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Talk Test Performance and its Physiological Correlates During Treadmill and Cycling Exercise in Young Adults

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ABSTRACT

Background: The Talk Test (TT) is an easy, simple technique to measure the intensity of exercise based on the comfortable level of talking while exercising. Though the TT is well validated in the West, there is limited information available about its physiological validity in South Asian people. This study aims to evaluate the cardiopulmonary responses to the Talk Test stages of treadmill and cycling ergometry in young healthy adults in Peshawar, Pakistan. **Methods:** Healthy volunteers, 20 males and 10 females, from Khyber Medical University, Peshawar, Pakistan, volunteered for the study. Two randomized sessions of exercises using the treadmill and cycle ergometer protocols were conducted. Physiological variables, including heart rate (HR), oxygen consumption (VO_2/kg), minute ventilation (VE), respiratory rate (RR), metabolic equivalents (METs), RER, oxygen saturation (SpO_2), and rating of perceived exertion (RPE), were measured at rest and at three

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stages of TT. Two-way repeated measures ANOVA was used to compare the variables, while the correlation between TT stages and physiological markers was determined using the Pearson correlation test. **Results:** Physiological measures increased significantly across TT stages ($p < 0.001$). Treadmill running was associated with increased HR, VO2/kg, METs, VE, and RPE compared to CE ($p < 0.05$). Oxygen saturation decreased significantly across stages ($p = 0.004$), albeit slightly. Strong positive correlations existed between TT stages and physiological measures, including HR ($r = 0.88$-0.84), VO2/kg ($r = 0.91$-0.87), RPE ($r = 0.93$-0.89), VE ($r = 0.90$-0.85), RR ($r = 0.86$-0.82), and MET. **Conclusion:** The Talk Test is a valid, reliable, and practicable measure of exercise intensity for healthy young adults in Pakistan. The TT is highly associated with physiological measures and is a cost-effective alternative to existing objective measures of exercise intensity, useful in clinical, rehabilitation, and fitness settings in resource-limited environments.

Keywords: Talk Test, exercise intensity, treadmill, cycle ergometer, oxygen uptake, ventilation, Pakistan, cardiopulmonary responses, speech comfort.

INTRODUCTION

Exercise intensity prescription is an essential aspect of safe and effective aerobic training, clinical rehabilitation, and cardiopulmonary evaluation. In the past, physiological measures such as heart rate, oxygen uptake, respiratory exchange ratio, and blood lactate concentration have been used to prescribe the intensity of exercise. Although these methods are scientifically sound, they demand expensive equipment, trained professionals, and a lab setting. This has limited their use in the clinical setting, community, or field setting, especially in developing countries [1,2]. In this regard, simple yet valid methods of estimating the intensity of exercise have received increased attention in the last few years.

The Talk Test (TT) has been recognized as an easy and simple technique for measuring exercise intensity without the need for sophisticated technology. The TT, which was first conceived as a conversational tool for exercising, is based on the fact that it becomes increasingly difficult to speak as the ventilatory demands increase [3]. During exercise, it becomes difficult to speak as the ventilatory demands approach the ventilatory threshold, as there is competition between the respiratory

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demands for carbon dioxide clearance and speaking during exercise [4]. Several studies have proven that the TT is closely related to other physiological limits, such as the ventilatory threshold and lactate threshold, thereby acting as a proxy for exercise intensity [5-7].

The TT has achieved universal acceptance due to its simplicity and applicability in different populations, including cardiac patients, elderly individuals, athletes, and pulmonary dysfunction patients [8,9]. Studies indicate that the TT phases, which are comfortable speech, difficult speech, and very difficult speech, are strongly related to incremental increases in HR, VO2, minute ventilation (VE), and perceived exertion, and the TT is therefore a useful method in the prescription and safety monitoring of aerobic exercises [10]. Furthermore, the TT has been shown to be reproducible with different modes of exercises, such as treadmill walking, cycling, and running on the road [11].

In spite of the accumulation of evidence from across the globe, little scientific information exists about the physiological responses related to the TT in the South Asian community, especially in the context of Pakistan. Variations in language style, speech mechanics, aerobic capacity, and exercise behaviors may affect the understanding of the TT and its correlation with physiological parameters. Exercise type, like running versus cycling ergometry, might provoke different cardiovascular and metabolic reactions even under the same RPE [12].

Therefore, the purpose of the current study is to investigate the physiological responses associated with the talk test for both treadmill and cycle ergometry exercises in healthy young adults of Pakistani origin. By measuring HR, VO2/kg, RPE, METs, RR, VE, RER, and SpO2 for each stage of the talk test, this study aims to evaluate the relationship between speech comfort and exercise intensity, as well as whether the talk test is a valid method for exercise prescription in the region of Pakistan, which will be useful for health professionals, physiotherapists, and exercise trainers working in the country.

MATERIALS AND METHODS

Participants

The design of this research involved the recruitment of thirty healthy young

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individuals, comprising twenty men and ten women, from Khyber Medical University (KMU) Peshawar, KPK, Pakistan. The recruitment was based on advertisements and voluntary registration from the university campus, followed by the screening of the recruited volunteers by the research team. The inclusion criteria were based on the lack of any known history of cardiovascular, metabolic, neuromuscular, or pulmonary disorders; the ability to perform moderate to vigorous physical activities without any functional limitations; normal gait and musculoskeletal functions without any recent injuries; exclusion of individuals consuming caffeine, nicotine, or alcohol within twenty-four hours prior to the research; exclusion of individuals with asthma, hypertension, pregnancy, or those unable to comply with verbal commands. Before the research, each individual was informed about the research objectives, procedures, potential harm, and safety measures. The study followed the ethical principles outlined in the Declaration of Helsinki and was approved by the Institutional Review Board of Khyber Medical University (KMU/IRB/2025-112).

Respiratory Gas and Physiological Measurements

All physiological assessments were carried out in the Exercise Physiology Laboratory at KMU in a controlled environmental setting. Testing was conducted uniformly between 3:00 p.m. and 6:00 p.m. to avoid the effects of circadian rhythm on metabolic and cardiovascular responses. Physiological parameters were recorded continuously using a breath-by-breath system with a metabolic gas analysis system (COSMED K4b², Rome, Italy), a computerized treadmill, and a computerized cycle ergometer. Physiological parameters recorded during the study included heart rate (HR), rating of perceived exertion (RPE), metabolic equivalents (METs), arterial oxygen saturation (SpO2), respiratory rate (RR), minute ventilation (VE), relative oxygen uptake (VO2/kg), carbon dioxide production (VCO2), respiratory exchange ratio (RER), and tidal volume (VT). These physiological parameters were recorded during the baseline phase and the entire phases of the TT. In order to avoid fatigue-related interference and allow a reliable comparison, the treadmill and ergometer exercises were conducted on different days with a minimum washout period of seventy-two hours.

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Talk Test Procedure

The participants were advised to avoid any kind of physical exercise at least twenty-four hours prior to the testing session. In the case of the Talk Test, it was conducted during the treadmill and cycling ergometer exercises, in which the participants had to talk while performing the exercises. A standard English reading, "The Quaid-e-Azam's Message to Youth," which is used in the context of the Pakistani academic environment, was chosen as the material to be read. At the end of each stage of the exercises, the participants had to read the material and then verbally respond to the question of whether they could speak comfortably. In the case of the treadmill, the exercises started with a four-minute warm-up period, during which the participants had to walk comfortably on the treadmill at zero percent grade with the speed set at a self-selected comfortable level. Then, the grade was increased by two percent every two minutes, with the speed kept constant. In the case of the ergometer exercises, the exercises started with a four-minute warm-up period at 40 watts, and the workload was increased by 25 watts every two minutes. The verbal comfort level was also assessed during both modalities and after each stage of exercise to identify the stage of TT, with Stage I being comfortable speech, Stage II being speech that became strained or slightly difficult, and Stage III being speech that became very difficult or having an RPE of 15 or higher. The test of exercise was stopped when Stage III or a respiratory exchange ratio of 1.10 or higher was attained, indicating near-maximum exertion. The sequence of using the treadmill and stationary bicycle was randomized using a computer program to reduce any learning effect or order effect.

Statistical Analysis

The statistical analysis was carried out using IBM SPSS Statistics version 29.0 software (IBM Corp., Armonk, NY, USA). Normality of distribution was determined using the Shapiro-Wilk test. A two-way repeated measures analysis of variance (ANOVA) was used to assess the impact of exercise modality (treadmill running vs. CE) and TT stage (rest, Stage I, Stage II, Stage III) on physiological measures including HR, RPE, METs, SpO_2, RR, VE, VO_2/kg, VCO_2, RER, and VT. Exercise modality was entered as a between-subject factor, while TT stage was entered as a

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within-subject factor. When significant main or interaction effects were obtained, post hoc tests using the Bonferroni correction method were used to detect significant differences. Additionally, Pearson correlation was used to examine the relationship between TT stages and physiological measures for both exercise modes independently. The alpha level was set at a significance level of .05.

Results

A total of 30 healthy young adults were included in the study. Table 1 shows the demographic and baseline characteristics of the study sample. The study sample had a mean age of 22.4 ± 2.1 years, with 66.7% males and 33.3% females. Their mean BMI was 23.1 ± 2.5 kg/m², and the physiological parameters, heart rate, blood pressure, and oxygen saturation, were within normal limits. Most of the study subjects had moderate levels of habitual PA, with 60%, whereas 20% had low and high levels of PA, respectively. Only 6.7% of the study subjects were occasional smokers.

Table 1: ***Participant Demographic and Baseline Characteristics***

Variable	**Mean ± SD / n (%)**
Age (years)	22.4 ± 2.1
Gender	
– Male	20 (66.7%)
– Female	10 (33.3%)
Height (cm)	169.8 ± 8.2
Weight (kg)	66.4 ± 9.1
Body Mass Index (kg/m²)	23.1 ± 2.5
Resting Heart Rate (bpm)	74.3 ± 6.4
Resting Systolic BP (mmHg)	117.6 ± 9.8
Resting Diastolic BP (mmHg)	74.2 ± 7.1
Resting SpO_2 (%)	98.1 ± 0.8
Physical Activity Level (Self-Reported)	
– Low	6 (20.0%)
– Moderate	18 (60.0%)

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– High	6 (20.0%)
Caffeine Use (≥3×/week)	12 (40.0%)
Smoking Status	
– Non-smoker	28 (93.3%)
– Occasional smoker	2 (6.7%)

PThe physiological responses at each stage of the TT indicated clear and progressive increases in each of the physiological variables for both treadmill and cycle ergometer exercise modes. The means for HR, VO_2/kg, RPE, METs, RR, VE, RER, and SpO_2 at each stage of the TT are provided in Table 2. A significant main effect of TT stage was found for each variable ($p < 0.001$), confirming the graded response in physiological demands from the Rest through Stage III. For instance, HR increased from 74 ± 6 bpm at the Rest stage to 162 ± 13 bpm at the Stage III for the treadmill exercise mode, while HR increased from 75 ± 7 bpm at the Rest stage to 150 ± 12 bpm at the Stage III for the cycle ergometer exercise mode.

A notable effect of modality was observed for HR ($p = 0.032$), VO2/kg ($p = 0.014$), RPE ($p = 0.041$), METs ($p = 0.020$), and VE ($p = 0.027$), which confirmed that treadmill exercise was more physiologically demanding than CE during equivalent TT stages (Table 2). For example, VO2/kg was 29.6 ± 2.8 mL/kg/min during treadmill exercise compared to 25.1 ± 2.3 mL/kg/min during CE for Stage III. Oxygen saturation (SpO2) was observed to decrease slightly during the TT stages ($p = 0.004$), from 98% during the Rest stage to 95% during the Stage III stage. However, no notable effect of modality was observed ($p = 0.218$).

Table 2: ***Mean Physiological Responses Across Talk Test Stages During Treadmill and Cycle Ergometer Exercise***

Variable	Mode	Rest	Stage I	Stage II	Stage III	p-value (Stage Effect)	p-value (Mode Effect)
HR (bpm)	Treadmill	74 ± 6	108 ± 9	136 ± 11	162 ± 13	<0.001	0.032
HR (bpm)	Cycle	75 ± 7	103 ± 8	128 ± 10	150 ± 12		

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VO_2/kg (mL/kg/min)	Treadmill	4.2 ± 0.5	14.5 ± 1.6	22.8 ± 2.1	29.6 ± 2.8	<0.001	0.014
VO_2/kg	Cycle	4.3 ± 0.6	12.8 ± 1.4	19.6 ± 1.9	25.1 ± 2.3		
RPE	Treadmill	6 ± 0	10 ± 1	13 ± 1	16 ± 2	<0.001	0.041
RPE	Cycle	6 ± 0	9 ± 1	12 ± 1	15 ± 2		
METs	Treadmill	1.2 ± 0.1	4.1 ± 0.5	6.4 ± 0.6	8.3 ± 0.8	<0.001	0.02
METs	Cycle	1.2 ± 0.1	3.6 ± 0.4	5.5 ± 0.5	7.0 ± 0.7		
RR (breaths/min)	T/M	14 ± 2	22 ± 3	29 ± 4	36 ± 4	<0.001	0.091
RR	Cycle	14 ± 2	21 ± 3	27 ± 3	33 ± 4		
VE (L/min)	T/M	9.1 ± 1.2	27.6 ± 3.2	42.9 ± 4.1	58.3 ± 5.4	<0.001	0.027
VE	Cycle	9.0 ± 1.1	24.1 ± 2.9	36.2 ± 3.8	48.7 ± 4.9		
RER	T/M	0.78 ± 0.04	0.86 ± 0.05	0.94 ± 0.06	1.12 ± 0.05	<0.001	0.31
RER	Cycle	0.79 ± 0.04	0.87 ± 0.04	0.95 ± 0.05	1.10 ± 0.06		
SpO_2 (%)	T/M	98 ± 1	97 ± 1	96 ± 1	95 ± 2	0.004	0.218
SpO_2	Cycle	98 ± 1	97 ± 1	96 ± 1	95 ± 2		

T/M = Treadmill

Pearson correlation analyses demonstrated strong positive associations between TT stage and major physiological markers, including HR, VO_2/kg, RPE, VE, RR, and METs (all $p < 0.001$). These relationships are presented in Table 3. The highest correlations were observed for RPE (treadmill $r = 0.93$; cycle $r = 0.89$), METs

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(treadmill r = 0.92; cycle r = 0.88), and VO_2/kg (treadmill r = 0.91; cycle r = 0.87), reinforcing the validity of the Talk Test as a subjective indicator of graded exercise intensity.

Table 3: ***Pearson Correlations Between TT Stage and Physiological Variables***

Variable	Treadmill r	Cycle r	p-value
HR	0.88	0.84	<0.001
VO_2/kg	0.91	0.87	<0.001
RPE	0.93	0.89	<0.001
VE	0.9	0.85	<0.001
RR	0.86	0.82	<0.001
METs	0.92	0.88	<0.001

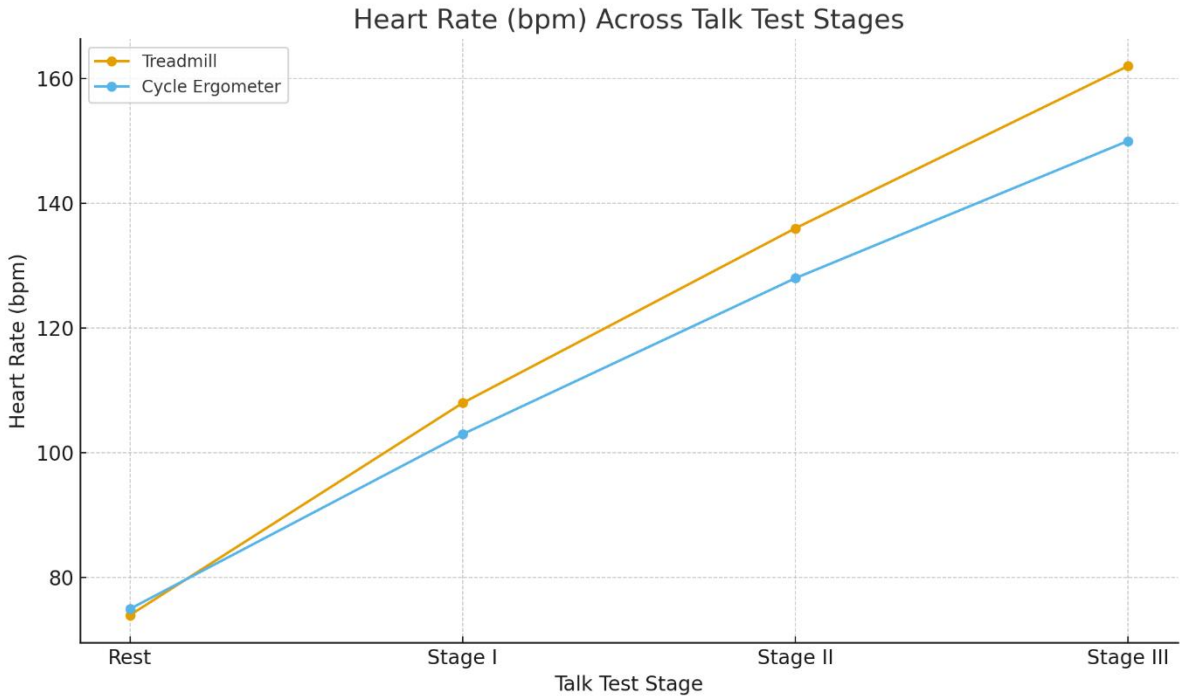


Figure 1. Heart Rate Response Across Talk Test Stages During Treadmill and Cycle Ergometer Exercise

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Heart rate (HR) progressively increased from Rest to Stage III of the Talk Test (TT) for both exercise modalities. Treadmill exercise elicited significantly higher HR values at each stage compared to the cycle ergometer, reflecting a greater cardiovascular load during weight-bearing activity. Data represent mean ± SD for 30 participants.

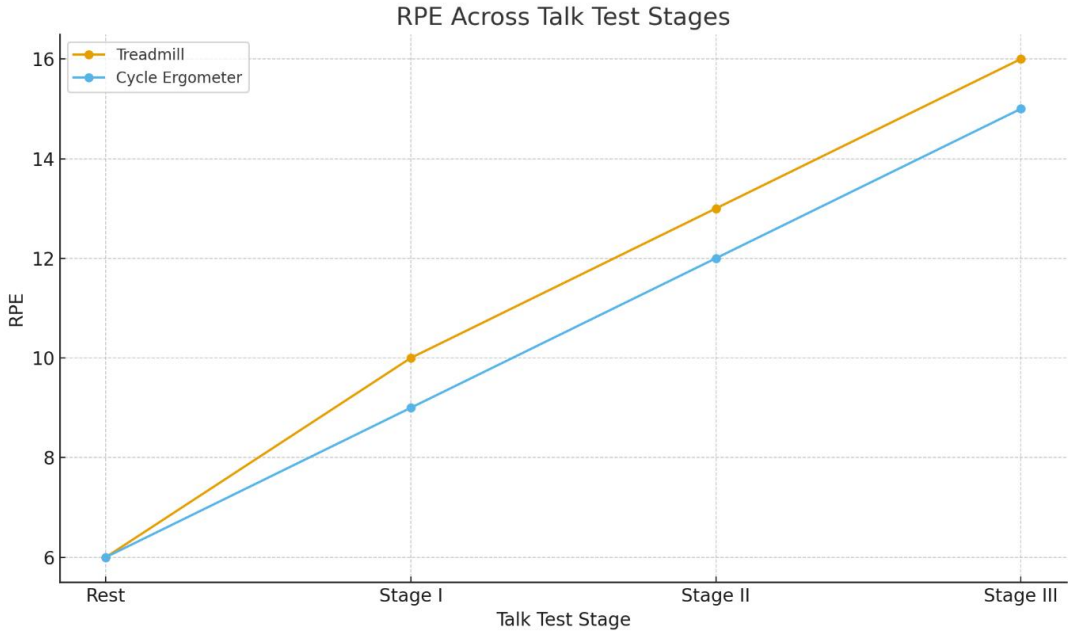


Figure 3. Rating of Perceived Exertion (RPE) Across Talk Test Stages

RPE scores increased systematically with advancing TT stages. Treadmill exercise showed slightly higher perceived exertion than cycling, particularly at Stage II and Stage III. The alignment between RPE progression and TT speech thresholds supports the Talk Test as a valid subjective measure of effort.

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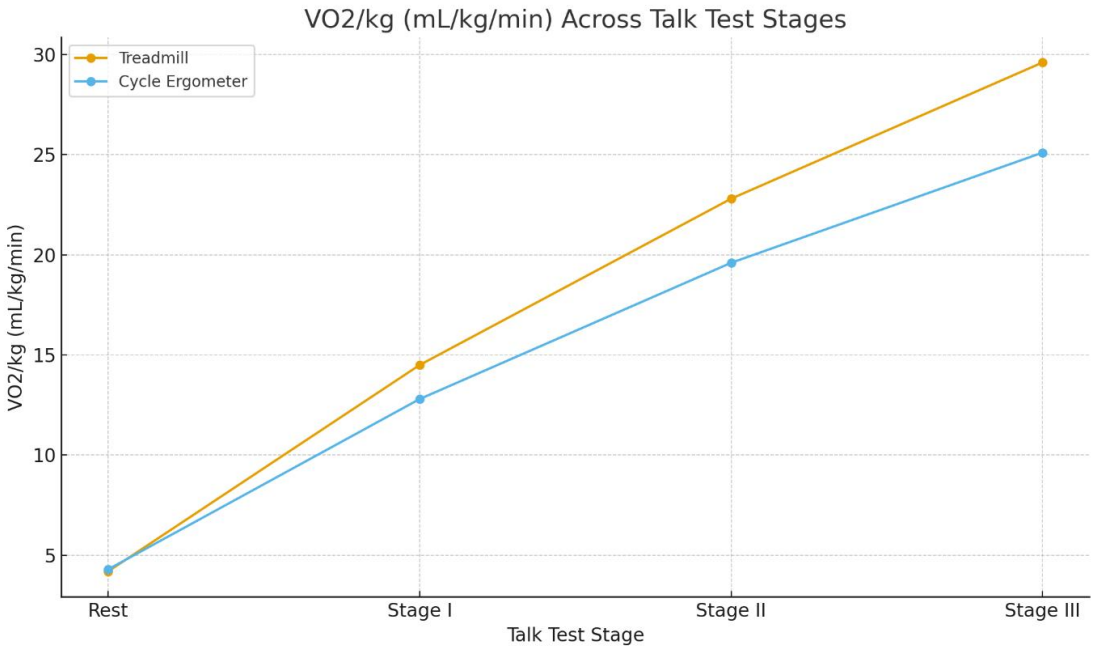


Figure 2. Oxygen Uptake (VO_2/kg) Across Talk Test Stages

Relative oxygen uptake (VO_2/kg) demonstrated a stage-wise rise during both treadmill and cycle ergometer protocols. Treadmill testing produced consistently higher VO_2/kg values across all stages, indicating greater metabolic demand. The sharp elevation from Stage I to Stage III corresponds to increasing respiratory effort and speech difficulty.

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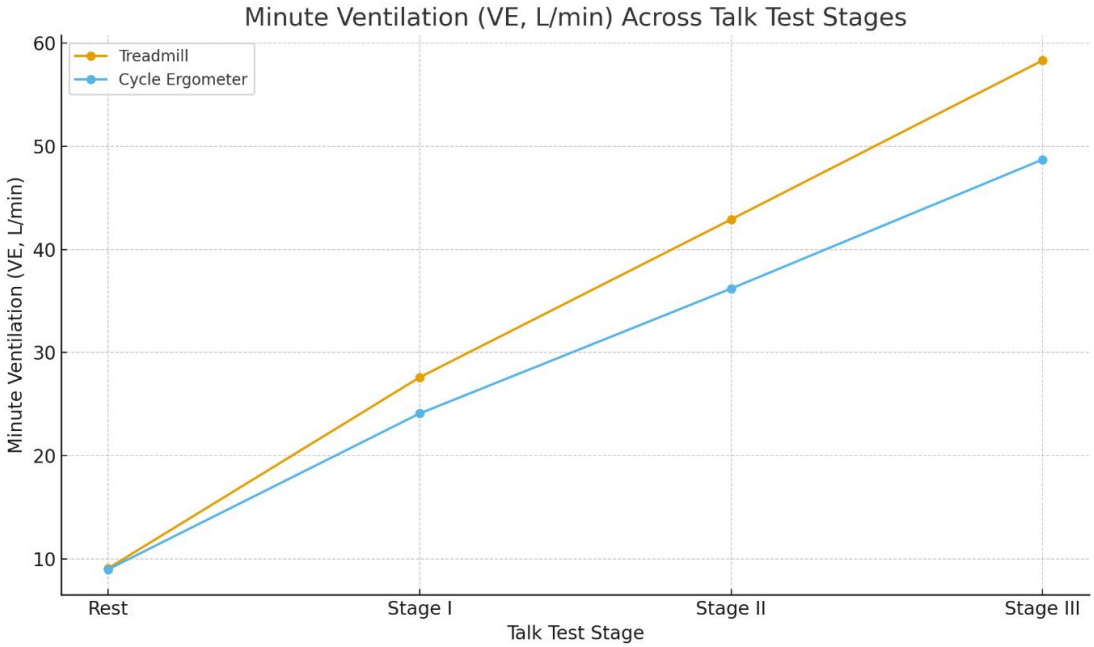


Figure 4. Minute Ventilation (VE) Response Across Talk Test Stages

Minute ventilation (VE) rose steadily across TT stages for both modalities, with treadmill exercise producing greater ventilatory output at each stage. The pronounced increase at Stage III reflects elevated respiratory drive associated with higher exercise intensity and reduced speech comfort.

DISCUSSION

The present study examined the physiological responses associated with the Talk Test (TT) during treadmill and cycle ergometer exercise among healthy young adults in Pakistan. The findings demonstrated that TT stages were closely aligned with progressive increases in key cardiopulmonary variables, including heart rate (HR), oxygen uptake (VO_2/kg), minute ventilation (VE), respiratory rate (RR), metabolic equivalents (METs), and rating of perceived exertion (RPE). These results support the applicability of the TT as a practical, low-cost, and physiologically valid tool for estimating exercise intensity within this population.

Consistent with previous work, a clear stage-wise rise in physiological responses was observed as speech became increasingly difficult. This aligns with the foundational principle of the TT—that the ability to converse comfortably decreases as ventilatory demands increase during exercise [13,14]. As exercise intensity

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approaches the ventilatory threshold (VT), phonation competes with ventilation for respiratory control, resulting in perceptible difficulty speaking. The strong correlations observed in the current study between TT stages and variables such as HR, METs, VO_2/kg, and RPE are consistent with earlier research demonstrating the TT's reliability as a surrogate marker for VT and lactate threshold [15–17]. These findings indicate that the TT can effectively guide exercise intensity prescriptions in both clinical and fitness contexts in Pakistan.

Comparisons between the two exercise modalities revealed that treadmill exercise elicited significantly higher physiological demands than cycle ergometry at equivalent TT stages. These findings are consistent with previous literature showing that treadmill exercise typically produces higher HR and VO_2 responses due to its weight-bearing nature and greater involvement of stabilizing musculature [18,19]. The higher metabolic and ventilatory load during treadmill exercise may also reflect greater muscle recruitment, increased stride mechanics, and overall biomechanical differences. This suggests that TT thresholds should be interpreted modality-specifically, particularly when designing exercise prescriptions across different equipment types.

Moreover, oxygen saturation (SpO_2) showed a modest but significant decline across TT stages in both modalities, although values remained within normal clinical ranges. Similar findings have been reported in studies where increasing respiratory demand reduces alveolar oxygen exchange efficiency during near-maximal effort [20]. The lack of a significant modality effect on SpO_2 in this study suggests that this parameter is less sensitive to differences between treadmill and cycle workloads in healthy individuals.

Importantly, the present study contributes novel data from a South Asian population, addressing a gap in the literature. Cultural, linguistic, and physiological factors can influence speech patterns, breathing mechanics, and exercise behaviors, all of which have the potential to affect TT performance [21]. For example, variations in cadence, phrasing, and vocal exertion may alter speech comfort thresholds during exercise. The current study, by using a standardized English passage commonly understood in Pakistan, provides a culturally appropriate method

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for evaluating speech difficulty during exercise. This enhances the ecological validity of the TT for use in local rehabilitation centers, fitness facilities, sports programs, and primary healthcare settings.

The strong associations observed between TT stages and RPE also reinforce the value of incorporating subjective measures of exertion into exercise monitoring. While RPE is widely used and well validated, it can be influenced by psychological factors such as motivation, anxiety, and mood [22]. The TT offers a complementary and intuitive cue that may be easier for beginners, clinical populations, or individuals with limited exercise training to interpret. Combining TT feedback with RPE may therefore enhance exercise safety and self-regulation, particularly in settings where advanced monitoring tools are unavailable.

This study has several strengths, including the use of breath-by-breath gas analysis, randomized testing order, and standardized protocols across modalities. However, certain limitations should be acknowledged. The sample consisted of young, healthy university students, which may limit generalizability to older adults, sedentary individuals, or those with cardiopulmonary disease. Future research should examine TT validity across broader age groups, clinical populations, and real-world exercise environments. Additionally, speech characteristics in Urdu and Pashto may differ from English, and future studies should explore whether TT outcomes vary when using passages in native languages.

Overall, the findings of this study support the Talk Test as a simple, robust, and cost-effective approach for monitoring exercise intensity. Given the limited availability of advanced cardiopulmonary testing equipment in many regions of Pakistan, the TT may serve as a valuable tool for physiotherapists, clinicians, and fitness professionals seeking safe and practical methods to prescribe and monitor aerobic exercise.

CONCLUSION

The findings of this study demonstrate that the Talk Test (TT) is a valid and practical method for estimating exercise intensity in healthy young adults in Pakistan. Physiological responses, including HR, VO_2/kg, METs, VE, RR, and RPE, increased progressively across TT stages during both treadmill and cycle ergometer

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exercise, confirming a strong relationship between speech comfort and cardiopulmonary workload. Treadmill exercise elicited consistently higher physiological demands than cycling at comparable TT stages, emphasizing the importance of modality-specific interpretation when prescribing exercise intensity. The strong correlations between TT stages and objective physiological markers support its utility as a simple, low-cost tool for guiding aerobic exercise prescription in resource-limited settings. Given the limited availability of cardiopulmonary testing equipment in many regions of Pakistan, the TT offers clinicians, physiotherapists, and fitness professionals an accessible means to monitor exercise intensity safely. Future research should explore the application of the TT across broader age groups, clinical populations, and in assessments using native-language speech passages to further enhance its cultural and clinical relevance.

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