Assessing Physical Performance in Older Adults during Isolation or Lockdown Periods: Web-Based Video Conferencing as a Solution

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Abstract

During the COVID-19 pandemic, face-to-face assessments were limited. Fortunately, older adults have access to web-technology (60%). Thus, we aimed to explore if assessing physical performance remotely is as reliable and valid as in person. At the end of the first lockdown, 15 older adults agreed to perform two similar evaluations in remote and face-to-face conditions. Functional capacities [5-repetitions Sit-to-Stand (STS); unipodal balance, 4-m walking speed (normal (NWS); fast (FWS)), 3-m Timed-Up and Go (normal (nTUG); fast (fTUG))] and muscle power and endurance were assessed. Fast walking speed was moderately reliable. Unipodal balance, NWS and nTUG were highly reliable (ICC>0.7). fTUG, STS, muscle endurance and power were extremely reliable (ICC>0.9). For absolute reliability, SEM varied from 15.54 to 5.14%. Finally, the MDC varied from 43.07 to 14.21%. Assessing functional capacities and muscle function remotely is as reliable and valid as a face-to-face assessment and should be considered as a clinical practice.

Key words: Aging, muscle function, evaluation, remote condition, validity.

Introduction

Normal aging leads to functional and physical declines, such as loss of muscle function (i.e. mass, strength; (1)) walking speed or balance (2). These age-related changes may impair activities of daily living (3) and increase the risk of falls, fractures (4, 5), and hospitalizations (6), which contribute to stressing the healthcare system (7). To identify these declines, it is important to perform geriatric assessments and therefore implement specific interventions in at-risk populations. These geriatric assessments are performed in "face-to-face" conditions using validated tools measuring function and physical capacities, such as the Short Physical Performance Battery (SPPB) test, senior fitness test etc. During the COVID-19 pandemic, these face-to-face assessments were very limited or even impossible due to safety restrictions (i.e. social and physical distancing), particularly for at-risk populations like older adults. Therefore, there is a crucial need to validate assessments performed in remote conditions to identify at-risk older adults, especially as the COVID-19 lockdown exacerbated physical deconditioning (8). Fortunately, previous studies showed that it is feasible and acceptable to provide rehabilitation care using synchronous and asynchronous Web-based technologies in pre-disabled (9) and frail older adults (10). In addition, the majority of older adults have digital devices (e.g. computer, tablet or smartphone) and use the Internet daily (11). Therefore, remote assessments using Web-based technologies appear to be a promising avenue to explore. To our knowledge, no studies have investigated the validity, feasibility and safety of remote physical performance assessments in older adults. However, it is important to compare face-to-face and remote conditions before implementing remote assessments as a clinical tool. Thus, we aimed to explore if physical performance evaluated in remote conditions is as reliable, sensitive and valid as in face-to-face conditions.

Methods

Study design

The COVID-19 lockdown and safety restrictions were lifted, which allowed us to carry out an exploratory tool validation study.

Population

Recruited through a volunteer databank, fifteen older adults agreed to undergo two similar evaluations within one week, under face-to-face and remote conditions, using validated tests (Figure 1). To be included in the study, participants needed to (a) have an e-mail address, an internet connection, and a digital device with a webcam at home, (b) be aged 60 and over, (c) live independently in the community, (d) be able to perform a physical performance test, (e) be able to consent (no cognitive impairments based on the Telephonic-Mini Mental State Examination (T-MMSE; (12)) The ethics committee approved this study (CERVN 20-21-05) and all participants signed a consent form prior to the study.

Table 1. Reliability and validity of virtual physical performance evaluations

	ICC (IC 95%)	SEM	SEM (%)	MDC	MDC (%)
Unipodal-balance (s)	0.79 (0.36-0.93)	7.80	15.5	21.6	43.1
Normal walking speed (m/s)	0.77 (0.32-0.92)	0.11	9.32	0.30	25.8
Fast walking speed (m/s)	0.62 (-0.14-0.87)	0.22	12.9	0.61	35.9
Normal 3m-TUG (s)	0.83 (0.50-0.94)	0.56	7.61	1.55	21.1
Fast 3m-TUG (s)	0.93 (0.78-0.98)	0.32	5.14	0,89	14.2
5 repetitions STS (s)	0.96 (0.89-0.99)	0.51	6.50	1.41	18.0
Muscle power (w)	0.99 (0.98-1.00)	2.91	5.66	8,07	15.7
Muscle endurance (n)	0.97 (0.92-0.99)	1.76	8.45	4.88	23.4

Legends: TUG: timed Up and Go; STS: sit-to-stand; ICC = Intraclass Correlation Coefficient; SEM (Standard Error of the Measurement) = SD* √1-ICC; MDC (Minimal Detectable Change) = SEM*1.96* √2; Muscle power was estimated using the validated Takaï equation18 and 10 rep STS tests; * Muscle endurance was estimated using the 30s STS.

Measures

Functional capacities

- Unipodal balance (13): Participants stood on one leg for as long as possible (max: 60 sec.) with arms along the side of the body.
- Walking speed (14): The 4-meter walking test was performed at normal and fast speeds and expressed as speed (m/s).
- Gait parameters (15): The 3-meter Timed-Up and Go (TUG), which consisted in standing from a chair, walking a 3-meter distance, turning around and then sitting down again. The TUG was performed at normal and fast speeds. This measure is related to the risk of falls (16).
- Sit-to-stand (STS) test (17): This test evaluates lower-body function. Subjects were asked to stand up from a standard height (45 cm) chair and to sit down five times (5 repetitions) as fast as possible, with arms crossed on their chest.

Muscle function

- Muscle power (18): Using the 10 repetitions of the STS, the validated Takaï equation (see ref.(18) for more details) was used to estimate muscle power.
- Muscle endurance (19): The 30-sec. chair-stand test was used to evaluate lower body muscular endurance. This test measures the maximum number of chair-stand repetitions performed in 30 seconds with arms crossed on the chest.

Evaluation protocols

Remote assessments were performed via Zoom®. To avoid measurement bias, evaluators were trained on all tests by the same research coordinator and specific technical webcam instructions were established. More specifically for the chair test, the webcam was positioned on the side to fully capture the subject in sitting and standing position. Regarding safety, the chair was placed against a wall to ensure that it could not move backward during the test. During the 4-m walking test, the webcam was placed in front or behind the participant to capture the starting and the ending points, but also the position of their feet. Regarding safety, participants were asked to remove any objects that could obstruct the passage or prevent them from stopping correctly and safely after the stop line. Finally, for the balance test, the webcam was placed in front or on the side of the participant to observe their feet and hands during the test. In addition, the set-up (chair position, distance measurement etc.) was arranged by the participant during the Zoom meeting with the help and validation of the evaluator. The face-to-face assessments were performed outside (health restrictions) by the same evaluator within a week of the remote assessment to avoid lifestyle bias.

Statistical analyses

Quantitative data were expressed as means ± SD. A Bland-Altman plot is a graphical method used to plot the difference scores of two measurements against the mean for each subject. A small range between the Limit Of Agreement (LOA) indicates a good level of agreement (20). Thereafter, we used intraclass correlation coefficient (ICC) analysis to examine the relative reliability of remote versus face-to-face measurements. The closer the coefficient is to 1, the higher is the reliability. An ICC over 0.90 is considered as excellent, between 0.9 and 0.75 as good, between 0.75 and 0.50 as moderate and less than 0.50 as poor (21).

The Standard Error of the Measurement (SEM) was used to measure the precision of measurement and the absolute reliability, and was calculated as follows: SEM = SD*√1-ICC (22). A small absolute SEM indicates a good absolute reliability of the measure. The SEM was expressed in absolute values and as a percentage of the mean scores (%SEM). More specifically, a relative SEM (%) with a value < 10% is considered acceptable (22, 23). Finally, we estimated the Minimal Detectable Change (MDC) using the absolute SEM (MDC = SEM*1.96√2; (22)). The MDC indicates the minimal amount of change that can be interpreted as a real change. A small MDC means a more sensitive measurement (22, 24).

Data were analyzed using SPSS Statistics® (Windows, v25.0; p ≤0.05: significant).

Figure 1. Individual data in face-to-face and remote condition on functional capacities and muscle function
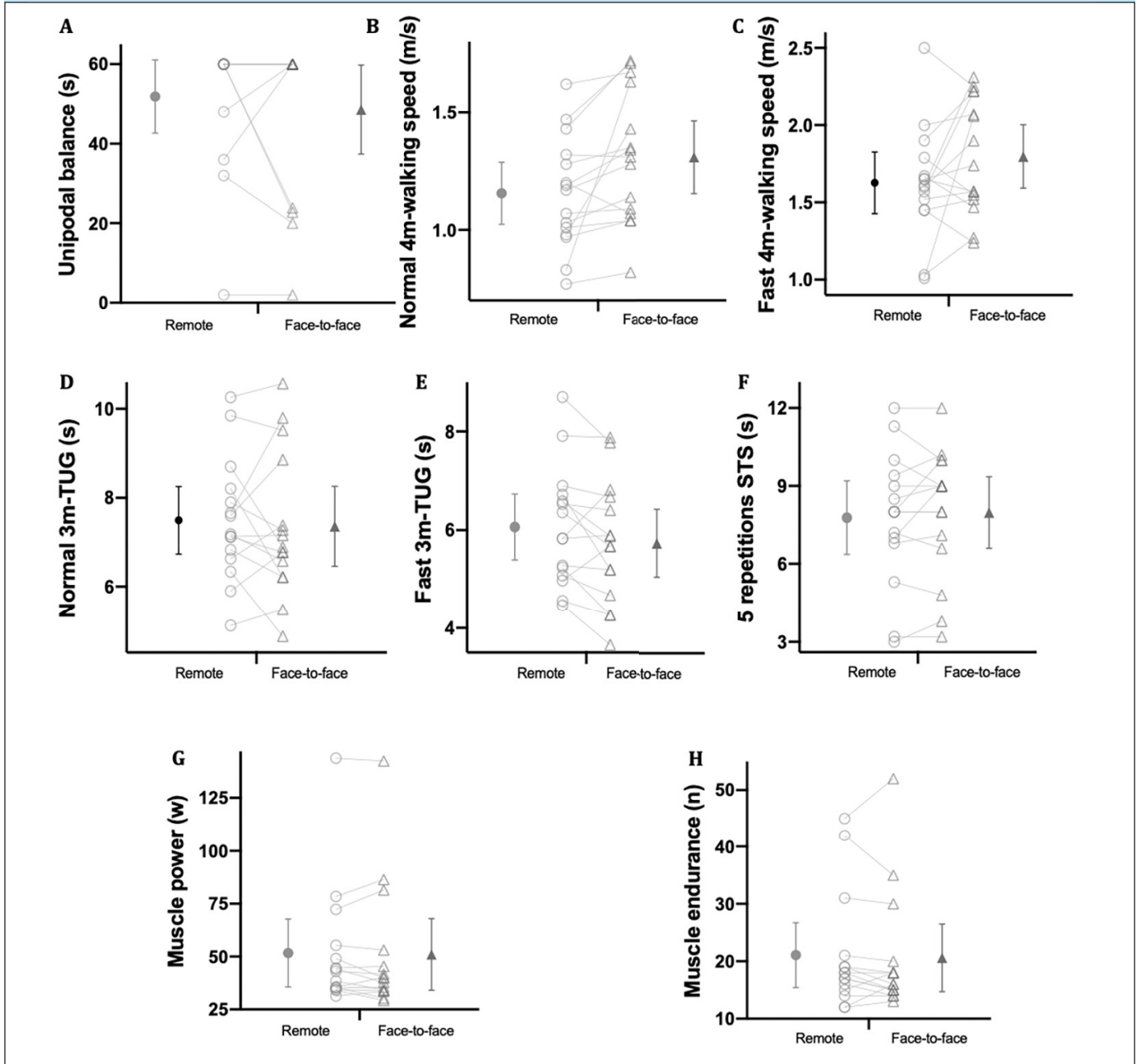
Individual data (n=15) for remote condition are presented as empty circle (○) and mean (±95% CI) as black circle (●) and for face-to-face condition as empty triangle (Δ) and mean (±95%CI) as black triangle (▲). (A) unipodal balance (s) individual data in face-to-face group (Mean: 48.6 ± 20.2; Min-Max: 2.00 – 60.00) and in remote group (Mean: 51.9 ± 16.6; Min-Max: 2.00 – 60.00); (B) normal 4m-walking speed (m/s) individual data in face-to-face group (Mean: 1.31 ± 0.28; Min-Max: 0.82 – 1.72) and in remote group (Mean: 1.16 ± 0.24; Min-Max: 0.77 – 1.62); (C) fast 4m-walking speed (m/s) individual data in face-to-face group (Mean: 1.80 ± 0.37; Min-Max: 1.24 – 2.31) and in remote group (Mean: 1.63 ± 0.36; Min-Max: 1.01 – 2.50); (D) normal 3m-Timed Up and Go (s; TUG) individual data in face-to-face group (Mean: 7.36 ± 1.63; Min-Max: 4.87 – 10.57) and in remote group (Mean: 7.49 ± 1.37; Min-Max: 5.11 – 10.26); (E) fast 3m-Timed Up and Go (s; TUG) individual data in face-to-face group (Mean: 5.73 ± 1.24; Min-Max: 3.66 – 7.88) and in remote group (Mean: 6.73 ± 1.21; Min-Max: 4.47 – 8.70); (F) 5-repetitions sit-to-stand (s; STS) individual data in face-to-face group (Mean: 7.97 ± 2.49; Min-Max: 3.15 – 12.00) and in remote group (Mean: 7.78 ± 2.56; Min-Max: 2.98 – 12.00); (G) muscle power (W; estimated using the Takaï equation (17)) individual data in face-to-face group (Mean: 51.0 ± 30.6; Min-Max: 29.4 – 142.5) and in remote group (Mean: 51.7 ± 29.1; Min-Max: 31.4 – 143.8); (H) muscle endurance (s; 30sec STS test (18)) individual data in face-to-face group (Mean: 20.6 ± 10.6; Min-Max: 13.0 – 52.0) and in remote group (Mean: 21.1 ± 10.2; Min-Max: 12.0 – 45.0).

Results

A total of 15 subjects (women:n=9) with a mean age of 69.3±3.6 years were included. Furthermore, 86.7% (n=13) of participants lived in non-collective housing (house, apartment), and 60% (n=9) of them lived alone. Finally, 66.7% (n=10) of participants had a university degree.

First, we performed the Bland Altman plot to evaluate the differences between the two measurement conditions (remote vs. face-to-face) on unipodal balance, walking speed, TUG, 5-repetitions of STS, muscle power and endurance. All the values were within the limit of agreement for muscle power (mean difference: -0.67±5.13; 95% LOA: -10.72 to 9.38

watts) and 5-repetitions of STS (mean difference: 0.19±0.94; 95% LOA: -1.65 to 2.03 s) indicating that these two tests have an excellent agreement between remote and face-to-face conditions. However, some measures were outside the LOA for muscle endurance (95% LOA: -6.96 to 6.02s): normal (95% LOA: -0.30 to 0.60m/s) and fast (95% LOA: -0.57 to 0.91m/s) walking speed; and normal (95% LOA :-2.37 to 2.09s) and fast (95% LOA: -1.60 to 0.94s) TUG. Two measures were outside the LOA for unipodal balance (95% LOA: -33.81 to 27.23s).

Relative reliability of remote compared to face-to-face measurements was considered moderate for fast walking speed (ICC=0.62 (95%: -0.14-0.87)), while unipodal balance (ICC=0.79 (95%: 0.36-0.93)), normal walking speed (ICC=0.77 (95%: 0.32-0.92)) and normal TUG (ICC=0,83 (95%: 0.50-0.94)) were considered highly reliable (ICC>0.75). Fast TUG (ICC=0.93 (95%: 0.78-0.98)), 5-repetitions of STS (ICC=0.96 (95%: 0.89-0.99)), muscle endurance (ICC=0.97 (95%: 0.92-0.99)) and power (ICC=0.99 (95%: 0.98-0.99)) were extremely reliable (ICC>0.9; Table 1).

SEM% varied from 15.54% (unipodal balance) to 5.14% (fast TUG). Only unipodal balance (SEM=15.54) and fast walking speed (SEM=12.94) were not acceptable (SEM>10%; (23)).

MDC varied from 43.07% (unipodal balance) to 14.21% (fast TUG; Table 1). Fast TUG, 5-repetitions of STS and muscle power were the most sensitive measures to detect minimal change.

Discussion

Even if remote interventions or remote subjective evaluations are already validated and often used, the validity and reliability of remote objective measurements in older adults remains unknown. It is well known that one-third of adults age 65 and older fall each year, which leads to loss of autonomy and quality of life (25). Unipodal balance and normal 3-m TUG are validated tests that are usually used to predict the risk of falls (16). Our results show that both tests have high (ICC>0.75) reliability in remote evaluations as well as a low inter-individual variability, even though only the 3-m TUG was acceptable (SEM<10%). These results suggest that Web-based videoconferencing should be used to predict the risk of falls via a remote TUG assessment.

Loss of muscle function – also called sarcopenia – occurs in 30% of older adults and is associated with disability and mortality (26). Muscle power and muscle endurance are two predictors of sarcopenia and its consequences. Our results show that the 30-sec. chair-stand test and 10-repetitions of the STS assessed remotely were of extreme (ICC>0.9) and acceptable (SEM<10%) reliability with low variability, suggesting that Web-based videoconferences can be considered a valid assessment procedure.

Normal aging is also associated with loss of functional capacities, which is related to loss of mobility, physical autonomy or mortality (27). The most well-known clinical tool to assess functional capacities in older adults is the SPPB (28). Our results show that normal walking speed and 5-repetitions of STS, which are part of the SPPB, have high or extreme relative reliability and acceptable absolute reliability as well as low variability, suggesting that Web-based videoconferences are also a valid assessment procedure for both these tests.

Overall, these results are clinically important as assessing physical performance remotely using valid, reliable methods will allow healthcare professionals to follow-up or intervene with older adults in lockdown periods such as during the COVID-19 pandemic. In addition, most older adults live far from geriatric clinics and some have some physical limitations which reduce access to health follow-ups. Indeed, transportation, lack of caregivers or the weather (i.e., icy roads; heat waves, etc.) are another main barrier to in-person healthcare follow-ups. Thus, remote assessments are a good alternative to counteract these barriers even if Web-based video conference technology can sometimes be challenging. Before COVID-19, the majority of older adults already owned a tablet or computer and used the Internet daily (11). Fortunately, this number increased during the COVID-19 lockdown. Moreover, performing these tests remotely can attenuate some human (lack of transportation, fatigue, stress, waiting period) and health (flu/gastroenteritis periods) barriers but also human error (e.g., transcription errors due to the recording method).

This study has some limitations that need to be addressed. First, the sample size was small, which does not allow generalization of our results Thus, further studies with a higher number of participants or other populations (i.e. Alzheimer's disease, Parkinson's disease, frail etc.) are needed. The quality of the Internet connection could lead to lags, which may limit the precision of remote assessment. For example, a difference of 1.5 seconds during the 3-m TUG is considerate as a clinically significant improvement or deterioration in older adults (29). Another limitation is that due to COVID-19 health restrictions, in-person assessments were performed outside instead of in laboratory settings. Limitations in space available at home to perform assessments safely may restrict the implementation of this practice. Finally, a participant's ability to use Web-based video conferencing technology may also be a potential limitation to the implementation of this type of follow-up. More specifically, even if standardized instructions are given, it may be complicated for participants to replicate the setup precisely.

In conclusion, assessing physical performance remotely in older adults seems feasible, reliable and valid compared to face-to-face assessments and should be considered as a potential new clinical practice even if future studies are needed.

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