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ORIGINAL ARTICLE

Agreement between tele-assessment and face-to-face assessment of 30-s sit-to-stand test in patients with type 2 diabetes mellitus

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Abstract

Background The globalization of healthcare systems, and the aim to lower healthcare costs have all contributed to the growth of telehealth technology in recent years. However, before these systems are put into use, their efficacy should be verified. To the best of our knowledge, this is the first study focusing on the evaluation of functional exercise capacity using the 30-s sit-to-stand (30-s STS) test as a tele-assessment method in patients with type 2 diabetes mellitus (T2DM).

Aims The purpose of the study is to investigate the level of agreement between tele-assessment and face-to-face assessment of 30-s STS test in patients with T2DM.

Methods Fifty participants performed two times 30-s STS tests separated by 1 h: a face-to-face and an Internet-connected video call examination (tele-assessment). Two physiotherapists conduct these evaluations; each was blinded to the other. The order of the evaluations was designated at random for each participant and physiotherapist.

Results There was a good level of agreement between tele-assessment and face-to-face assessment of the 30-s STS test (mean differences = 0.20 ± 0.88, limits of agreement = 1.93 to − 1.53). Excellent interrater reliability was found for scores of the 30-s STS test [ICC = 0.93 (95% CI: 0.88; 0.96)]. In addition, all before and after test parameters show that there was a very good interrater reliability ($\rho \geq 0.75$).

Conclusions This study shows a good level of agreement between tele-assessment and face-to-face assessment of the 30-s STS test. Our study's findings indicate that tele-assessment is a potential application to determine the level of physical capacity remotely in patients with T2DM.

Keywords Physical assessment · Tele-assessment · Telehealth · Type 2 diabetes · 30-s sit-to-stand

Introduction

Type 2 diabetes mellitus (T2DM) is caused by hyperglycemia brought on by reduced insulin synthesis, impaired insulin utilization, or both, with symptoms such as thirst, polyuria, and weight loss [1]. Because of the high prevalence and high medical costs worldwide, research is continuing in both the diagnosis and treatment of the disease and important developments are being experienced [2]. Maintaining sufficient glycemic control and lowering cardiovascular risk factors is part of the therapy of T2DM, along with the treatment of complications and related comorbidities [3]. Many systemic complications such as cardiovascular, cognitive, psychological, and neuropathy can occur in T2DM [4]. One of the keys to the management of the disease is maintaining a healthy lifestyle that includes maintaining a healthy weight, eating a balanced diet, quitting smoking, and engaging in physical activity [5].

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Glycemic control is enhanced by physical activity, which reduces the risk of cardiovascular disease and also reduces mortality [6]. However, patients with T2DM often do not have adequate physical activity habits that may help glycemic balance [6–8]. Physical activity has psychological benefits as well as physical benefits and reduces depressive symptoms [9, 10]. Therefore, the physical conditions of T2DM patients need to be assessed to recommend individualized exercise programs and follow up on their progression by health professionals [7]. However, few studies have investigated the reliability of the 30-s sit-to-stand (30-s STS) test for assessing functional exercise capacity in the T2DM population [11, 12].

The 30-s STS test involves standing up and sitting down from a regular chair as many times as a person can in 30 s, and its validity and reliability have been proven in patients with T2DM [11, 12]. It is commonly used to assess physical performance in the lower extremities and to provide insight into functional exercise capacity [13–15]. The 30-s STS test has many advantages in that the materials required to perform this test are widely used, easy to use, and inexpensive. It also does not require professional personnel to perform the test. The test is very fast as it requires no more than 1 min per assessment. It is also a type of test used in many studies without a ground effect [16].

Nowadays, new options for clinical evaluation are provided by information and communication technology. In particular, it can benefit from Internet-based systems for the evaluation and follow-up of patients with chronic diseases who reside in distant places or lose their independence. Thus, accessibility to health services increases and the economic burden of the disease decreases [17]. However, scientific evidence is needed before recommending their use. Instead of traditional face-to-face evaluation, tele-assessment methods can be used with video conferencing method with any device with a camera, screen, microphone, speaker, and Internet access. To the best of our knowledge, there is no previous study focusing on the evaluation of the functional exercise capacity of individuals with T2DM as a tele-assessment method has been found. The aim of this study is to investigate the level of agreement between tele-assessment and face-to-face assessment of the 30-s STS test in patients with T2DM.

Methods

Study design and participants

The interrater reliability was tested using a descriptive crossover design. T2DM patients, who consult the Internal Medicine Department of Health Sciences University—İzmir Bozyaka Training and Research Hospital, for routine outpatient follow-up and were diagnosed by an internal diseases specialist were included in this study. Inclusion criteria were having been diagnosed with T2DM by an internal diseases specialist (or endocrinologist), being able to walk independently, having a smartphone and the ability to use it, and having a pulse oximeter device (for O_2 saturation measurement) and a blood pressure monitor. Exclusion criteria were having a health problem (orthopedic, neurological, internal, or cardiorespiratory) that prevents standing/walking; acute inflammation; intestinal tumor; cognitive impairment; vision and hearing loss; and/or an orthopedic, vascular, neurological, or psychiatric problem affecting balance.

Assessment procedure

The 30-s STS test was taught once when participants came for the routine control appointment. Participants' demographic and clinic details (age, gender, educational status, height, body weight, and comorbidities) were recorded after receiving consent for the study. Participants perform two physical tests: a traditional in-person examination (face-to-face) and an Internet-connected video call examination (tele-assessment). Two physiotherapists with an experience of more than 7 years did these evaluations; one physiotherapist always performed the face-to-face assessment while the other always performed the tele-assessment, and each was blinded to the other. The two evaluations were separated by 20 min, and to counterbalance any testing order effects, the order of the evaluations was designated at random for each participant and physiotherapist [18].

Thirty-second STS tests were conducted under the same time frame from 11.00 am to 3.00 pm, Monday to Friday. Participants were informed not to do any vigorous physical activities 3 h before testing and to continue taking their prescription medications. The 30-s STS is a test consisting of getting up from a standard chair (with 45–47 cm seat height) and sitting down, and the participants were instructed to rise up straight and sit down again as many times as they could in 30 s starting from the seated position [13–15].

A smartphone with a built-in microphone and camera and high-speed Internet were used for the tele-assessment. Using the WhatsApp application (WhatsApp Inc., Mountain View, CA), a live video communication was kept running between the patient and the therapist. WhatsApp is an application that has been used frequently in recent years with the coronavirus pandemic and is a promising application as a communication tool between healthcare professionals and patients [19]. When the patient was performed to tele-assessment, he was required to position the smartphone so that all his/her limbs were visible from the camera.

Before and after the tests, dyspnea perception and lower limb fatigue were questioned according to the 10-grade modified Borg scale [20], and peripheral oxygen saturation

(SpO_2), systolic/diastolic blood pressure, and heart rate were measured and recorded. While the perception of dyspnea and fatigue was questioned in the tele-assessment, oxygen saturation and blood pressure measurements were obtained by the patient by self-measurement. The patient's devices were used in both tele-assessment and face-to-face assessment to eliminate measurement tool differences.

Statistical analysis

On the recommendation of the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN), a total sample size of 50 participants was selected [21]. The Bland–Altman limits of agreement test were used to investigate the agreement between tele-assessment and face-to-face assessment methods for the 30-s STS test. Additionally, two-way random effect intraclass correlation coefficients (ICC) (ρ) and confidence intervals of the parameters were calculated for the interrater reliability analysis. SPSS Version 21 for Windows (SPSS Inc., Chicago, IL) was used to perform all of the statistical analysis, with a 0.05 α value. The ICC was considered excellent (≥ 0.75), fair to good (0.4–0.75), or poor (≤ 0.4) [22].

Results

Fifty-eight of the patients were assessed for eligibility to participate in the study. Four did not meet the inclusion criteria and four did not join in some of the assessment stages. The study was completed with a total of 50 patients (Fig. 1).

The mean + SD age and BMI of patients were 54.5 ± 6.3 years and 28.8 ± 3.5 kg/m^2, respectively. Sixty-two percent of the patients were male and 38% female. Table 1 presents the descriptive characteristics of patients.

In Fig. 2, the Bland–Altman plot illustrated a good level of agreement between tele-assessment and face-to-face assessment for the 30-s STS, with no evidence of systematic bias. The mean of the differences was 0.20 ± 0.88. The limits of agreement were 1.93 and − 1.53, respectively. Excellent interrater reliability was found for scores of the 30-s STS test [ICC = 0.93 (95% CI: 0.88; 0.96)] (Table 2).

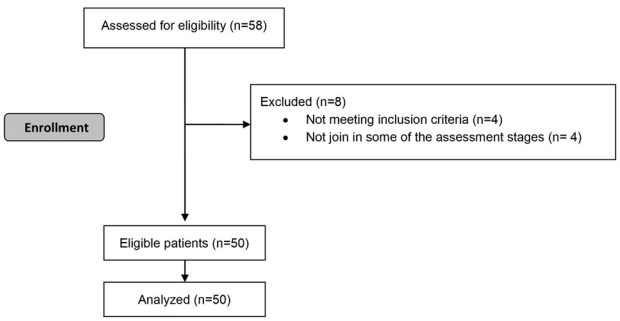


Fig. 1 Recruitment flowchart

Table 1 Descriptive characteristics of patients

Parameters	Mean ± SD
Gender (% male/female)	62.0/38.0
Age (years)	54.5 ± 6.3
BMI (kg/m^2)	28.8 ± 3.5
Educational status, *n* (%)	
Primary school	3 (6.0)
Secondary school	33 (66.0)
High school	2 (4.0)
University	10 (20.0)
Postgraduate	2 (4.0)
30-s sit-to-stand test score (face-to-face)	12.4 ± 1.83
30-s sit-to-stand test score (tele-assessment)	12.2 ± 1.62
Comorbidity, *n* (%)	
HT	25 (50.0)
COPD	2 (4.0)
CAD	6 (12.0)
HF	0

SD Standart Deviation, *BMI* Body Mass Index, *HT* Hypertension, *COPD* Chronic Obstructive Pulmonary Disease, *CAD* Coronary Artery Disease, *HF* Heart Failure

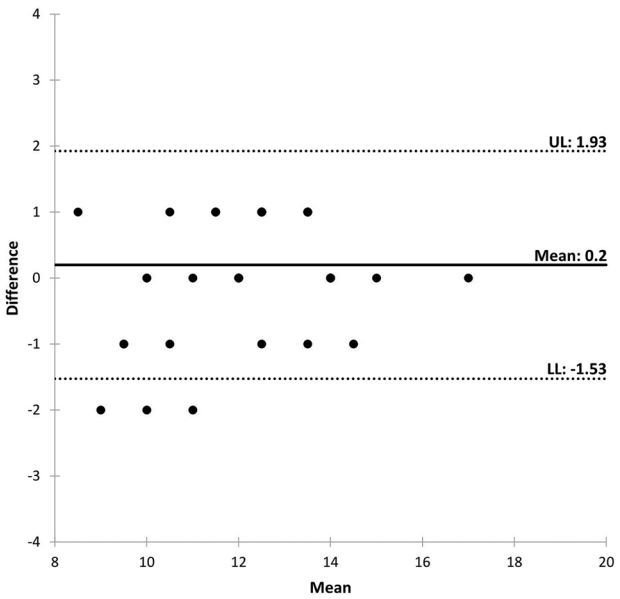


Fig. 2 Bland–Altman plot of the difference between tele-assessment and face-to-face assessment for the 30-s sit-to-stand test. The *Y* axis shows the difference between the two paired measurements and the *X* axis represents the average of these measures. The solid line represents the mean difference between the face-to-face and tele-assessment. Dotted lines are the upper and lower limits of agreement (UL and LL, respectively)

Table 2 Interrater reliability between tele-assessment and face-to-face assessment of 30-s sit-to-stand test parameters

	Mean difference between assessments (95% CI)	Interrater reliability ICC (95% CI)
30-s sit-to-stand test score (repetitions)	0.20 (−0.05, 0.45)	0.93 (0.88, 0.96)
Resting dyspnea (mBorg)	0.14 (0.03, 0.26)	0.92 (0.85, 0.95)
Resting lower limb fatigue (mBorg)	0.14 (−0.001, 0.28)	0.85 (0.74, 0.92)
Resting heart rate (bpm)	0.66 (−0.62, 1.94)	0.75 (0.56, 0.86)
Resting systolic blood pressure (mmHg)	2.16 (−1.30, 5.62)	0.89 (0.81, 0.94)
Resting diastolic blood pressure (mmHg)	1.12 (−1,24, 3.48)	0.80 (0.64, 0.88)
Resting SpO2 (%)	−0.12 (−0.36, 0.12)	0.79 (0.63, 0.88)
End-dyspnea (mBorg)	0.06 (−0.12, 0.24)	0.85 (0.74, 0.92)
End-lower limb fatigue (mBorg)	0.04 (−0.14, .022)	0.86 (0.76, 0.92)
End-heart rate (bpm)	2.06 (0.68, 3.43)	0.76 (0.57, 0.86)
End-systolic blood pressure (mmHg)	2.16 (−1.30, 5.62)	0.84 (0.72, 0.91)
End-diastolic blood pressure (mmHg)	0.12 (−1.80, 2.04)	0.88 (0.79, 0.93)
End-SpO2 (%)	−0.04 (−0.28, 0.20)	0.75 (0.57, 0.86)

CI Confidence Interval, *ICC* Intraclass Correlation Coefficient, *SpO2* Peripheral Oxygen Saturation, *mBorg* Modified Borg Score

In Table 2, the mean differences between tele-assessment and face-to-face assessment for the 30-s STS parameters and the interrater reliability values are shown. Interrater reliability was deemed "acceptable" if the score was ≥ 0.75 [22]. All parameters show that there was a very good interrater reliability ($\rho \geq 0.75$). Additionally, most of the 95% CI were narrow.

Discussion

The main finding of this study is that the 30-s STS test tele-assessment can be successfully used to assess functional exercise capacity in patients with T2DM. Our results show that there is high interrater reliability between tele-assessment and the face-to-face test methods.

The COVID-19 epidemic, the globalization of healthcare systems, and the aim to lower healthcare costs have all contributed to the growth of telehealth technology in recent years [18, 23]. However, before these systems are put into use, their efficacy should be verified against that of the more traditional health systems. Technological developments in the last decade have increased telehealth opportunities and provided greater flexibility in accessing health services [24]. In this study, we used the WhatsApp application, which can be used freely just that it needed an Internet-connected smartphone or tablet, for performing tele-assessment. WhatsApp is seen as a simple, inexpensive, and effective communication tool in the clinical health sector and its use will increase [25]. The security policy of WhatsApp is one of the important issues for its potential widespread usage in patient evaluation. WhatsApp uses end-to-end encryption for its services. It means that data and calls/video calls are encrypted and secured against third parties and wrong hands, even WhatsApp developers and authorities [26].

The 30-s STS test is often used for the evaluation of physical performance in adults because it is a simple and easy-to-use test [27]. The Centers for Disease Control recommend it as one of the tests for fall-risk screening [15]. The first reliability findings of the 30-s STS test were shown by the authors who developed it [28]. They found a high ICC for men and an excellent ICC for women. The 30-s STS reliability has been investigated in various populations. It was found an excellent ICC for people with total hip arthroplasty [29], a high ICC for people with dementia [30], excellent results in people who suffered a stroke [31], and an excellent ICC for people with multiple sclerosis [32]. To the best of our knowledge, only two studies researched on the reliability of the 30-s STS test in people with T2DM [11, 12]. Relative reliability for the 30-s STS test was excellent in both studies (for both, ICC > 0.90). In addition, Ogawa et al. [33] examined the reliability of virtual physical performance assessments in a group consisting of various diseases, and in this study, they found an excellent ICC for the 30-s STS test performed remotely. However, we think that there is a heterogeneous population in the mentioned study and that patients' self-reporting of the diagnosis was a weakness of the study. In our study, we investigated the level of agreement between tele-assessment and face-to-face assessment of the 30-s STS test in patients physician-diagnosed with T2DM. We found excellent interrater reliability (ICC = 0.93) for the 30-s STS test of T2DM patients.

When tele-assessment studies are investigated, it is shown that different methods are used in various groups [34–37]. In a systematic review, it was shown that the evaluation of some functional and neurodynamic tests with the

tele-assessment method is applicable [35]. In a recent study, Güngör et al. [34] showed that functional and core strength-endurance tests assessed using the tele-assessment approach were valid and practicable for assessing the capabilities of healthy young adults. Another recent review emphasized the fact that while tele-assessments are useful for monitoring the progression of neuromuscular illnesses, they still require improvement [38]. In our study, we showed that the 30-s STS test tele-assessment method used in the measurement of functional capacity in patients with type 2 diabetic patients is easy to use, applicable, and reliable.

The validity of the measurement of the vital signs before and after the test are crucial outcomes for the tele-assessment procedure. Kagiyama et al. [39] investigated the feasibility and validity of a tele-assessment in which healthcare providers monitor vital signs remotely. They demonstrated that telemedicine-based self-assessment of vital signs was feasible and reliable; additionally, it is a useful alternative to traditional face-to-face vital sign measurements. In their study, the agreement between tele-assessment and face-to-face assessment was excellent for all parameters. The ICC for systolic (0.92), diastolic blood pressure (0.86), heart rate (0.89), and SpO2 (0.92) were statistically significant [39]. In our study, we also found excellent agreement between tele-assessment and face-to-face assessment for vital signs both before and after the tests.

Strengths and limitations

Being the first study examining the interrater reliability, validity, and feasibility of a 30-s STS tele-assessment test in patients with T2DM, and having a sufficient sample according to COSMIN [21], can be listed as the strengths of our study. We have some limitations in our study. Our study was limited to T2DM who are more familiar with the Internet and be able to use technology. Therefore, we cannot generalize the findings of the study to all T2DM patients. Future research should assess the effectiveness of a complementing home-based treatment centered on functional capacity tele-assessment methods with a minimal clinical difference in light of our findings.

Conclusions

This study shows a good level of agreement between tele-assessment and face-to-face assessment for the 30-s STS test. Additionally, the 30-s STS test tele-assessment to assess functional exercise capacity in patients with T2DM was found to have high interrater reliability. The study's findings indicate that tele-assessment is a potential application to conduct physical evaluations remotely.

Author contribution All authors contributed to the study conception and design. Material preparation: Rıdvan Aktan, Hayriye Yılmaz, and İsmail Demir. Data collection: Rıdvan Aktan and Hayriye Yılmaz. Analysis of data: Rıdvan Aktan and Sevgi Özalevli. The first draft of the manuscript was written by Rıdvan Aktan and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability On request.

Code availability Not applicable.

Declarations

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the local Ethical Committee of the Health Sciences University Izmir Bozyaka Training and Research Hospital with approval number 2022–33 on 23/02/2022, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication Not applicable.

Conflict of interest The authors declare no competing interests.

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