J Frailty Aging 2023;in press
Published online January 18, 2023, http://dx.doi.org/10.14283/jfa.2023.4

Original Research

Reference Standard for the Measurement of Loss of Autonomy and Functional Capacities in Long-Term Care Facilities

F. Buckinx[1,2,], E. Peyrusqué[1,2,*], M.J. Kergoat[2,3], M. Aubertin-Leheudre[1,2]*

1. Département des sciences de l'activité physique, Groupe de recherche en activité physique adaptée, Université du Québec à Montréal, Montréal (Qc), Canada; 2. Centre de Recherche de l'Institut universitaire de gériatrie de Montréal, Montréal (Qc), Canada; 3. Faculté de médecine, département de médecine, Université de Montréal, Montréal (Qc), Canada; * F. Buckinx and E. Peyrusqué contributed equally.

Corresponding Author: Aubertin-Leheudre Mylene, Département des sciences de l'activité physique, Faculté des Sciences, UQAM, Pavillon Sciences Biologiques, SB-4615, 141, Avenue du Président Kennedy, Montréal, Québec, Canada, H2X 1Y4, Email: aubertin-leheudre.mylene@uqam.ca

Abstract

The vast majority of people living in long-term care facilities (LTCFs) are octogenarians (i.e., in Québec, 57.4% of the residents are age 85 or older, 26.2% are between age 75 and 84, 10.7% are between age 65 and 74, and 5.7% are below age 65 (1)), who are affected by a great loss of physical or cognitive autonomy due to illnesses and are unable to maintain their independence, safety and mobility at home. For the majority of them, their last living environment will be a LTCF. Moreover, the annual turnover in LTCFs is one-third of all residents (2) while the average length of stay is 823 days (1). Therefore the main challenges for caregivers in LTCFs are the maintenance of functional capacities and preventing patients from becoming bedridden and isolated. Measuring the level of autonomy and functional capacities is therefore a key element in the care of institutionalized people. Several validated tools are available to quantify the degree of dependence and the functional capacities of older people living in long-term care facilities. This narrative review aims to present the characteristics of the specific population living in long-term care facilities and describe the most widely used and validated tools to measure their level of autonomy and functional capacities.

Key words: Nursing home, dependance, functional capacities.

Introduction

Long-term care facilities are reserved for people who are no longer able to live at home due to complex pathologies and significant motor and sensory disabilities that are often associated with major cognitive problems. Admission into long-term care depends on many factors such as the person's characteristics and their support system (e.g. family, friends,…), but also on the resources available (3). It is therefore important to categorize each individual and select the appropriate facility based on their level of functional autonomy.

According to the AViQ (Agency for a Quality Life), the quality of care and prevention of further loss of autonomy are the greatest challenges in long-term care facilities (4). Loss of functional autonomy can be defined as the partial or total inability for a person to carry out essential activities of daily living, such as getting up, bathing, getting dressed, eating, and moving inside or outside (5). The intensity and the nature of loss of autonomy vary over time depending on the individual. For example, some individuals feel that they are losing their autonomy because they are not able to stand and walk or because they have memory impairment. Overall, loss of autonomy leads to the inability to carry out basic activities of daily living, which leads to dependence.

In addition, older adults living in long-term care facilities are at a greater risk of falling and sustaining an injury compared to community-dwelling older adults (6). Indeed, around 50% of long-term care residents need assistance for walking or mobility (7). Thus, it is important to assess the functional capacities of older adults. In addition, data from the SENIOR cohort highlighted that the trajectories of physical capacities are useful for predicting three-year mortality among nursing home residents (8). Functional disabilities can be assessed using several validated scales, which allow the healthcare team to quantify the degree of dependence and functional capacities of an individual. This assessment provides the opportunity to evaluate and promote maintenance of health through specific interventions or care. Nevertheless, the literature has not established a consensus on the "best" tests to measure dependence and functional capacities in long-term care residents, neither before admission nor during their stay. This article focuses on physical incapacity and reviews the widely used and validated tools measuring loss of autonomy and functional capacities in long-term care facilities in response to the need for consensus and standardization for both clinicians and researchers. First, the characteristics of long-term care residents will be described.

What are the characteristics of people living in long-term care facilities?

Taking into account the characteristics of this specific population is important to select the appropriate tests that measure the level of autonomy and functional capacities.

In North America, 46% of the population living in long-term care is age 85 and over, while 5.9% of this population is between the age of 65 and 69. Institutionalized patients under age 65 are an extremely heterogeneous group and include people with mental health issues, physical and/or intellectual disabilities, degenerative diseases (i.e., multiple sclerosis), or people who have suffered a stroke, brain tumor or physical trauma (4).

Received August 19, 2022
Accepted for publication November 25, 2022

Furthermore, 82% of long-term care residents are women (4), which can be explained by the fact that women live longer on average than men (life expectancy = 83 years; 81.1 years for men vs. 84.9 years for women) (9) and because widowed men are more likely to remarry more often and to younger women.

In addition, older adults living in long-term care have a severe loss of autonomy (4). Indeed, this rate reaches 42% among people age 65 and over. It is recognized that the disability rate increases with age. Thus, 34% of people between the age of 65 and 74 experience loss of autonomy, compared to 55% among those age 75 or over. Moreover, at the same age, this rate increases to 63% among those living in long-term care.

A large proportion of older adults in long-term care are bedridden or unable to move independently, or have walking difficulties that limit their movements within the institution [4]. Indeed, more than half of long-term care residents need technical or human assistance to move (7).

The health of most people admitted into long-term care is very compromised with concomitant chronic physical, psychological, cognitive, social deficits and impairments (4). Therefore, a lot of staff is required for basic care in these institutions, as well as the presence of qualified professionals. The pathologies most often encountered are the aftermath of a stroke, major neurodegenerative disorders, multiple organ failure, long-term effects of vascular risk factors, major cognitive disorders, and pathologies related to mobility, undernutrition or mental health disorders (10). In addition, it is also estimated that 60% to 80% of older adults living in long-term care have cognitive disorders (4). These disorders are most often related to neurodegenerative diseases, which are manifested by various symptoms, including memory loss, time and space disorientation and dependence in activities of daily living (11).

Finally, many studies have highlighted the high prevalence of the frailty phenotype in long-term care settings (12). Depending on the operational definition used, the percentage of frail residents varies from 19.0% to 75.6% (12, 13). However, frailty is associated with physical and muscular performance but also with quality of life (7).

How do we measure the loss of autonomy in long-term care facilities?

The organization of healthcare is very heterogeneous among various countries around the world. Similarly, care for older people with loss of autonomy but also access to health and care services vary considerably from one country to another. In fact, admission into long-term care was conceptualized by the WHO in 1980 and is based on the notion of dependency by assessing the needs to be met (14).

As a means of eligibility for long-term care

To categorize patients and choose their accommodation according to the level of functional autonomy, the validated Iso-SMAF profile system (Functional Autonomy Measurement System) can be used (15, 16). This tool consists of the evaluation of 29 disabilities divided into five domains: 1) Activities of daily living: eating, bathing, getting dressed, self-care, bladder function, bowel function, using the toilet; 2) Mobility: transfers, walking indoors, presence of prosthesis or orthosis, moving indoors in a wheelchair, using the stairs, moving around outdoors; 3) Communication: seeing, hearing, speaking; 4) Mental functions: memory, orientation, understanding, judgment, behaviours; 5) Domestic tasks: cleaning the house, preparing meals, shopping, washing clothes, using the telephone, using transport, taking medication, managing budget. The assessment of these disabilities determines 14 loss of autonomy profiles, which are grouped into four categories. These categories correspond to homogeneous groups of people who have similar characteristics and require similar services at similar costs, depending on the accommodation considered. Thus, the 14 profiles qualitatively and quantitatively represent the functional capacities of the individual and their needs in terms of resources and services (See Table 1).

Table 1. Iso-SMAF profiles

Categories	14 Iso-SMAF profiles	Observed impairments
Category 1	profiles 1, 2 and 3	Limited impairments, mostly related to domestic chores
Category 2	profiles 4, 6 and 9	Predominant motor impairments
Category 3	profiles 5, 7, 8 and 10	Predominant mental impairments
Category 4	profiles 11, 12, 13 and 14	Mixed and severe impairments

Thus, older adults admitted into long-term care have an ISO-SMAF profile ranging between 10 and 14 (16).

Another interesting tool is the AGGIR grid ("Grille Autonomie Gérontologique Groupe Iso-Ressources") (17). This tool covers both instrumental dimensions, corresponding to relatively complex activities (e.g., cooking, treatment monitoring, budget management, etc.) and dimensions with a strong physical component (i.e., fundamental dimensions, which correspond to activities such as moving around, getting dressed, bathing, etc.). The AGGIR grid includes the following questions:

1) Orientation: Can the person find their bearings in time, times of day and places?
2) Toilet: What is their ability to ensure personal hygiene of the upper and lower body?
3) Dressing: Can the person get dressed and undressed, and choose their own clothes?
4) Food: Can the person prepare food and eat alone?
5) Elimination hygiene: Does the person suffer from urinary or fecal incontinence?
6) Transfers: What is their ability to get up, lie down and sit down?
7) Movements inside the accommodation or institution: Can the person move around inside, possibly with a mobility aid or wheelchair?
8) Movements outside: Is the person able to move outside, from the front door of their home?
9) Communication at a distance: What is their ability to use

communication tools (telephone, alarm, doorbell)?
10) Coherence: converse or act in a meaningful way

For each of the above variables, the observer assigns one of the following three scores:
A: done alone, totally, habitually and correctly;
B: done partially, or not usually, or not correctly;
C: does not.

Based on these responses, seniors are categorized into six groups according to their degree of dependence or six iso-resources groups (GIRs). The GIRs range from 1 to 6, from the least autonomous to the most autonomous (Table 2).

Table 2. Six Iso-resources groups (GIRs)

GIR 1	Older people confined to a bed or chair, whose mental functions are severely impaired and who require the continuous presence of caregivers
GIR 2	Corresponds to two categories of dependent older adults: 1) People confined to bed or chair, whose mental functions are not totally impaired, and who need support for most activities of daily living 2) People whose mental functions are seriously impaired but who have retained their ability to move.
GIR 3	People who have retained their mental autonomy but who need help every day and several times a day to perform activities of daily living (e.g. getting up, going to bed, getting dressed, using the toilet, etc.).
GIR 4	Corresponds to two categories of people: 1) People who need help to get up and go to bed, but can then move around on their own inside the accommodation. Sometimes need help getting dressed and for personal hygiene. 2) People who have no difficulty moving around but need help with physical activities and meals.
GIR 5	People who occasionally need help with bathing, meal preparation and housework
GIR 6	People who have fully retained their autonomy in activities of daily living

Thus, older people living in long term-care facilities are part of GIR 1 and 2.

To be able to determine the level of autonomy, several criteria must be met (18):
- Autonomy must be measured accurately with an instrument that generates a score with a proven test-retest, inter-rater reliability and low measurement error;
- The data must be collected in a database that makes it possible to link the successive evaluations of a given user in order to produce a longitudinal follow-up for each of them;
- The expected natural evolution of the loss of autonomy must be known and taken into consideration in order to assess the user's deviation from this natural deterioration over time.

The AGGIR grid, widely used in France, does not generate a total score and the variability of this rating system has been highlighted despite the adjustments introduced by the addition of adverbs in recent years (18).

However, the SMAF system, widely used in Canada, would fulfill this condition. Moreover, the content validity of the SMAF is recognized and based on the functional concept of health and the World Health Organization's international classification of impairments, disabilities and handicaps (18). The SMAF profile has also demonstrated reproducibility; test-retest and inter-rater reliability have been estimated by intraclass correlation coefficients of 0.96 and 0.97 (15). The criterion validity of the SMAF has been studied and has proven to be excellent based on a strong correlation between the results of the SMAF and the number of hours of care required by the person being evaluated (18). Generally, the SMAF and GIR tools are easy to use. The SMAF tool is more comprehensive than the GIR, but the disadvantage of the SMAF is that it takes longer to complete (+/- 45 min).

It is also important to note that the comparison revealed some disparities between the classification of Iso-SMAF profiles and the AGGIR (18).

At the admission level

Once patients are admitted into long-term care, loss of autonomy can be estimated using several common and validated tools described below.

1) The Katz scale: Developed during the 1970s, it is the first dependency scale from which the other scales were inspired. The Katz scale measures the independence of the subject in six basic and instrumental activities of daily living: bathing, getting dressed, personal hygiene, transferring to and from a bed or chair, continence and feeding. A score ranging from 1 to 4 is attributed to each item depending on how independent the individual is when performing the activity. Higher scores indicate higher dependence in activities of daily living. The sensitivity and specificity of the tool in long-term care are 38% and 80%, respectively, and the predictive value is 50% (19). This original scale is not very sensitive to change. In the SENIOR cohort (a cohort comprising Belgian nursing home residents), the mean Katz scale score was 11.4 ± 4.55 (7).

2) The Lawton scale: Used in all geriatric care settings, it measures the instrumental activities of daily living (iADL; i.e. shopping, using public transport, cooking, doing housework or laundry, using the telephone, taking medication, managing a budget, ...) and includes eight activities, evaluated on a four-level scale (from 0 to 3). Thus, the total score varies from 8 to 32 points. A higher score corresponds to a higher dependence, and a lower score corresponds to a higher level of autonomy (20). Inter-rater reliability is established at 0.85 (21) and the minimally important change (MIC) is between 0.31 and 0.54 points (22). The reproducibility coefficient is 0.96 for men and 0.93 for women (21). Administration time is 10-15 minutes (21).

3) The Barthel scale: It was developed for rehabilitation settings and measures 10 activities of daily living (iADL; i.e., bowel control, continence, self-care, ability to usetoilet use, eating, transfers, locomotion, dressing, climbing stairs and grooming). The minimum score is 0 (dependence) and the maximum score is 100 (total independence). A higher the

score indicates a better degree of functional independence (23). The Barthel index has demonstrated high inter-rater reliability (0.95) and test–retest reliability (0.89) as well as high correlations (0.74–0.8) with other measures of physical disability (24). The standard error of measurement and smallest detectable change are 1.1 and 3.0 points, respectively (25). The sensitivity and specificity are, respectively, 88% and 40% while the predictive value is 44% (19). The self-report takes 2-5 minutes to administer and another 20 minutes are required for direct observation. Patients receiving geriatric home care have a mean score of 83.9 (26).

4) The Functional Independence Measure (FIM): This tool was developed for rehabilitation settings and aims to assess the progress of a subject suffering from functional deficiencies. This instrument consists of 18 criteria divided into six domains (i.e., personal care, sphincter control, transfers, locomotion, communication, awareness of the outside world). The total score ranges from 18 to 126. A higher score indicates a higher level of dependence (27). A recent systematic review classified FIM test-retest and inter-rater reliability as "high/excellent" (defined as reliability coefficients >0.75) (28). The standard error of measurement for the total FIM has been reported to be 4.7 points (29), which equates to a minimum detectable change (90 % confidence) of 11 points (29). In addition, FIM scores differ between known groups and have been shown to correlate in a predictable manner with other scales measuring disability, and measures of related and unrelated constructs (30). The FIM is reported to take between 30-45 minutes to administer and score, with an additional seven minutes to gather demographic information. The mean FIM score is 59 (34–82) at admission into long-term care in Japan (31), and between 76 and 90.5 in long-term care in Taiwan (32). The FIM is 78 (37-123) in US nursing homes (33).

5) The inter-RAI scale: This tool includes five instrumental activities (i.e., preparing meals, housework, shopping, and managing finances and medications) and four non-instrumental activities of daily living (i.e., hygiene, using the toilet, locomotion and food) to estimate the level of dependence (34). Using an algorithm, severity patterns of the variables categorize people from 0 (independent) to 6 (total dependence) (35). The average time to complete the assessment is one hour (36). The psychometric properties and internal consistencies are satisfactory (Cronbach's alpha ≥0.75). The overall mean kappa statistics of the items in the inter-RAI in long-term care facilities was 0.78. All key common items in the inter-RAI LTCF had almost perfect ($\varkappa \geq 0.81$) or substantial ($0.61 \leq \varkappa \leq 0.80$) interrater reliability (35).

It is also important to note that the above tools are not always free. In addition, the tools need cultural adaptation as well as training to be reliable and valid.

How to assess functional capacities during the follow-up in long-term care?

The level of physical function is a key determinant for maintaining the autonomy of older adults. It is therefore important to reliably and validly measure the functional capacities of seniors living in long-term care. Following up on these capacities over time would certainly be a good indicator of the maintenance of the level of autonomy in older adults.

In this section, we have reviewed validated tools to assess functional capacities in long-term care (tools adapted for people in loss of autonomy: SMAF 3-4). Therefore, all measurements requiring specific equipment, and which are not feasible in long-term care settings, have been excluded from this narrative review (e.g., isokinetic tests).

Table 3 below summarizes the tools and protocols as well as feasibility, clinical change and reliability in long-term care settings.

Overall, these tools are clinically important and allow healthcare professionals to measure the functional capacities of a subject at a specific time, as well as follow their evolution over time. This helps implement specific interventions (e.g. physical activity intervention) to maintain or increase these parameters (in order to maintain or improve quality of life).

The tests described in the present section are in line with the systematic review recently published by Galhardas et al. (46). Indeed the authors suggest that the most common physical/motor component assessed was muscular strength in nursing home settings. They identified five stand-out tests to assess strength: handgrip strength, five times sit-to-stand test, 30-second sit-to-stand test and the arm curl test. These five tests are described in Table 3, and data are provided related to their feasibility, clinical changes, interpretation of the score and reliability.

However, except for grip strength and the arm curl test, the tests described in Table 3 are only valid for people who are mobile with or without mobility aids even if the majority of long-term care residents use mobility aids, such as a wheelchair (7). In addition, the systematic review by Galhardas and al. did not describe adapted and validated tests for people in wheelchairs (46).

Thus, for people using wheelchairs, we recommend using the following tests:

- The wheelchair propulsion test: This test aims to assess propulsion velocity (m/sec) and consists of wheeling 10 m while time is recorded with a stopwatch. In addition, the number of cycles and propulsion methods can be recorded by observation. Intra and inter-rater reliability is good with an ICC that ranges between 0.72 and 0.96 (66). The mean value is 0.73±0.29 m/sec among adults aged 58.1±17.9 years (66). Note that this test can also be carried out over a 20-m distance while 10 m is the most common distance cited in the literature.
- The 6-min wheelchair push test: This test aims to assess cardiorespiratory fitness (67). When performed on a dual-belt motorized treadmill, the exercise workload is gradually intensified by increasing the treadmill slope or the speed every minute in a standardized manner. The test ends when the participant is unable to match the treadmill's speed. The test-retest reliability is excellent (ICC ranges between 0.91 and 0.76). In addition, the absolute SEM is 2.27 mL/kg/min and the absolute MDC90% is 5.30 mL/kg/min for VO2 peak (67). The mean VO2 peak is 17.90 (5.28) mL/kg/min among

Table 3. Assessment of functional capacities in long-term care

Test	Measure	Protocol	Feasibility	Clinical changes	Interpretation of the score/ result	Reliability in long-term care
6-meter walking test([37)	Walking speed	The person walks 10 meters at a safe and comfortable pace, using the usual technical aid (if applicable). The stopwatch will start after the first 2 meters and stop before the last 2 meters to eliminate the acceleration and deceleration phases (and thus measures only the 6 meters).	Requires a 10-meter space (more complex implementation)	Small meaningful change: 0.04 to 0.06 m/s or 19-22 m (38) Substantial meaningful change: 0.08 to 0.14 m/s or 47-49 m (38)	< 0.5 m/s = loss of mobility, motor dependency (39)	ICC = 0.97 SEM = 0.03 MDC = 15.2 % (40) ICC = 0.86* SEM = 0.10* MDC = 0.27* (41)
Timed up and go (42)	Dynamic balance, mobility, risk of falls	The person gets up from their chair, walks at a safe and comfortable speed, using the usual technical support, goes around a cone, walks another 3 meters and sits down again. The timer starts when the participant lifts their back off the backrest, and stops when their back touches the backrest. Place the chair against a wall to ensure safety.	Need 3 meters of space, and a chair. simple (easy to implement (43))	MDC: 7.17 s (44)	TUG < 15 s = risk of falls (45)	ICC = 0.99 SEM = 0.5 MDC = 1.5 (46) ICC= 0.76 à 0.99* SEM= 1.24 - 2.12* MDC= 2.42-5.88*(41)
5-repetiton chair stand test (47)	Lower limbs muscle strength, dynamic balance	The person sits on a chair, against a wall to ensure safety, and must then stand up completely, so that their body is straight (knees unlocked and hips fully extended), then sit down again, 5 times, as quickly as possible. The timer stops when the person is completely seated on the chair, after the 5th repetition.	Need a chair (easy to implement)	The MDC data ranged from 1.18 to 2.93, values indicating a low change in performance [48] Minimal clinically & important difference (MCID) is 2.3 seconds (49)	ND	ICC = 0.80 à 0.97* SEM = 1.39* MDC = 2.73* (41) ICC = 0.89 à 0.96** (50)
30-sec chair stand test (51)	Endurance or muscular capacities	The goal is to perform as many repetitions of chair stands as possible in 30 seconds.	Need a chair (easy to implement)	MDC: 2.6 reps	Physical dependence: 80-84 years → 12 -reps (W), 13-reps (M) 85 yrs → 11-reps 90-94 yrs → 9-reps**	ICC = 0.83 - 1 SEM = 0 MDC = 0.08- 0 %(40, 52)
Short physical performance battery (SPPB; (47))	Functional capacities	This battery is composed of 3 tests: 1) balance (feet together, semi-tandem and tandem) for 10 seconds, 2) time required to get up from a chair (5 times) and 3) time required to walk 4 meters a comfortable speed. Each test is scored out of 4 points, for a maximum of 12 points. The higher the score, the better the person's abilities.	Need a 4 meters space and a chair (easy to implement)	MCID: 1point**(53)	Score ≤ 10 indicates increased risk of mobility disability** (54)	SEM = 5.6 %# ICC = 0.97# MDC = 1.9#(55)
Berg scale (56)	Static and dynamic balance	This scale consists of 14 balance tasks. Each task is rated from 0 to 4; the total score ranges from 0 to 56. The higher the score, the better the balance.	Easy to implement (57)	MCID: 8 points (96)	A score of < 45 indicates individuals may be at higher risk of falls** (58)	ICC= 0.99 SEM= 0.97 MDC= 2.7-7 % (40, 59)
Grip strength	Proxy of total body muscle strength	The person should be seated in a chair with a 90-degree angle between their arm and forearm. The goal is to squeeze a dynamometer as hard as possible for 3 seconds. Perform 3 trials for each arm and take the average or the better score for the analysis	Need a hand-held dynamometer	Meaningful changes: 5-6.5 kg (60)	The cut-off thresholds for sarcopenia are: 32 kg & 22 kg for males and females**(61)	ICC = 0.95# SEM = 1.26# MDC = 3.50# ICC = 0.97 SEM = 0.82 MDC = 2.29 (62)
The arm curl test.	This reflects upper body strength	The person repeatedly lifts a 5 lb (2.27 kg) weight (for women) or an 8 lb (3.63 kg) weight (for men) for 30 seconds, while sitting in a chair. The number of lifts is recorded.	Need 5 pound and 8 pound weight, A chair without armrests, stopwatch.	No minimal clinically important difference (MCID) available	The cut-off thresholds sarcopenia are: 11 reps (63)	ICC= 0.76 (0.62–0.85) (64)** MDC= 2.3 reps [65)

Legend: *older people with dementia; ** community-dwelling older people; # older people with cognitive impairments; W = women; M = men; ICC = Intra-class correlation; SEM = Standard error of measurement; MDC = Minimal detectable change; MCID= Minimal clinical and important difference; ND= not determined.

young adults (35.3 ± 14.9 years) (67). Finally, this test can also be performed on a 25-m oval track, where the individual is requested to propel their wheelchair as far as they can for six minutes.

- The slalom wheelchair test: This test aims to assess dynamic abilities (68). Participants are asked to propel their own wheelchair at a self-selected maximum velocity along a slalom trajectory (linear length, 18 m) defined by seven cones aligned in a straight line and set 3 m, 2 m, and 1 m apart from one another. The time needed to complete the test is expressed in seconds. The reliability coefficient (ϕ=.981) and accuracy (standard error of measurement=3.47%, MDC=8.097%) are high (68). The mean score is 16.8±4.4 seconds among adults aged 40.7±12.6 years (68). This test can be also performed at a self-selected normal/usual velocity. Evidence suggests that maximal velocity (Vmax), and a 10-m back and forth slalom could be used to evaluate wheelchair skills and create a new scale (69).
- The sitting balance scale: This test comprises 11 items that measure sitting balance in frail older adults who are primarily non-ambulatory (70). Each item is scored on a 5-point ordinal scale (0-4), where 0 indicates the lowest level of function and 4 the highest level function. The total score is 44. The mean is 43.17/44 for healthy community dwelling older adults and 34.41/44 for those with pathologies requiring healthcare or for nursing home residents (70) . The scale demonstrates good internal consistency (α = 0.762), intra-rater rater reliability (ICC ranged between 0.96 and 0.99), and inter-rater reliability (ICC = 0.87) (70).
- The Ottawa sitting scale: This scale aims to asses sitting balance in acute care settings using 12 items. The intra-rater reliability of the tool is considered excellent (ICC ranged between 0.746 and 0.997) as well as its inter-rater reliability (ICC ranged between m 0.723 to 0.985) (71). The mean score is 32.5 ± 13.4 among people between the age of 21–92 (71).
- The Wheelchair Skills Test Questionnaire (WST-Q): This self-report test evaluates 32 skills. Each skill is scored using a dichotomous response format (pass/fail). Thus, the total WST-Q percentage score is calculated (number of passed skills/number of possible skills × 100%) (72). Cronbach's alpha is 0.90 and the one-month test-retest intraclass correlation coefficient (ICC) is 0.78 (confidence interval: 0.68–0.86). The standard error of measurement (SEM) and smallest real difference (SRD) are 5.0 and 6.2 respectively (72). The mean ± SD total percentage scores for WST-Q is 83.0% ±12.1 for capacity and 98.9% ±2.5 for safety among community-dwelling people age 21-94 (72, 73).
- The modified Continuous Scale Physical Functional Performance measure (CS–PFP): This test assesses functional capacities in people using a wheelchair (74). Briefly, the CS–PFP yields subscale scores for five physical domains—upper-body strength, lower body strength, upper-body flexibility, balance and coordination, and endurance—as well as a total score. In the modified version, the lower-body functional tasks (e.g., getting up and down from the floor and stair climbing) has been removed; transfer from a wheelchair to a standard chair has been added; and walking has been replaced by wheeling for the assessment of the timed distance measure (74). Thus, four domain scores (upper-body strength, upper-body flexibility, balance and coordination, and endurance) can be calculated (74). The final version of the WC–PFP test requires an average administration time of 40 minutes (74). Normative data is 41.39 ± 23.8 among wheelchair users (i.e., upper-body strength = 39.4 ± 26.9, upper-body flexibility = 43.3 ± 19.2, balance and coordination= 38.3 ±23.3 and endurance=41.3 ±30.1) (74).
- Four functional tasks: 1) timed forward wheeling, 2) ramp ascent, 3) forward vertical reach distance, 4) ramp descent. These tasks are scored by a 3-point ordinal scale (75). Test-retest reliability of all four functional tasks are excellent (r=0.99). Interrater reliability is excellent (intraclass correlation coefficient r=0.99) (75). These tasks appear practical, safe and reliable for clinical evaluation.

These tests are valid and easy to implement. However, further studies are needed to validate these tests in older adults living in long-term care specifically, and determine the threshold values as well as the minimal clinically detectable changes in this population. Moreover, cognitive impairments and neurosensory disorders negatively affect the performance of wheelchair skills (76). Thus, rehabilitation therapists may need to adjust wheelchair mobility training methods for cognitively impaired older adults or people with neurosensory disorders (76).

Conclusion

In conclusion, efforts are being made to allow seniors to keep living at home, even in situations of loss of autonomy. Thus, increasing attention is being paid to the measurement of loss of autonomy and functional capacities in different contexts and populations, and specifically in long-term care settings. Indeed, accurate and valid measurement is important to evaluate and promote the maintenance of health through specific interventions or care, and therefore contribute to maintaining or improving the quality of life of seniors. Moreover, the establishment of a consensus on accurate and reliable tools to assess loss of autonomy and functional capacities across research and clinical settings is of utmost importance. As shown above, a wide range of techniques can be used by clinicians and researchers. Cost, availability, and ease of use (i.e., administration time, material required) can determine whether the techniques are better suited to clinical practice or are more useful for research. However, the present paper shows the need to continue to develop more specific reference standards for long-term care residents who use mobility aids such as a wheelchair. While this article has focused on the physical dimension for the assessment and management of loss of autonomy, other dimensions of health (i.e., cognition, psychosocial, neurosensorial) should be taken into account in future studies.

Conflicts of Interest: The authors declare that they have no conflicts of interest.

Ethical standards: This is not a human experiment. All authors participated in the writing of this article and agree with the content.

References

1. Castonguay, J., Bourassa Forcier, A., Lemay, A., & Denis, J.-L. Le devoir de faire autrement Partie 2: Réorienter la gouvernance vers des résultats qui comptent pour les gens. 2022 [cited 2022 13 march]; Available from: https://www.csbe.gouv.qc.ca/fileadmin/www/2022/Rapportfinal_Mandat/CSBE-Rapport_final_Partie2.pdf.
2. Vossius, C., et al., Mortality in nursing home residents: A longitudinal study over three years. PLoS One, 2018. 13(9): p. e0203480.
3. van Loon, J., et al., Facilitators and barriers to autonomy: A systematic literature review for older adults with physical impairments, living in residential care facilities. Aging & Society, 2019. 41(5).
4. van Loon, J., Luijkx, K., Janssen, M., de Rooij, I., & Janssen, B. (2019). Facilitators and barriers to autonomy: A systematic literature review for older adults with physical impairments, living in residential care facilities. Aging & Society, 41(5). , Facilitators and barriers to autonomy: A systematic literature review for older adults with physical impairments, living in residential care facilities. Aging & society, 2019. 41(5).
5. Laan, W., et al., Validity and reliability of the Katz-15 scale to measure unfavorable health outcomes in community-dwelling older people. J Nutr Health Aging, 2014. 18(9): p. 848-54.
6. Rubenstein, L.Z., Falls in older people: epidemiology, risk factors and strategies for prevention. Age Ageing, 2006. 35 Suppl 2: p. ii37-ii41.
7. Buckinx, F., et al., Relationship between frailty, physical performance and quality of life among nursing home residents: the SENIOR cohort. Aging Clin Exp Res, 2016. 28(6): p. 1149-1157.
8. Charles, A., et al., Physical performance trajectories and mortality among nursing home residents: results of the SENIOR cohort. Age Ageing, 2020.
9. Québec, I.d.l.S.d., Le bilan démographique du Québec. 2021: Québec.
10. Moore, K.L., et al., Patterns of chronic co-morbid medical conditions in older residents of U.S. nursing homes: differences between the sexes and across the agespan. J Nutr Health Aging, 2014. 18(4): p. 429-36.
11. Björk, S., et al., Exploring the prevalence and variance of cognitive impairment, pain, neuropsychiatric symptoms and ADL dependency among persons living in nursing homes; a cross-sectional study. BMC Geriatr, 2016. 16(1): p. 154.
12. Kojima, G., Prevalence of Frailty in Nursing Homes: A Systematic Review and Meta-Analysis. J Am Med Dir Assoc, 2015. 16(11): p. 940-5.
13. Buckinx, F., et al., Prevalence of Frailty in Nursing Home Residents According to Various Diagnostic Tools. J Frailty Aging, 2017. 6(3): p. 122-128.
14. Organisation, W.H., International classification of impairments, disabilities, and handicaps, a manual of classification relating to the consequences of diseases», in CIDIH 1980.
15. Desrosiers, J., et al., Reliability of the revised functional autonomy measurement system (SMAF) for epidemiological research. Age Ageing, 1995. 24(5): p. 402-6.
16. Hebert, R., R. Carrier, and A. Bilodeau, The Functional Autonomy Measurement System (SMAF): description and validation of an instrument for the measurement of handicaps. Age Ageing, 1988. 17(5): p. 293-302.
17. Aguilova, L., et al., [AGGIR scale: a contribution to specifying the needs of disabled elders]. Rev Neurol (Paris), 2014. 170(3): p. 216-21.
18. Hébert, R., et al., [Development of indicators to promote measures for the prevention and rehabilitation of functional decline in older people]. Rev Epidemiol Sante Publique, 2012. 60(6): p. 463-72.
19. Törnquist, K., M. Lövgren, and B. Söderfeldt, Sensitivity, specificity, and predictive value in Katz's and Barthel's ADL indices applied on patients in long term nursing care. Scand J Caring Sci, 1990. 4(3): p. 99-106.
20. Lawton, M.P. and E.M. Brody, Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist, 1969. 9(3): p. 179-86.
21. Graf, C., The Lawton instrumental activities of daily living scale. Am J Nurs, 2008. 108(4): p. 52-62; quiz 62-3.
22. Suijker, J.J., et al., Minimal Important Change and Minimal Detectable Change in Activities of Daily Living in Community-Living Older People. J Nutr Health Aging, 2017. 21(2): p. 165-172.
23. Wade, D.T. and C. Collin, The Barthel ADL Index: a standard measure of physical disability? Int Disabil Stud, 1988. 10(2): p. 64-7.
24. O'Sullivan Susan B; Schmitz, T.J., Physical Rehabilitation, ed. F. Edition. 2007, Philadelphia, PA: Davis Company.
25. Bouwstra, H., et al., Measurement Properties of the Barthel Index in Geriatric Rehabilitation. J Am Med Dir Assoc, 2019. 20(4): p. 420-425.e1.
26. Hasselkus, B.R., BARTHEL SELF-CARE INDEX AND GERIATRIC HOME CARE PATIENTS. Physical & Occupational Therapy In Geriatrics, 1982. 1(4): p. 11-22.
27. Dickson, H.G. and F. Köhler, Functional independence measure (FIM). Scand J Rehabil Med, 1999. 31(1): p. 63-4.
28. Sivan, M., et al., Systematic review of outcome measures used in the evaluation of robot-assisted upper limb exercise in stroke. J Rehabil Med, 2011. 43(3): p. 181-9.
29. Ottenbacher, K.J., et al., The reliability of the functional independence measure: a quantitative review. Arch Phys Med Rehabil, 1996. 77(12): p. 1226-32.
30. McDowell, I., Measuring health: A guide to rating scales and questionnaires (3rd ed.). 2006, New York: Oxford University Press.
31. Saji, N., et al., Functional independence measure scores predict level of long-term care required by patients after stroke: a multicenter retrospective cohort study. Disability and Rehabilitation, 2015. 37(4): p. 331-337.
32. Lin, K.-H., et al., Functional independence of residents in urban and rural long-term care facilities in Taiwan. Disability and Rehabilitation, 2004. 26(3): p. 176-181.
33. Kosasih, J.B., et al., Nursing home rehabilitation after acute rehabilitation: predictors and outcomes. Arch Phys Med Rehabil, 1998. 79(6): p. 670-3.
34. Morris, J.N., et al., Scaling functional status within the interRAI suite of assessment instruments. BMC Geriatr, 2013. 13: p. 128.
35. Kim, H., et al., Reliability of the interRAI Long Term Care Facilities (LTCF) and interRAI Home Care (HC). Geriatr Gerontol Int, 2015. 15(2): p. 220-8.
36. Hirdes, J.P., et al., The interRAI Suite of Mental Health Assessment Instruments: An Integrated System for the Continuum of Care. Front Psychiatry, 2019. 10: p. 926.
37. Kuys, S.S., et al., Gait speed in ambulant older people in long term care: A systematic review and meta-analysis. Journal of the American Medical Directors Association, 2014. 15(3): p. 194-200.
38. Perera, S., et al., Meaningful change and responsiveness in common physical performance measures in older adults. J Am Geriatr Soc, 2006. 54(5): p. 743-9.
39. Fien, S., et al., Gait speed characteristics and their spatiotemporal determinants in nursing home residents: A cross-sectional study. Journal of Geriatric Physical Therapy (2001), 2019. 42(3): p. E148-E154.
40. Telenius, E.W., K. Engedal, and A. Bergland, Inter-rater reliability of the Berg balance scale, 30 s chair stand test and 6 m walking test, and construct validity of the Berg balance scale in nursing home residents with mild-to-moderate dementia. BMJ open, 2015. 5(9): p. e008321.
41. Blankevoort, C.G., M.J.G. van Heuvelen, and E.J.A. Scherder, Reliability of six physical performance tests in older people with dementia. Physical Therapy, 2013. 93(1): p. 69-78.
42. Podsiadlo, D. and S. Richardson, The timed «Up & Go»: A test of basic functional mobility for frail elderly persons. Journal of the American Geriatrics Society, 1991. 39(2): p. 142-148.
43. Herman, T., N. Giladi, and J.M. Hausdorff, Properties of the 'timed up and go' test: more than meets the eye. Gerontology, 2011. 57(3): p. 203-210.
44. Takada, Y. and S. Tanaka, Standard Error of the Mean and Minimal Detectable Change of Gait Speed in Older Adults Using Japanese Long-Term Care Insurance System. Gerontol Geriatr Med, 2021. 7: p. 23337214211048955.
45. Nordin, E., et al., Prognostic validity of the timed up-and-go test, a modified get-up-and-go test, staff's global judgement and fall history in evaluating fall risk in residential care facilities. Age and Ageing, 2008. 37(4): p. 442-448.
46. Galhardas, L., A. Raimundo, and J. Marmeleira, Test-retest reliability of upper-limb proprioception and balance tests in older nursing home residents. Archives of Gerontology and Geriatrics, 2020. 89: p. 104079.
47. Guralnik, J.M., et al., A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. Journal of Gerontology, 1994. 49(2): p. M85-94.
48. Muñoz-Bermejo, L., et al., Test-Retest Reliability of Five Times Sit to Stand Test (FTSST) in Adults: A Systematic Review and Meta-Analysis. Biology (Basel), 2021. 10(6).
49. Meretta, B.M., et al., The five times sit to stand test: responsiveness to change and concurrent validity in adults undergoing vestibular rehabilitation. J Vestib Res, 2006. 16(4-5): p. 233-43.
50. Tiedemann, A., et al., The comparative ability of eight functional mobility tests for predicting falls in community-dwelling older people. Age and Ageing, 2008. 37(4): p. 430-435.
51. Jones, C.J., R.E. Rikli, and W.C. Beam, A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. Research Quarterly for Exercise and Sport, 1999. 70(2): p. 113-119.
52. Binder, E.F., J.P. Miller, and L.J. Ball, Development of a test of physical performance for the nursing home setting. The Gerontologist, 2001. 41(5): p. 671-679.
53. Perera, S., et al., Meaningful change and responsiveness in common physical performance measures in older adults. Journal of the American Geriatrics Society, 2006. 54(5): p. 743-749.
54. Vasunilashorn, S., et al., Use of the Short Physical Performance Battery Score to predict loss of ability to walk 400 meters: analysis from the InCHIANTI study. J Gerontol A Biol Sci Med Sci, 2009. 64(2): p. 223-9.
55. Braun, T., et al., Reliability of mobility measures in older medical patients with cognitive impairment. BMC geriatrics, 2019. 19(1): p. 20.
56. Berg, K., et al., Measuring balance in the elderly: Preliminary development of an instrument. Physiotherapy Canada, 1989. 41(6): p. 304-311.
57. Bergland, A., Evaluating the feasibility and intercorrelation of measurements on the functioning of residents living in Scandinavian nursing homes. Physical & occupational therapy in geriatrics. 28(2).
58. Berg, K.O., et al., Measuring balance in the elderly: validation of an instrument. Can J Public Health, 1992. 83 Suppl 2: p. S7-11.
59. Conradsson, M., et al., Berg balance scale: intrarater test-retest reliability among older people dependent in activities of daily living and living in residential care facilities. Physical Therapy, 2007. 87(9): p. 1155-1163.
60. Bohannon, R.W., Minimal clinically important difference for grip strength: a systematic review. J Phys Ther Sci, 2019. 31(1): p. 75-78.
61. Bahat, G., et al., Cut-off points to identify sarcopenia according to European Working

Group on Sarcopenia in Older People (EWGSOP) definition. Clin Nutr, 2016. 35(6): p. 1557-1563.
62. Ferreira, S., A. Raimundo, and J. Marmeleira, Test-retest reliability of the functional reach test and the hand grip strength test in older adults using nursing home services. Irish Journal of Medical Science, 2021. 190(4): p. 1625-1632.
63. Lim, S.K. and S. Kong, Prevalence, physical characteristics, and fall risk in older adults with and without possible sarcopenia. Aging Clin Exp Res, 2022. 34(6): p. 1365-1371.
64. Boshnjaku, A., et al., Test-retest reliability data of functional performance, strength, peak torque and body composition assessments in two different age groups of Kosovan adults. Data Brief, 2021. 36: p. 106988.
65. Fishleder, S., et al., Predictors of Improvement in Physical Function in Older Adults in an Evidence-Based Physical Activity Program (EnhanceFitness). J Geriatr Phys Ther, 2019. 42(4): p. 230-242.
66. Askari, S., et al., Wheelchair propulsion test: development and measurement properties of a new test for manual wheelchair users. Arch Phys Med Rehabil, 2013. 94(9): p. 1690-8.
67. Gauthier, C., et al., Reliability and minimal detectable change of a new treadmill-based progressive workload incremental test to measure cardiorespiratory fitness in manual wheelchair users. J Spinal Cord Med, 2017. 40(6): p. 759-767.
68. Gagnon, D., S. Décary, and M.F. Charbonneau, The timed manual wheelchair slalom test: a reliable and accurate performance-based outcome measure for individuals with spinal cord injury. Arch Phys Med Rehabil, 2011. 92(8): p. 1339-43.
69. Pradon, D., et al., Could mobilty performance measures be used to evaluate wheelchair skills? J Rehabil Med, 2012. 44(3): p. 276-9.
70. Medley, A. and M. Thompson, Development, reliability, and validity of the Sitting Balance Scale. Physiother Theory Pract, 2011. 27(7): p. 471-81.
71. Thornton, M. and H. Sveistrup, Intra- and inter-rater reliability and validity of the Ottawa Sitting Scale: a new tool to characterise sitting balance in acute care patients. Disabil Rehabil, 2010. 32(19): p. 1568-75.
72. Rushton, P.W., et al., Measurement properties of the Wheelchair Skills Test-Questionnaire for powered wheelchair users. Disabil Rehabil Assist Technol, 2016. 11(5): p. 400-6.
73. Rushton, P.W., R.L. Kirby, and W.C. Miller, Manual wheelchair skills: objective testing versus subjective questionnaire. Arch Phys Med Rehabil, 2012. 93(12): p. 2313-8.
74. Cress, M.E., et al., Physical functional performance in persons using a manual wheelchair. J Orthop Sports Phys Ther, 2002. 32(3): p. 104-13.
75. May, L.A., et al., Measurement reliability of functional tasks for persons who self-propel a manual wheelchair. Arch Phys Med Rehabil, 2003. 84(4): p. 578-83.
76. Krayn-Deckel, N., K. Presaizen, and A. Kalron, Cognitive status is associated with performance of manual wheelchair skills in hospitalized older adults. Disabil Rehabil Assist Technol, 2022: p. 1-6.

How to cite this article: F. Buckinx, E. Peyrusqué, M.J. Kergoat, et al. Reference Standard for the Measurement of Loss of Autonomy and Functional Capacities in Long-Term Care Facilities. J Frailty Aging 2023; http://dx.doi.org/10.14283/jfa.2023.4