Article's History: Received: 26.12.2025; Revised: 15.04.2026; Accepted: 14.05.2026; Published: 29.05.2026

Bulletin of Medical and Biological Research

Vol. 8, No. 2
2026

DOI 10.11603/bmbr.2706-6290.2026.2.14143
UDC 616.1/.2-071.3:616-08-039.76:004.77

Journal homepage: https://ojs.tdmu.edu.ua/index.php/bmbr

The 1-minute sit-to-stand test: a simple tool for remote functional assessment in the era of telemedicine

Olena Bakalets*
PhD in Medical Sciences, Associate Professor
I. Horbachevsky Ternopil National Medical University
46001, 1 Maidan Voli, Ternopil, Ukraine
https://orcid.org/0000-0002-5309-4675

Abstract. Current challenges facing the healthcare system, particularly the COVID-19 pandemic and military conflicts, necessitate the expansion of remote healthcare delivery capabilities. Telemedicine creates new opportunities for monitoring patients' conditions; however, it requires the implementation of simple, valid, and accessible tools for assessing functional status. Therefore, the aim of this study was to justify the feasibility of using the 1-minute sit-to-stand test for remote assessment of functional ability, as well as to analyze its clinical utility and potential for use in outpatient telerehabilitation. The study was conducted as an analytical review of scientific sources, systematizing data selected from the PubMed and Web of Science databases over the past 10 years. Results indicate that assessing cardiorespiratory interaction during physical exertion and in the recovery period is more informative than analyzing resting parameters; at the same time, cardiopulmonary exercise testing remains the gold standard, but its application is limited by complexity, the need for specialized equipment and high resource costs. The 6-minute walk test partially overcomes these limitations, but is not always suitable for remote use. Against this backdrop, the 1MSTST stands out for its practical utility: it allows for the quantitative determination of exercise tolerance, the assessment of cardiorespiratory response during test and in recovery phase, and identification of signs of reduced physical performance in patients. Its ease of use and lack of need for specialized equipment make it suitable for use outside the clinic. Additional benefits are provided by the use of mobile digital devices (smartphones, pulse oximeters, ECG patches, etc.), which increase the accuracy of data recording, enable automated data collection and transmission to the physician, and improve real-time communication between the patient and the healthcare professional. Thus, 1MSTST is a useful tool for remote assessment of functional capacity, combining accessibility with sufficient clinical information and integrating well into modern models of telemedicine and home telerehabilitation.

Keywords: field test; physical activity; exercise tolerance; telerehabilitation; telemetry.

INTRODUCTION

Telemedicine is a distinct type of digital healthcare service that involves the provision of clinical care remotely, through synchronous or asynchronous interaction between a patient and a healthcare professional, or between healthcare professionals [1]. Throughout the various stages of human development, there has been a constant need for means of communication, which led to the emergence of writing, while messages were exchanged using birds, animals, or messengers – who can be viewed as the precursors of modern courier services. Starting in the second half of the 18th century, industrial revolutions fostered scientific, technical, and economic progress and, naturally, the rapid development of the global healthcare system. The telegraph, telephone, and other means of communication emerged, providing a qualitatively new level of communication and creating the conditions for the development of remote medical technologies. In the modern sense, the origins of telemedicine are usually associated with the use of telephone communication in medical practice. In particular, in the book "The Evolution of Telemedicine across Time", Charles R. Doarn cites one of the first documented examples of remote medical interaction: a clinical case described in 1879 in The Lancet, in which a doctor consulted a mother about her child's health over the telephone [2].

A major impetus for the development of telemedicine stemmed from the need to remotely

Suggested Citation:
Bakalets O. The 1-minute sit-to-stand test: a simple tool for remote functional assessment in the era of telemedicine. Bull Med Biol Res. 2026;8(2):6–13. DOI: 10.11603/bmbr.2706-6290.2026.2.14143

*Corresponding author

monitor the health of astronauts during space missions. To this end, NASA developed biomedical telemetry systems that enabled the real-time transmission of physiological parameters (information on heart rate, respiration, and other vital signs) to Earth. However, according to Andrew T. Simpson and his co-authors, the development of telemedicine during this period was driven not only by technological innovations but also by political and social factors, particularly the desire to reduce disparities in access to medical care. Specifically, as part of a project for the Tohono O'odham people in Arizona, space-based telemetry and communication solutions were used to provide remote consultations for patients and monitor their condition in remote regions. This made it possible to provide access to specialized medical care without the need to transport patients over long distances [3].

Thus, as early as the 1970s, the basic principles of telemedicine – which are today defined by the World Health Organization (WHO): the provision of medical services at a distance, where geographical remoteness is a determining factor, using information and communication technologies to exchange reliable information for the purposes of diagnosis, treatment, disease prevention, and improving public health [4].

The rapid development and significant transformation of the global healthcare digital landscape were accelerated by pandemic response measures during the 2019 coronavirus disease (COVID-19) pandemic and the additional strain of armed conflicts. The ongoing Russia-Ukraine war has led to catastrophic disruptions in the provision of healthcare services. As of April 2023, a WHO survey found that accessing medical care both within the country and abroad is becoming increasingly difficult due to financial, transportation, time, and other barriers. At the same time, nearly half of those surveyed noted that at least one member of their family has a chronic illness. The most common conditions cited were cardiovascular disease, diabetes, and kidney disease, highlighting the urgent need for uninterrupted access to medical care even in wartime [5].

Despite the proven effectiveness of cardiac rehabilitation, patient participation in such inpatient programs remains low due to a combination of systemic and individual barriers. These include limited access to resources, significant distance to rehabilitation centers, difficulties in organizing regular visits, financial considerations, as well as insufficient patient motivation to change their lifestyle and a lack of proper monitoring of achieved results. The situation is complicated by the limited duration of standard programs without follow-up support, which reduces the sustainability of long-term behavioral changes. Home telerehabilitation is being considered as an alternative; it is based on remote monitoring and allows for the individualization of physical exercise, the rapid transmission of clinical indicators – including electrocardiographic data – and the assessment of the patient's physical and psycho-emotional state. The use of such technologies helps increase treatment adherence through regular feedback, reminders, and clear goal-setting [6].

Despite this, the use of telemedicine in Ukraine remains limited. According to a report by the U.S. Agency for International Development, only about 4.7 % of consultations are conducted using telecommunication tools, such as video conferences, phone calls, text messaging, and other digital communication channels [7]. Under these conditions, it is particularly important to find effective ways to monitor human physiological parameters that do not require expensive and technically complex equipment, yet still provide reliable data on health status.

Robert Ross et al. [8] argue that assessing physiological parameters at rest is insufficient to reflect the body's overall health, and that analyzing the body's response to physical exertion is far more informative, as it requires the coordinated interaction of many bodily systems. Physical activity is defined as any body movement performed by skeletal muscles that requires energy expenditure and, consequently, oxygen consumption. At rest, oxygen consumption is approximately 250 ml/min. During physical exertion, oxygen consumption can increase up to 15-fold. Increased energy consumption by skeletal muscles leads to an increase in lung tidal volume, ventilation rate, gas exchange efficiency, and so on [9]. To meet the increased metabolic demands of tissues, cardiac output increases by at least eight times compared to the resting state. This is achieved through an increase in heart rate (HR), improved cardiac contractility, increased venous return, and vasodilation of blood vessels in the areas involved in physical activity [10].

Thus, a quantitative assessment of cardiorespiratory interaction reflects the level of the body's functional capacity and is a powerful predictor of mortality risk. It encompasses the efficiency of pulmonary ventilation and gas diffusion, systolic and diastolic function of both ventricles, ventricular-arterial coupling, the efficiency of the vascular bed and blood system in ensuring proper redistribution and delivery of oxygen in accordance with the increasing energy demands of tissues, as well as the metabolic activity of skeletal muscles, including their capacity to consume and utilize oxygen and nutrient substrates and to generate afferent regulatory signals to the centers controlling cardiovascular and respiratory activity [8].

Sundeep Chaudhry et al. [11] define cardiopulmonary exercise testing (CPET) as the "gold standard" for assessing cardiorespiratory fitness. Peak oxygen consumption (VO2) during exercise characterizes the complex mechanism by which the respiratory system meets oxygen demand, its transport by the cardiovascular system, and its utilization by tissues, and allows for the differentiation of cardiac, pulmonary, or peripheral causes of functional impairment for effective personalized treatment [9, 11].

Cardio-pulmonary exercise testing is a universal clinical assessment tool used for a comprehensive analysis of functional status in cardiovascular (coronary artery disease, chronic heart failure, cardiomyopathies, congenital heart defects, pulmonary hypertension), respiratory (chronic obstructive pulmonary disease, bronchial asthma, interstitial lung diseases, cystic fibrosis), and metabolic (obesity, diabetes mellitus, metabolic syndrome) pathologies, as well as in diseases of the musculoskeletal system (myopathies, deconditioning) and peripheral vascular diseases; at the same time, the method is used for preoperative risk stratification, monitoring the effectiveness of rehabilitation measures, and determining the causes of dyspnea of unknown origin [12, 13].

Despite its high diagnostic value, cardiopulmonary exercise testing has a number of significant limitations. In particular, performing CPET requires specialized, expensive equipment (gas analyzers, ergometric systems), standardized conditions, and the involvement of qualified medical personnel, which limits the availability of this diagnostic test, especially in outpatient settings [14]. In addition, the test is relatively lengthy and physically exhausting for the patient, which may complicate its performance in patients with severe functional impairments or comorbidities.

The combination of these factors necessitates the search for and implementation of simpler, more accessible, and safer alternative methods for assessing the body's functional status, which are simultaneously characterized by adequate validity and suitability for remote application.

The aim of the study: to justify the feasibility of using the 1-minute sit-to-stand test for remote assessment of patients' functional capacity, as well as to analyze its clinical informative value and potential for use in home telerehabilitation settings.

MATERIALS AND METHODS

This study was conducted as a narrative review incorporating elements of a systematic analysis of current scientific data, which were retrieved from the electronic scientometric databases PubMed and Web of Science. The analysis included publications from the past 10 years containing data on the validity, reproducibility, sensitivity, and clinical significance of the 1MSTST in patients with cardiorespiratory, metabolic, and other pathologies, as well as studies devoted to the use of the test in telemedicine and home telerehabilitation. During the screening phase, titles and abstracts were analyzed, followed by a full-text evaluation of articles relevant to the review's scope. Exclusion criteria included publications without full text, duplicate publications, conference abstracts without a detailed presentation of results, studies with an insufficiently described or methodologically flawed research base, as well as articles with incomplete or contradictory data. No statistical data analysis was performed within the scope of this study, as the work is of a review nature.

RESULTS AND DISCUSSION

During physical exertion, patients with chronic cardiorespiratory disorders often experience disturbances in the ventilation-perfusion ratio, accompanied by a decrease in the partial pressure of oxygen in arterial blood. The development of arterial hypoxemia limits the ability to perform physical work and leads to a decrease in exercise tolerance. Clinically, this manifests as dyspnea, which reflects metabolic changes and hypoxia-induced cardiorespiratory disturbances. According to Mallikarjuna Korivi and colleagues, the severity of symptoms correlates with the degree of reduced arterial blood oxygenation [9, 15].

Traditionally, patients' functional capacity has been assessed primarily based on their responses to questions regarding daily physical activity, specifically their ability to climb stairs or walk a certain distance without becoming short of breath. This approach relies on self-reporting and does not ensure the objectivity of the results. Consequently, the data obtained may either overestimate or underestimate the actual level of physical endurance [16].

Studies of the interaction between the cardiovascular and respiratory systems under various physiological and pathological conditions have long been the subject of scientific analysis. Igor Malović et al. [17] define physical exercise as an organized, structured, and repetitive form of physical activity aimed at achieving a specific functional outcome that directly modifies cardiorespiratory interaction. At the same time, the coordinated functioning of these systems is maintained even at rest: in particular, the phenomenon of respiratory sinus arrhythmia reflects the physiological variability of the heart rate, in which the heart rate increases during inhalation and decreases during exhalation.

Modern approaches to assessing the cardio-respiratory connection involve not only identifying changes that maintain homeostasis – particularly gas exchange – during physical exertion, but also analyzing the recovery period. The rate and completeness of the return of physiological parameters to baseline levels after the cessation of exertion are decisive. Early post-exercise changes are considered the most informative, as they reflect the restoration of parasympathetic regulation and the gradual reduction of sympathetic influence. Although recovery is viewed as a process opposite to exercise, its assessment must be based on clear time intervals and the rate of normalization of parameters. A delay in these processes or an insufficient degree of recovery may indicate limited adaptive capacity of the autonomic nervous system or the presence of autonomic dysfunction. This approach has particular diagnostic value in patients who are asymptomatic at rest. In particular, in patients with heart failure and preserved ejection fraction, reduced exercise tolerance is often one of the first objective indicators of functional impairment [10, 17].

It is clear that when selecting the type of physical activity for remote testing, we must take into account the patient's physical capabilities, the availability of technical equipment for both recording the measured parameters and for communication, and, above all, the purpose of the testing – that is, the clinical problem that needs to be addressed. In addition, the results obtained must have high sensitivity and correlate with peak VO2. It is reasonable to choose types of physical activity that do not require special training and correspond to a person's usual daily activities, that is, that replicate real-life conditions as closely as possible. It is precisely these methods of assessing the body's functional state that have come to be known as field tests. As early as the 1960s, walking was proposed as a standardized physical exercise, with the body's functional reserves and ability to adapt to the load analyzed by varying the test duration, distance covered, pace, and gait pattern [16]. Subsequently, among numerous modifications, the 6-minute walk test (6MWT) was identified, characterized by adequate validity, ease of administration, good patient tolerance, and the ability to adequately reflect the level of daily physical activity [18, 19]. However, the use of the 6MWT is also accompanied by a number of limiting conditions. For example, results depend on patient motivation, the adequacy of instruction comprehension, and the learning effect, while standardized administration requires a straight path at least 30 meters long. An additional limiting factor is the risk of falling, especially among elderly patients. The combination of these factors often complicates the use of the method in outpatient settings [20].

Therefore, during the COVID-19 pandemic, the 1-minute sit-to-stand test (1MSTST) became an alternative for both in-person and virtual consultations, in which the physical exertion involved repeated transitions from a sitting to a standing position over a fixed period of time.

To perform the 1MSTST, a chair without armrests with a seat height of approximately 43–46 cm and a timing device (stopwatch, clock, timer) are used; if necessary, a pulse oximeter is used to monitor heart rate (HR) and oxygen saturation (SpO2). Before starting, the patient is instructed on the procedure and shown the technique. The starting position is sitting, with the feet flat on the floor and the arms crossed over the chest to prevent using them for assistance when standing up. It is important to ensure the chair is stable and the environment is safe. For one minute, the patient performs as many full transitions as possible from a standing to a sitting position (standing up and sitting down), maintaining their own pace and without using their hands. During the test, the number of repetitions performed is recorded, and, if possible, changes in clinical symptoms (shortness of breath, fatigue) and the dynamics of hemodynamic parameters and oxygen saturation are assessed. After the test is completed, exercise tolerance is analyzed; if necessary, monitoring continues during the recovery period, which allows for a comprehensive assessment of the patient's functional status and the nature of their response to submaximal physical exertion [20, 21].

The number of full sit-to-stand repetitions performed in one minute is the primary outcome of the 1MSTST. Additionally, it is advisable to record blood oxygen saturation, changes in heart rate, blood pressure (BP), as well as subjective assessments of exertion, shortness of breath, and fatigue using the Borg scale. The method does not require complex, expensive equipment, is easily reproducible under various conditions, and is highly standardized, ensuring its practical suitability for clinical use [19, 21].

With the advent of affordable personal digital devices, such as mobile phones and smartwatches, accelerometers or GPS technology can be used to analyze results. This allows patients to independently conduct field tests in their familiar surroundings and at a time that is convenient for them. For convenience, special interactive apps can be installed on personal mobile phones or other devices—that is, those with which patients are already familiar. This allows for the additional recording of data on spontaneous physical activity collected by the phone's sensors or any wearable gadget connected to it [22].

Improvements to the classic 1STST through the integration of biomechanical sensors aim to increase the objectivity, scope, and clinical relevance of the results obtained, not only for monitoring the progression of neuromuscular, cardiorespiratory, and other diseases, but also for tracking age-related declines in physical activity. The range of auxiliary systems is rapidly expanding, and it is already possible to measure heart rate and heart rate variability (HRV) [23]. Some systems include a cardiac patch for ECG, a portable cuff for measuring blood pressure, and/or a respiratory monitor [24]. As a result, telemetry (mHealth) is rapidly developing—a set of technologies and tools that ensure continuous data collection (remote measurement), real-time interpretation, and transmission of information to the physician. Some digital platforms allow for the processing of results from multiple patients, offer capabilities for retrospective analysis, and utilize PACS (Picture Archiving and Communication System), i.e., a service for the collection, transmission, storage, and processing of images, etc. It is clear that the implementation of the capabilities offered by the industry requires sustainable funding, regulatory frameworks, training for healthcare professionals, and, of course, appropriate technological infrastructure [25].

Remote monitoring of physical activity at home involves the step-by-step collection of data (questionnaires, heart rate, blood pressure, SpO2, ECG readings, etc.) before, during, and after the activity, followed by the transmission of this information to the monitoring center (Fig.). Data transmission can occur in three modes: synchronous, which provides continuous real-time monitoring of parameters; asynchronous, which involves accumulating information for later transmission and delayed analysis; and remote monitoring mode, designed for long-term observation of the patient's condition. Practical application is most often based on a combination of these approaches, which allows for simultaneous monitoring of exercise safety, analysis of parameter dynamics, and, if necessary, timely remote adjustment of the rehabilitation program [2, 6].

When administering functional capacity tests remotely, significant challenges arise regarding the verification of proper performance and the objectivity of data recording. In a study by Simin Xie et al., an approach to overcoming these challenges was proposed by developing and validating a machine learning model in patients with COPD based on the use of built-in smartphone sensors. Specifically, an accelerometer and a gyroscope were used to record physical activity, and their signals were analyzed to identify "sit-stand" cycles. The peak and minimum values of the accelerometer signals underwent preliminary screening, which allowed for the precise determination of transition points between movement phases and the quantitative assessment of the number of repetitions. This approach minimizes the influence of subjective errors characteristic of self-counting or visual monitoring. Additionally, the algorithm accounted for patients' individual clinical characteristics, ensuring more accurate modeling of functional exercise tolerance. The resulting digital parameters were used to construct a predictive model of 6MWT distance, which demonstrated high agreement with actual values. Thus, the integration of smartphone sensor data with machine learning methods allows for increased objectivity in remote testing, standardizes the assessment of the 1-minute sit-to-stand test, and expands its application in the telemedical management of patients with COPD [20].

Md Rafi Islam et al. set out to develop a device capable of continuously monitoring physical activity in real-life settings. The system they proposed combines inertial sensors (an accelerometer and a gyroscope), which record the trajectory and velocity characteristics of foot movement, with a strain gauge integrated into the shoe laces, which detects changes

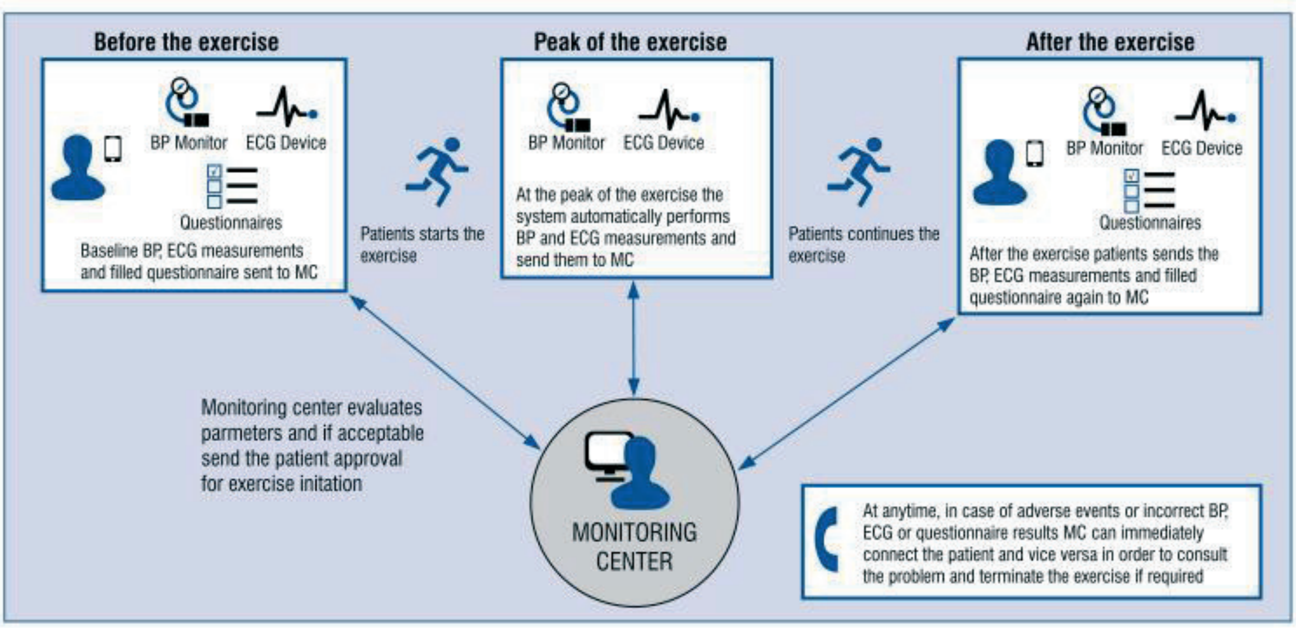

Fig. Concept and design of home training utilizing telemonitoring technology: BP – blood pressure; ECG – electrocardiogram; MC – Monitoring Center [6].

in their tension. The signals obtained reflect the redistribution of mechanical load during the initiation of the transition from a sitting to a standing position. The integration of these data sources enables not only the quantitative counting of standing-up events but also the determination of their duration, which is clinically significant as an indicator of lower limb muscle strength and the functional state of the musculoskeletal system for assessing the risk of falls. The compactness and autonomy of the sensor system allow for its use in everyday living conditions without significantly affecting the user's behavioral patterns, which, in turn, enhances the ecological validity of the results obtained. Given that postural stability during movement is a key prerequisite for maintaining independence, especially in elderly patients, such indicators can be considered objective markers of the level of daily physical activity [26].

The 1-minute sit-to-stand test plays a crucial role in assessing a person's functional status, prognosis, and disease outcomes, as well as in monitoring the effectiveness of treatment and rehabilitation measures for virtually all chronic respiratory diseases and many cardiovascular conditions. It allows for the assessment of a patient's functional status without the need for the complex and expensive equipment required for cardiorespiratory stress testing, as well as in patients for whom such testing is contraindicated. Remote monitoring facilitates the early detection of changes and the prompt adjustment of treatment measures, reducing the number of hospitalizations and emergency visits [27]. In cases of chronic lung diseases (e.g., COPD, interstitial lung diseases), remote monitoring (using pulse oximeters, wearable devices, and smartphone apps) enables improved self-management, timely detection of exacerbations, and reduced burden on inpatient services [20, 28].

The scope of application of the 1-minute sit-to-stand test has long extended beyond the cardiopulmonary field. The simplicity of the test allows for a non-specific, comprehensive assessment of many systems involved in physical activity. In particular, its results can help determine the degree of functional impairment in neuromuscular diseases [29], chronic fatigue, post-viral asthenia syndrome, post-COVID-19 recovery, in frail older adults [20, 30], and other conditions.

CONCLUSSIONS

It has been established that the 1-minute sit-to-stand test (1MSTST) is a simple, safe, and accessible tool for assessing functional capacity that does not require specialized equipment and can be performed in an outpatient setting. It has been demonstrated that the 1MSTST has adequate clinical utility and can be used as an alternative to more complex or resource-intensive methods, such as exercise cardiopulmonary testing or the 6-minute walk test. It has been shown that the test allows for the objective assessment of exercise tolerance by evaluating the integrated response of the cardiorespiratory system, not only during exercise but also during the recovery period, which enhances the diagnostic value of the test and enables the detection of early signs of impaired adaptive mechanisms. It is emphasized that the use of the 1-minute sit-to-stand test in a telemedicine format contributes to increased access to medical care, ensures continuous monitoring of patients' condition, and can be effectively integrated into home telerehabilitation programs.

Thus, the implementation of the 1MSTST into clinical practice and remote monitoring models is a feasible and promising direction, especially in the context of limited access to medical resources and the growing need for personalized patient care.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

The author declares no conflict of interest.

REFERENCES

1. World Health Organization. Scaling up telemedicine I n the WHO European Region. Available from: https://www.who.int/europe/publications/i/item/WHO-EURO-2025-12185-51957-79682.
2. Charles R. Doarn. The evolution of telemedicine across time. In: Telemedicine – Models of Care. Rijeka: IntechOpen; 2025. p. 1-19. Available from: https://www.researchgate.net/publication/395372434_The_Evolution_of_Telemedicine_across_Time.
3. Simpson AT, Doarn CR, Garber SJ. Interagency cooperation in the twilight of the great society: Telemedicine, NASA, and the Papago nation. The Journal of Policy History. 2020;32(1):25-51. DOI: 10.1017/S0898030619000265.
4. World Health Organization, International Telecommunication Union. National eHealth strategy toolkit. Geneva: World Health Organization; 2012. Available from: https://iris.who.int/items/9cc67c08-78e6-432a-996e-0fa06f47e6ce. [Accessed 27 June 2022].
5. Narayan A, Petryk M, Savchuk S, Villarino K, Lopez I, Morgun E, Bakirova A, Kamets B, Le Tran Q, Komzyuk S, Kharbas V, Asch S, Pickering A. TeleHelp Ukraine: A distributed international telemedicine response to the ongoing war. J Glob Health. 2024;14:04158. DOI: 10.7189/jogh.14.04158.

6. Milewski K, Małecki A, Orszulik-Baron D, Kachel M, Hirnle P, Orczyk M, Dunal R, Mikołajowski G, Janas A, Nowak Z, Kozak K, Roskiewicz W, Nierwińska K, Izworski A, Rybicki A, Buszman PP, Piotrowicz R, Buszman PE. The use of modern telemedicine technologies in an innovative optimal cardiac rehabilitation program for patients after myocardial revascularization: Concept and design of RESTORE, a randomized clinical trial. Cardiol J. 2019;26(5):594-603. DOI: 10.5603/CJ.a2018.0157.
7. World Health Organization. Health needs assessment of the adult population in Ukraine. Geneva: World Health Organization; 2023. Available from: https://www.who.int/europe/publications/i/item/WHO-EURO-2023-6904-46670-70096. [Accessed: 24 Oct 2025].
8. Ross R, Blair SN, Arena R, Church TS, Després JP, Franklin BA, Haskell WL, Kaminsky LA, Levine BD, Lavie CJ, Myers J, Niebauer J, Sallis R, Sawada SS, Sui X, Wisløff U; American Heart Association Physical Activity Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Clinical Cardiology; Council on Epidemiology and Prevention; Council on Cardiovascular and Stroke Nursing; Council on Functional Genomics and Translational Biology; Stroke Council. Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign: A Scientific Statement From the American Heart Association. Circulation. 2016;134(24):e653-99. DOI: 10.1161/CIR.0000000000000461.
9. Korivi M, Ghanta MK, Nuthalapati P, Natesh NS, Tang J, Bhaskar L. Influence of Exercise on Oxygen Consumption, Pulmonary Ventilation, and Blood Gas Analyses in Individuals with Chronic Diseases. Life (Basel). 2025;15(8):1255. DOI: 10.3390/life15081255.
10. Fresiello L, Meyns B, Di Molfetta A, Ferrari G. A Model of the Cardiorespiratory Response to Aerobic Exercise in Healthy and Heart Failure Conditions. Front Physiol. 2016;7:189. DOI: 10.3389/fphys.2016.00189.
11. Chaudhry S, Kumar N, Arena R, Verma S. The evolving role of cardiopulmonary exercise testing in ischemic heart disease - state of the art review Curr Opin Cardiol. 2023;38(6):552-72. DOI: 10.1097/HCO.0000000000001086.
12. Radtke T, Crook S, Kaltsakas G, Louvaris Z, Berton D, Urquhart DS, Kampouras A, Rabinovich RA, Verges S, Kontopidis D, Boyd J, Tonia T, Langer D, De Brandt J, Goërtz YMJ, Burtin C, Spruit MA, Braeken DCW, Dacha S, Franssen FME, Laveneziana P, Eber E, Troosters T, Neder JA, Puhan MA, Casaburi R, Vogiatzis I, Hebestreit H. ERS statement on standardisation of cardiopulmonary exercise testing in chronic lung diseases. Eur Respir Rev. 2019;28(154):180101. DOI: 10.1183/16000617.0101-2018.
13. Glaab T, Taube C. Practical guide to cardiopulmonary exercise testing in adults. Respir Res. 2022;23(1):9. DOI: 10.1186/s12931-021-01895-6.
14. Neder JA, Phillips DB, Marillier M, Bernard AC, Berton DC, O'Donnell DE. Clinical Interpretation of Cardiopulmonary Exercise Testing: Current Pitfalls and Limitations. Front Physiol. 2021;12:552000. DOI: 10.3389/fphys.2021.552000.
15. Bakalets O., Fedoniuk L.Ya., Shapoval O. M., Behosh N. Current pathogenetic and diagnostic aspects of dyspnea in long COVID. Bulletin of Problems Biology and Medicine. 2023;2(169):18-27. DOI: 10.29254/2077-4214-2023-2-169-18-27.
16. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166(1):111-7. DOI: 10.1164/ajrccm.166.1.at1102.
17. Malović I., Zeković M.M., Zeković J., Mazić S., Platiša M.M. Assessment of Cardio-Respiratory Relationship during and after Exercise in Healthy Recreative Male Subjects: A Pilot Study. Applied Sciences. 2024;14(12):5170. DOI: 10.3390/app14125170.
18. Lachant D., Kennedy E., Derenze B., Light A., Lachant M., White R.J. Cardiac Effort to Compare Clinic and Remote 6-Minute Walk Testing in Pulmonary Arterial Hypertension Chest. 2022;162(6):1340-48. DOI: 10.1016/j.chest.2022.06.025.
19. Pepera G, Antoniou V, Karagianni E, Batalik L, Su JJ. Validity and Reliability of the Six-Minute Walking Test Compared to Cardiopulmonary Exercise Test in Individuals with Heart Failure Systematic Review and Meta-Analysis. J Clin Med. 2025;14(23):8303. DOI: 10.3390/jcm14238303.
20. Xie S, Ge X, Huang L, Zhu W, Yang Y, Zhou M, Qu J, Guo Y. A novel machine learning model of smartphone-based 1-minute sit-to-stand test for prediction of six-minute walk test distance in patients with COPD. Clinics (Sao Paulo). 2026;81:100923. DOI: 10.1016/j.clinsp.2026.100923.
21. Hollier S. The One-Minute Sit to Stand Test Protocol. Available from: https://www.pcrs-uk.org/sites/default/files/2022-December-PCRU-1-MSTST.pdf.
22. Salvi D, Olsson CM, Molloy J, Orchard E. Clinical Usefulness of a Smartphone-Based 6-Minute Walk Test in a Hospital Outpatient Clinic Within the Constraints of the COVID-19 Pandemic: Mixed Methods Study. JMIR Form Res. 2025;9:e70495. DOI: 10.2196/70495.
23. Nierwińska K, Myśliwiec A, Konarska-Rawluk A, Lipowicz A, Małecki A, Knapik A. SMART System in the Assessment of Exercise Tolerance in Adults. Sensors (Basel). 2023;23(24):9624. DOI: 10.3390/s23249624.
24. Yamamoto A, Nakamoto H, Yamaguchi T, Sakai H, Kaneko M, Ohnishi S, Nishiuma T, Sawada K, Iwata Y, Osawa S, Ono K, Ishikawa A. Validity of a novel respiratory rate monitor comprising stretchable strain sensors during a 6-min walking test in patients with chronic pulmonary obstructive disease. Respir Med. 2021;190:106675. DOI: 10.1016/j.rmed.2021.106675.
25. Kruse CS, Krowski N, Rodriguez B, Tran L, Vela J, Brooks M. Telehealth and patient satisfaction: a systematic review and narrative analysis. BMJ Open. 2017;7(8):e016242. DOI: 10.1136/bmjopen-2017-016242.

26. Islam MR, Haque MR, Choma E, Hayes S, McMahon S, Shen X, Sazonov E. Sit-to-Stand Transitions Detection and Duration Measurement Using Smart Lacelock Sensor. Available from: https://paper.dou.ac/p/2604.00175v1 DOI: 10.48550/arXiv.2604.00175.
27. Craig W, Ohlmann S. The Benefits of Using Active Remote Patient Management for Enhanced Heart Failure Outcomes in Rural Cardiology Practice: Single-Site Retrospective Cohort Study. J Med Internet Res. 2024;26:e49710. DOI: 10.2196/49710.
28. Althobiani MA, Ranjan Y, Jacob J, Orini M, Dobson RJB, Porter JC, Hurst JR, Folarin AA. Evaluating a Remote Monitoring Program for Respiratory Diseases: Prospective Observational Study JMIR Form Res. 2023;7:e51507. DOI: 10.2196/51507.
29. Souron R, Ruiz-Cárdenas JD, Gruet M. The 1-min sit-to-stand test induces a significant and reliable level of neuromuscular fatigability: insights from a mobile app analysis. Eur J Appl Physiol. 2024;124(11):3291-01. DOI: 10.1007/s00421-024-05537-9.
30. Amput P, Srithawong A, Konsanit S, Phrompao P, Wongphon S. Test–Retest Reliability and Minimal Detectable Change of the 6-Minute Step Test and 1-Minute Sit-to-Stand Test in Post-COVID-19 Patients. J Environ Sci Health B. 2026;61(2):53-8. DOI: 10.1080/03601234.2026.2619314.

1-хвилинний тест «сісти-встати»: простий інструмент для дистанційної оцінки функціональної здатності в епоху телемедицини

Олена Бакалець
Кандидат медичних наук, доцент
Тернопільський національний медичний університет імені І. Я. Горбачевського МОЗ України
46001, майдан Волі, 1, м. Тернопіль, Україна
https://orcid.org/0000-0002-5309-4675

Анотація. Сучасні виклики системи охорони здоров'я, зокрема пандемія COVID-19 та воєнні дії, зумовлюють необхідність розширення можливостей дистанційного надання медичної допомоги. Телемедицина створює нові можливості для спостереження за станом пацієнтів, однак вимагає впровадження простих, валідних і доступних інструментів оцінки функціонального стану, придатних для використання в домашніх умовах. Саме тому метою дослідження було обґрунтувати доцільність використання 1-хвилинного тесту «сісти-встати» (1MSTST) для дистанційної оцінки функціональної здатності, а також проаналізувати його клінічну інформативність й можливості використання в позагоспітальній телереабілітації. Роботу виконано у форматі аналітичного огляду наукових джерел із систематизацією даних, відібраних у базах PubMed та Web of Science за останні 10 років. Узагальнення результатів свідчить, що оцінка кардіореспіраторної взаємодії під час фізичного навантаження та у відновному періоді є більш інформативною, ніж аналіз показників у спокої; водночас референтним методом залишається кардіопульмональне тестування з фізичним навантаженням, застосування якого обмежене складністю, потребою у спеціалізованому обладнанні, високими ресурсними витратами тощо. Тест 6-хвилинний ходьби частково долає ці обмеження, однак не завжди придатний для дистанційного використання. На цьому тлі 1MSTST вирізняється практичною доцільністю: він дозволяє кількісно визначити толерантність до навантаження, оцінити кардіореспіраторну відповідь під час виконання тесту та у фазі відновлення, а також виявити ознаки зниження фізичної працездатності у пацієнтів. Простота виконання та відсутність потреби у спеціальному обладнанні забезпечують можливість його застосування поза клінікою. Додаткові переваги створює використання мобільних цифрових пристроїв (смартфонів, пульсоксиметрів, кардіологічних патчей для ЕКГ тощо), які підвищують точність фіксації показників, забезпечують їх автоматизовану реєстрацію та передачу лікарю, а також покращують комунікацію між пацієнтом і медичним фахівцем у режимі реального часу. Таким чином, 1MSTST є доцільним інструментом для дистанційної оцінки функціональної здатності, який поєднує доступність із достатньою клінічною інформативністю та добре інтегрується у сучасні моделі телемедицини і домашньої телереабілітації.

Ключові слова: польовий тест; фізична активність; толерантність до фізичного навантаження; телереабілітація; телеметрія.