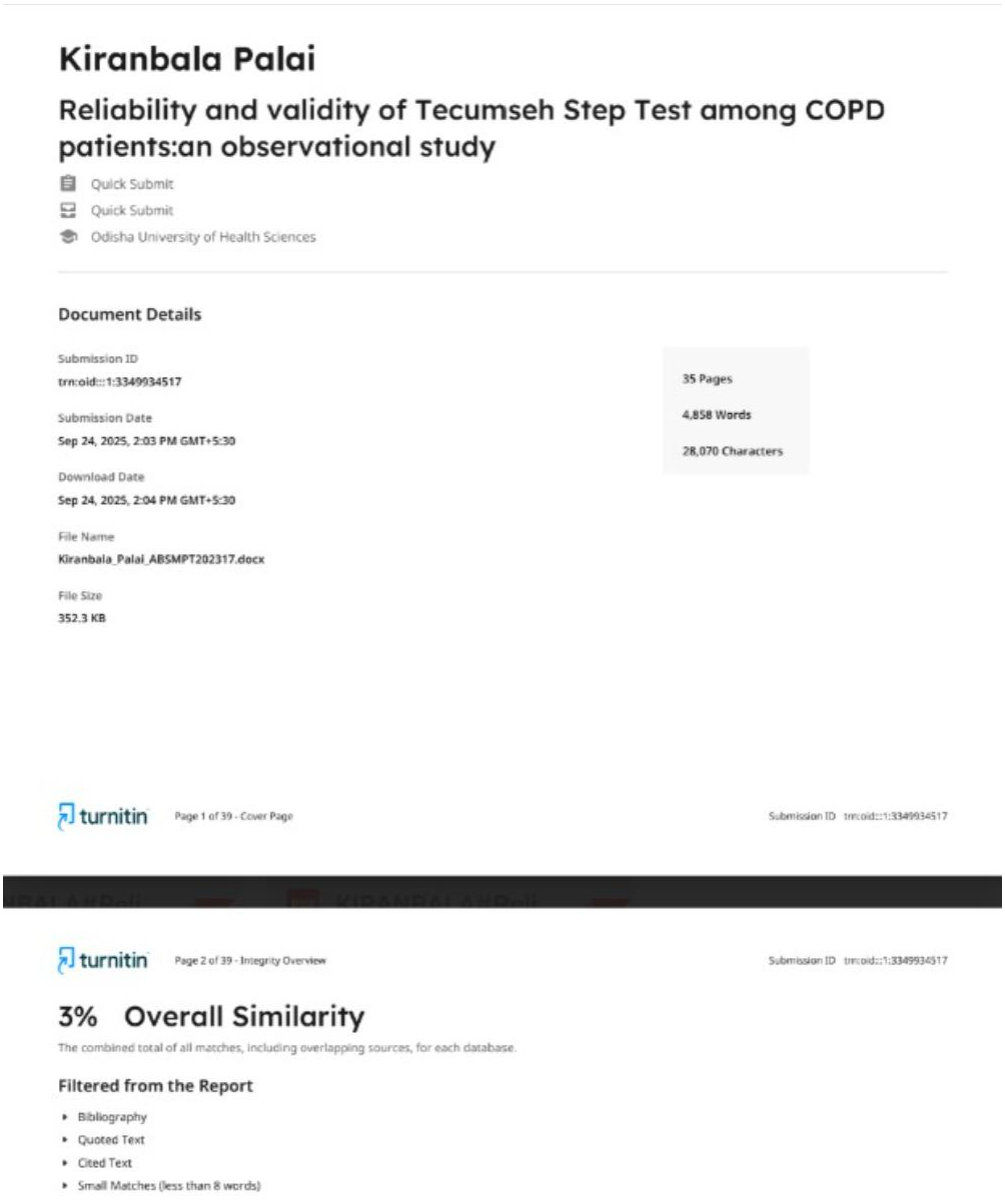

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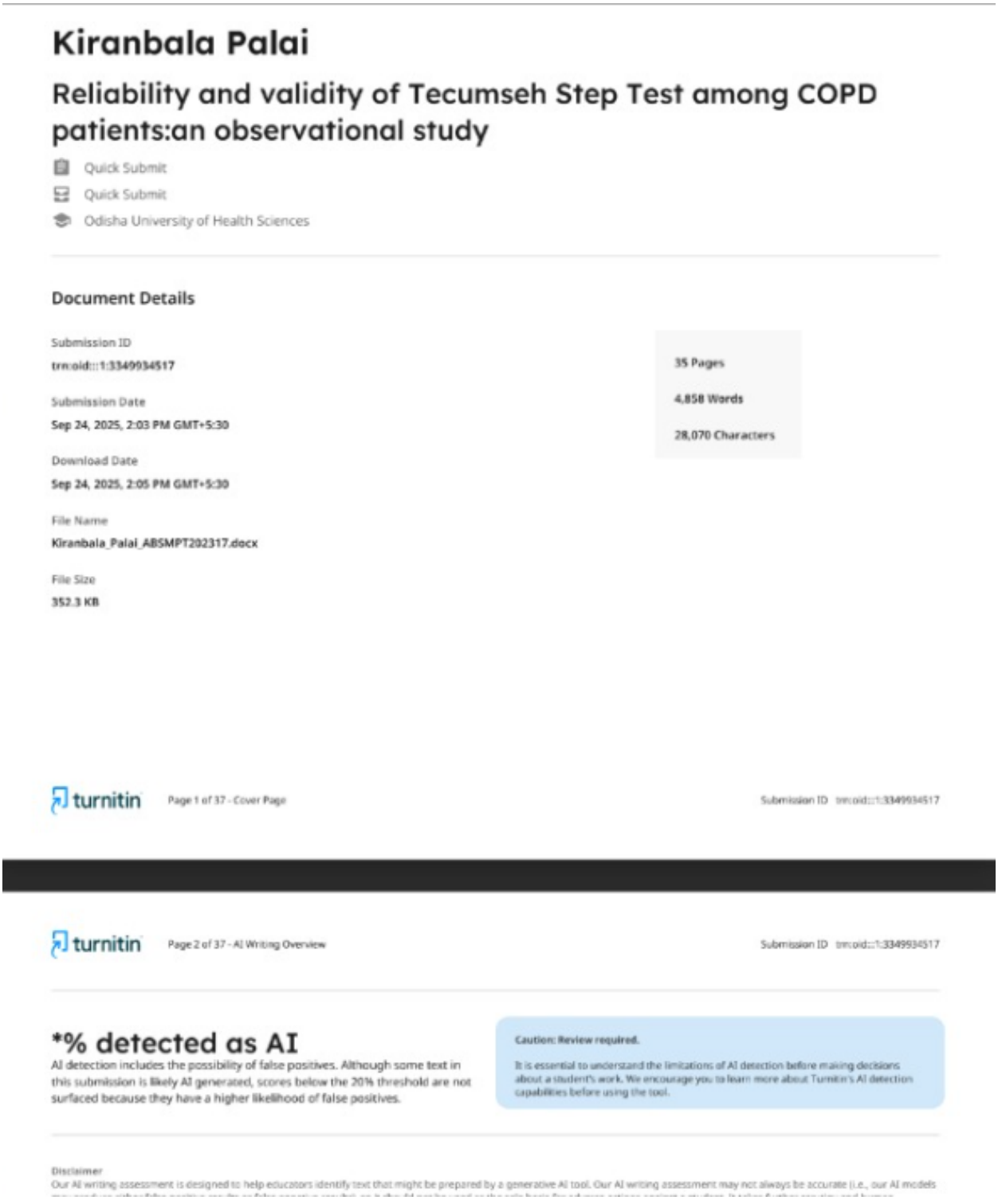

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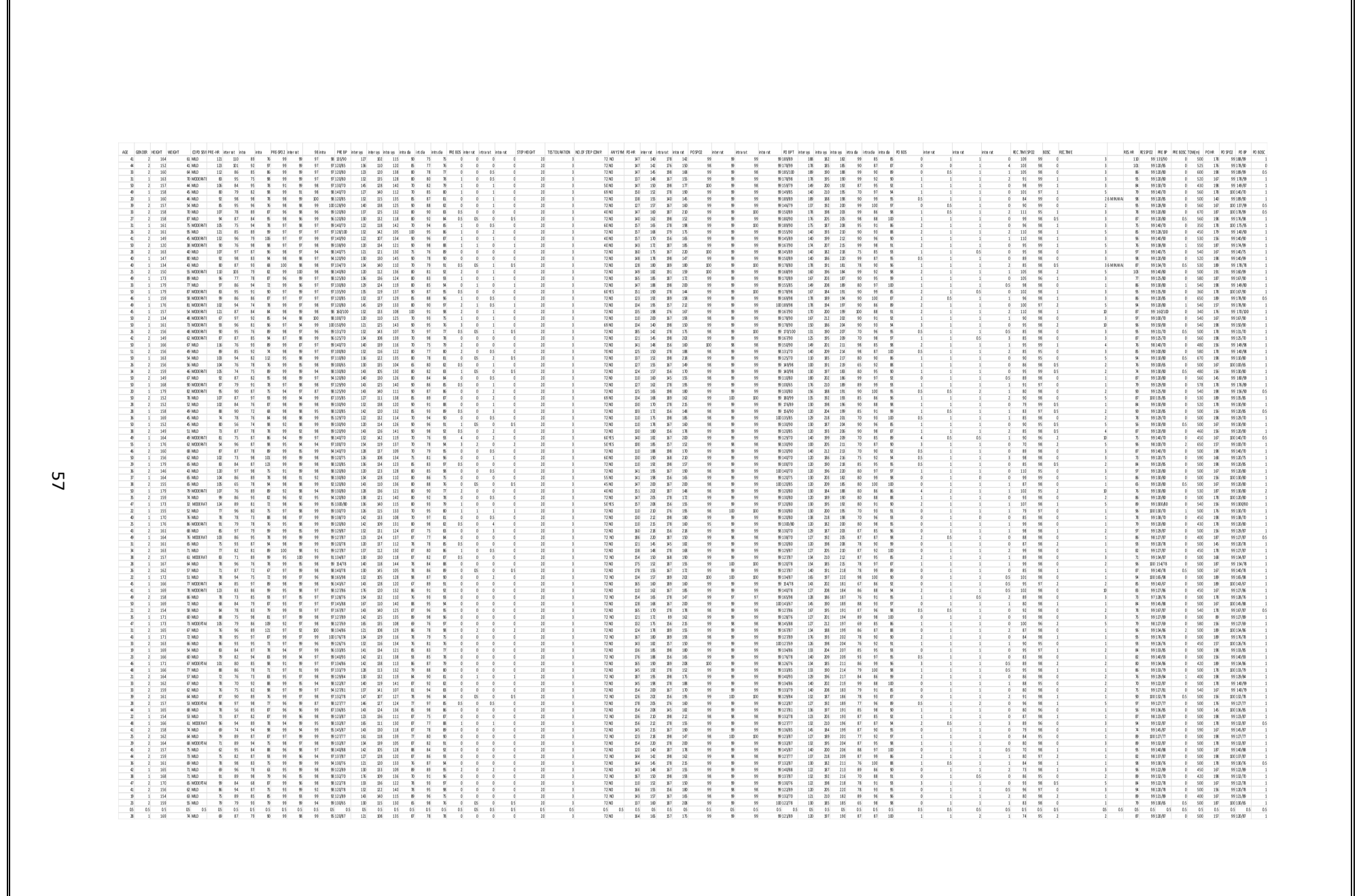

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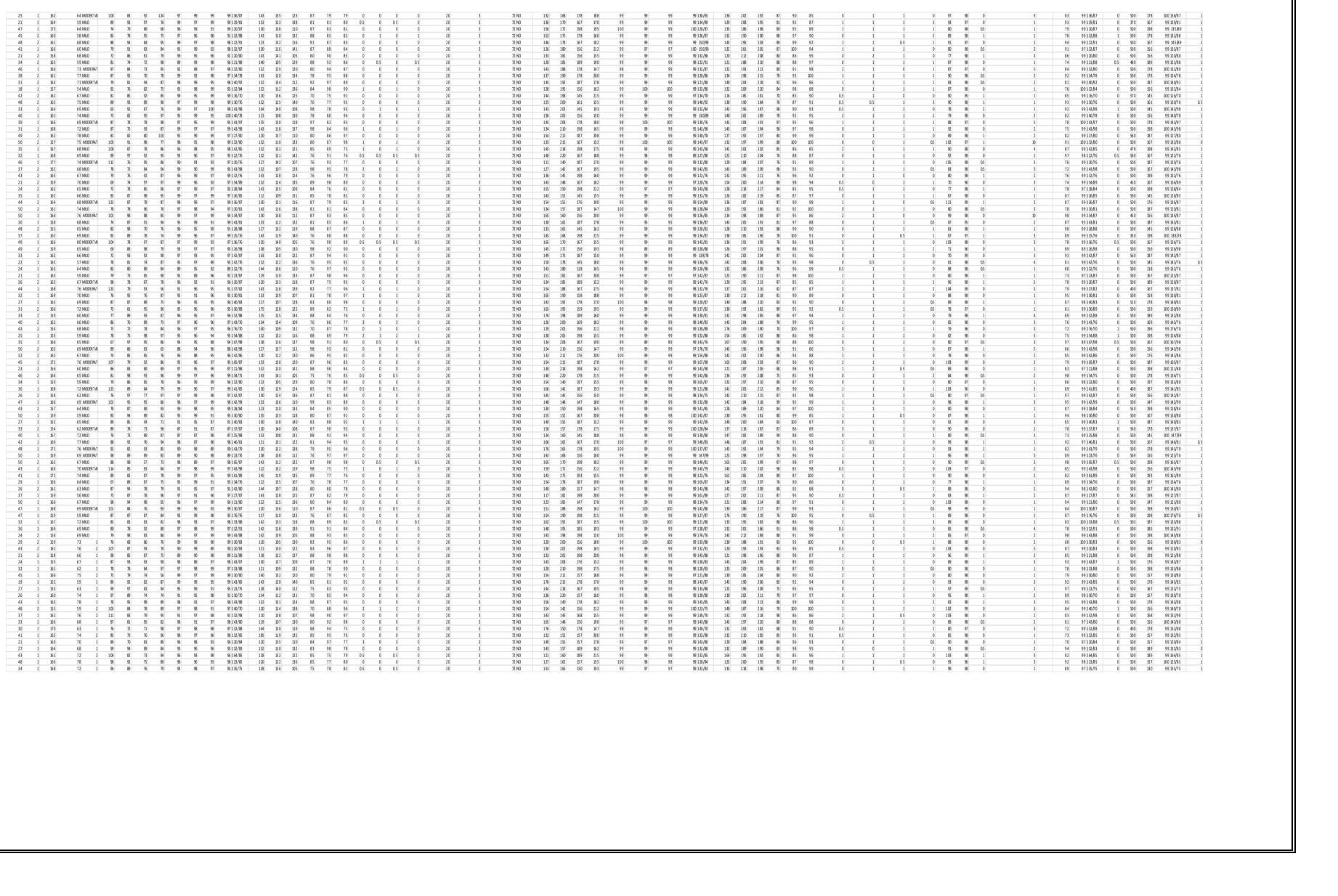

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