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Functional Autonomy GDLAM Protocol Classification Pattern in Elderly Women

KEYWORDS: functional autonomy; evaluation indexes; activities of daily living (ADL); elderly

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ABSTRACT *Background: Functional autonomy is associated with activities of daily living (ADL), and a protocol measuring its patterns in elderly women is a welcome strategy for optimize their wellbeing. Objective: To establish a classification system of the GDLAM protocol - devised by the Group of Development Latin-American for Maturity (1) - for measuring functional autonomy in ADL in a group of elderly women stratified by age. Methods: involving 2158 volunteers elderly women randomly selected the study was conducted in Rio de Janeiro, Brazil. The elderly women performed the GDLAM protocol - a set of tests on main ADL movements - and had their scores stratified by age-bracket. The GDLAM Autonomy Index (AI) score was then calculated from these scores. Results: The Pearson Chi-square test between the AI score that was found via GDLAM formula and the AI score that was calculated via fuzzy classification method showed a significant association (p<0.001). Therefore, a classification of both types of AI calculations for each age-bracket according to their percentile rank (P) was established: Very Good (P< 0.15), Good (0.16 <P< 0.50), Regular (0.51<P<0.85) and Insufficient (P>0.85). Conclusion: The GDLAM protocol has shown evidence of validity to be properly utilized as an instrument to evaluate functional autonomy; it consistently classified the performance of ADL (adjusted by age) in our sample.*

Introduction

Aging is a multidimensional phenomenon associated with changes to organ, tissue and cell activities, as well as reduction in efficacy of many physiological processes (2, 3); a process of decline for multiple organic systems (4, 5). This process includes changes to hormone systems (6, 7) that affect the performance of activities of daily living (ADL) (8). Such changes occur earlier in women than in men, with the functional decrease starting around menopause (9). Deterioration in various systems as aging progresses can lead to postural control instabilities (10, 11) that induce changes in walking and posture (12, 13).

A lack of physical conditioning is associated with an increase of fat and progressive muscle decline, which are factors that can result in a reduction in muscle strength (14), flexibility (15), aerobic capacity (16, 17), quality of life (18, 19) and functional autonomy (20, 21). These factors can limit an elderly individual's ADL performance (12, 22) by increasing his illness rate and his dependence on help (3, 23). Daily physical activity to reduce the number of health risks affecting the elderly is recommended by various governmental health agencies (24). A variety of physical exercise programs have been proposed to minimize the detrimental effects of aging, with an emphasis on walking (16, 25, 26), strength training (14), water exercises (27, 28), dance (29) and yoga (30). These activities improve balance and prevent falls (31, 32), which positively affects the skeletal muscle system (14, 33), thereby contributing to the quality of ADL performance (22, 34) as aging progresses.

An aging population is becoming a major challenge of the twenty-first century (35-39), and the shift in age structure (increase of people in older versus younger age ranges) is having a profound impact (5) on a broad range of economic, political and social conditions (40). New studies on the elderly ADL performance (41, 42) are giving health professionals precise norms to classify functional autonomy and evaluate training program efficacy. One of those studies is the GDLAM protocol that measures the time it takes (in seconds) to complete 5 physical activities: a. walking 10 m (W10m); b. rising from a sitting position (RSP); c. rising from a ventral decubitus position (RVDP), d. sitting in, rising from, and walking around a chair (SRWC); and e. putting on and taking off a t-shirt (PTTs) (1).

Assessing ADL performance using an elderly population and the GDLAM transcultural protocol the purpose of this study was to establish a method for classifying functional autonomy during ADL in a group of elderly women, stratified by age, using the GDLAM protocol.

2. Methods

2.1. Consent

All study participants signed an informed consent form. We complied with the principles of the Helsinki Declaration confirmed in the World Medical Association conferences (43), and the research was approved by the Castelo Branco University Research Ethics Committee.

2.2. Sampling

A sample of 2158 elderly woman - defined by the World Health Organization (WHO) as over sixty (44) – randomly selected from a population attending a wide variety of Social Public Programs run by Rio de Janeiro Municipality, in Brazil, during 2009, based on the following inclusion criteria: being independent in their ADL; and passing a medical evaluation for performing the study's tests. Practicing physical exercises

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was not an inclusion or exclusion criterion.

The sample consisted of 2158 volunteer elderly women between the ages of 60 and 88 years, which distribution is given in Table 1. The sample had an average Body Mass Index (BMI) of 27±4.

Table 1. The frequency distribution of ages in the sample

Age Group	N	%
G1 (60-64)	814	37.72
G2 (65-69)	648	30.03
G3 (70-74)	387	17.93
G4 (75-79)	222	10.29
G5 (≥ 80)	87	4.03
Total	2158	100.00

2.3. Data collection
Anthropometric Measurement
All procedures followed the International Society for the Advancement of Kinanthropometry protocol (45). Subjects were weighed to the nearest 0.1 kg on a calibrated scale (Filizola, Brazil). Each subject's height was measured via a standard stadiometer that was connected to the scale. BMI was calculated adopting these height and weight measurements.

Evaluation of Functional Autonomy
The protocol used to evaluate functional autonomy was created and validated by the Group of Latin-American Development for Maturity (GDLAM) hence called the GDLAM protocol (22, 46). It is composed of the following tests, for which the subject 's scored is the number of seconds needed to complete a specific task: a. walking 10 m (W10m) (47); b. rising from the sitting position (RSP) (48); c. rising from a ventral decubitus position (RVDP) (49) on either floor or bed; d. sitting in, rising from, and walking around a chair (SRWC) (50), evaluating agility and balance during short displacements inside a house; and e. putting on and taking off a t-shirt (PTTs) (51) - upper-body movements. Each task was performed twice with a five minutes minimum between-task-interval. The shortest time was recorded using a chronometer (Casio, Brazil) and the GDLAM autonomy index (AI) was calculated (52) as follows:

$$AI = \frac{[(W10\ m + RSP + RVDP + PTTs) \times 2] + SRWC}{4}$$

2.4. Data analysis
Predictive Analytics Software (PASW) Statistics 18 was used to calculate the mean, standard deviation, variance and variation coefficient for AI. The Box-Cox method was used to adjust the data normality. In addition to the above calculation, fuzzy classification was used to analyze all possible combinations of test classification and to adjust the nominal decision-tree classification to obtain a final classification that yielded a logically-coherent AI. The Pearson Chi-square Test was then used to test the significance of the association between the nominal classification given by the formula-calculated AI and fuzzy-classification AI. The Spearman correlation was used to confirm the association between the two methods of calculating AI. Classification levels were established for each age group using percentiles (P): Very good (P<0.15), Good (0.16<P<0.50), Regular (0.51<P<0.85) and Insufficient (>0.85). Because performance time was measured in seconds a lower percentile value is considered better. The threshold for statistical significance was set at $p < 0.05$.

3. Results
Descriptive statistics for the functional autonomy tests and the age group classifications are presented in Table 2. Of note, the mean scores of G3 (70-74) on the SRWC test and G5 (≥ 80) on the W10 m are classified as "Good", while all other test results for all other groups are "Regular."

Table 2. The descriptive statistics for the GDLAM protocol, with scores separated by age group and reported in seconds

Groups	Tests	Mean	SD	MD	CV	Classification
G1 (60-64)	W10 m	7.37	1.93	6.99	0.26	Regular
	RSP	11.01	4.10	10.10	0.37	Regular
	RVDP	4.27	1.98	3.65	0.46	Regular
	PTTs	12.80	4.15	12.03	0.32	Regular
	SRWC	43.54	8.78	42.28	0.20	Regular
G2 (65-69)	W10 m	7.60	1.84	7.34	0.24	Regular
	RSP	11.03	3.97	10.32	0.36	Regular
	RVDP	4.33	2.06	3.83	0.48	Regular
	PTTs	12.30	4.15	11.40	0.34	Regular
	SRWC	43.88	7.86	43.28	0.18	Regular
G3 (70-74)	W10 m	7.56	1.91	7.23	0.25	Regular
	RSP	10.73	3.81	10.15	0.36	Regular
	RVDP	4.46	1.97	3.84	0.44	Regular
	PTTs	12.98	4.29	12.19	0.33	Regular
	SRWC	44.11	7.26	43.97	0.16	Good
G4 (75-79)	W10 m	7.92	1.84	7.66	0.23	Regular
	RSP	11.39	4.11	10.34	0.36	Regular
	RVDP	5.00	2.31	4.53	0.46	Regular
	PTTs	13.72	3.95	13.29	0.29	Regular
	SRWC	47.15	9.13	45.54	0.19	Regular
G5 (≥ 80)	W10 m	7.68	1.72	7.23	0.22	Good
	RSP	11.62	3.33	12.56	0.29	Regular
	RVDP	5.98	2.55	5.34	0.43	Regular
	PTTs	14.80	4.53	14.34	0.31	Regular
	SRWC	51.19	11.77	48.05	0.23	Regular

SD= standard deviation; MD= median; CV= coefficient of variation; W10 m= walking 10 m; RSP= rising from the sitting position; RVDP= rising from ventral decubitus position; PTTs= dressing and taking off a t-shirt; SRWC= sitting and rising from a chair and walking around.

Table 3 presents AI data by age group after they were adjusted using the Box-Cox method. The classification was "Regular" for all categories.

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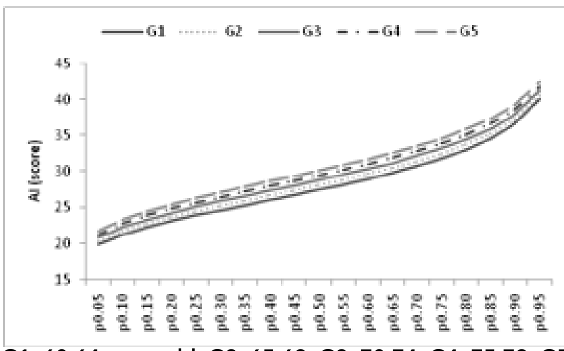
Table 3. Descriptive statistics for AI, which was adjusted using the Box-Cox method

Group	Mean	S.D.	Median	Classification
G1 (60-64)	28.61	6.28	27.94	Regular
G2 (65-69)	28.60	5.91	27.76	Regular
G3 (70-74)	28.90	5.78	28.40	Regular
G4 (75-79)	30.80	6.31	30.18	Regular
G5 (≥ 80)	32.84	6.99	32.40	Regular

The AI percentile distribution, organized by age group, is presented in Figure 1, with a lower percentile denoting higher functional autonomy. The percentile curves show a normal distribution for all age group.

Figure 1. The percentile distribution of the adjusted AI scores for each age group



G1: 60-64 years old; G2: 65-69; G3: 70-74; G4: 75-79; G5: ≥ 80

The association between the classification results using the AI calculated using both the formula and fuzzy classification presented significant statistic ($\chi 2= 3602.44$; $p < 0.001$). The magnitude of the statistical significance demonstrates high reliability between the two classification methods. The Spearman test between the two methods of calculating AI also showed a strong and significant correlation ($r = 0.9$; $p < 0.001$). Table 4 shows the classification pattern for each test of the GDLAM protocol and the resulting AI, broken into age groups using five-year intervals.

Table 4. GDLAM protocol of functional autonomy classification adjusted by age group

Tests	Groups	Very Good	Good	Regular	Insufficient
W10 m	G1 (60-64)	< 5.52	5.52 - 7.04	7.05 - 8.92	> 8.92
	G2 (65-69)	< 5.67	5.67 - 7.21	7.22 - 9.04	> 9.04
	G3 (70-74)	< 5.83	5.83 - 7.38	7.39 - 9.16	> 9.16
	G4 (75-79)	< 5.98	5.97 - 7.56	7.57 - 9.28	> 9.28
	G5 (≥ 80)	< 6.14	6.14 - 7.73	7.74 - 9.40	> 9.40
RSP	G1 (60-64)	< 6.84	6.84 - 10.12	10.13 - 13.62	> 13.62
	G2 (65-69)	< 6.91	6.91 - 10.19	10.20 - 13.72	> 13.72
	G3 (70-74)	< 6.97	6.97 - 10.26	10.27 - 13.81	> 13.81
	G4 (75-79)	< 7.04	7.04 - 10.33	10.34 - 13.91	> 13.91
	G5 (≥ 80)	< 7.11	7.11 - 10.40	10.41 - 14.01	> 14.01
RVDP	G1 (60-64)	< 2.30	2.30 - 3.52	3.53 - 5.41	> 5.41
	G2 (65-69)	< 2.47	2.47 - 3.81	3.82 - 5.80	> 5.80
	G3 (70-74)	< 2.63	2.63 - 4.11	4.12 - 6.20	> 6.20
	G4 (75-79)	< 2.80	2.80 - 4.40	4.41 - 6.60	> 6.60
	G5 (≥ 80)	< 2.96	2.96 - 4.70	4.71 - 6.99	> 6.99
PTTs	G1 (60-64)	< 8.22	8.22 - 11.45	11.46 - 15.51	> 15.51
	G2 (65-69)	< 8.75	8.75 - 12.00	12.01 - 16.04	> 16.04
	G3 (70-74)	< 9.29	9.29 - 12.54	12.55 - 16.56	> 16.56
	G4 (75-79)	< 9.83	9.83 - 13.08	13.09 - 17.08	> 17.08
	G5 (≥ 80)	< 10.36	10.36 - 13.63	13.64 - 17.60	> 17.60
SRWC	G1 (60-64)	< 35.17	35.17 - 42.37	42.38 - 49.68	> 49.68
	G2 (65-69)	< 35.96	35.96 - 43.28	43.29 - 50.81	> 50.81
	G3 (70-74)	< 36.76	36.76 - 44.19	44.20 - 51.94	> 51.94
	G4 (75-79)	< 37.55	37.55 - 45.11	45.12 - 53.06	> 53.06
	G5 (≥ 80)	< 38.35	38.35 - 46.02	46.03 - 54.19	> 54.19
AI	G1 (60-64)	< 22.28	22.28 - 27.43	27.44 - 33.01	> 33.01
	G2 (65-69)	< 22.82	22.82 - 28.10	28.11 - 33.71	> 33.71
	G3 (70-74)	< 23.37	23.37 - 28.77	28.78 - 34.41	> 34.41
	G4 (75-79)	< 23.91	23.91 - 29.45	29.46 - 35.11	> 35.11
	G5 (≥ 80)	< 24.46	24.46 - 30.12	30.13 -35.81	> 35.81

All values are in seconds – W10m: walking 10 m; RSP: rising from the sitting position; RVDP: rising from ventral decubitus position; PTTs: putting on and taking off a t-shirt; SRWC: sitting in, rising from, and walking around a chair; AI: GDLAM autonomy index scores.

4. Discussion

We used fuzzy classification as a nominal classification tool of the GDLAM protocol's set of proposed dimensions and found it was more robust than other adjustment methods because they required a continuous monitoring of the normality of the distribution of ages in a group. This study presented a two-stage process for demonstrating validity: definitional and confirmatory (53). During the definitional stage we described our constructs: functional autonomy and aging, using a review of the current literature. Evidence of validity was found during the confirmatory stage. The AI calculated by the formulae and by Fuzzi Logic Method presented excellent and significant correlation between the two methods of calculating AI.

During the confirmatory stage, we also used fuzzy classification to produce a classification tree for presenting the normative scores of elderly women performing the GDLAM protocol's test battery. This method produced results using gathered data. Study results also showed a significant association between the AI score classifications calculated using a formula and using fuzzy classification. The magnitude of this effect allowed us to establish an AI classification of the GDLAM's protocol of functional autonomy broken into age groups at five-year intervals.

Our findings are corroborated by the studies listed in Table 5, which are researches conducted between 2006 and 2010 that utilized the GDLAM protocol to evaluate functional autonomy in relation to ADL in the elderly.

Table 5. The autonomy findings of studies conducted between 2006 and 2010 that adopted the GDLAM protocol

Study (year)	Program / characteristics	W10 m	RSP	RVDP	PTTs	SRWC	AI
Alencar et al. 2009 (54)	Physical activity*	7.21	10.49	3.75	16.19	43.99	29.81
Belloni et al. 2008 (28)	Water resistance training Inactive	5.17 5.82	6.65 12.3	2.24 4.01	- -	37.5 49.4	- -
Boechat et al. 2007 (55)	Moderated DPOC	8.9	12.6	3.6	-	42.9	-
Cader et al. 2006 (18)	Institutionalized Inactive	13.39	13.07	6.15	15.70	76.60	47.32
Cader et al. 2007 (56)	Institutionalized Inactive	9.30	9.36	6.65	14.05	63.13	35.46
Daniel et al. 2010 (12)	Inactive	7.01	9.68	3.73	11.31	41.15	26.15
Daniel et al. 2010 (8)	Physical activity*	6.53	6.78	3.42	10.49	37.81	23.06
Guimarães et al. 2008 (57)	Physical activity* Flex	8.37 6.29	18.80 11.11	5.73 3.24	13.64 11.59	50.07 40.59	38.62 27.33
Oliveira et al. 2009 (27)	Water resistance training	7.21	11.46	3.49	11.29	45.32	27.68
Paula et al. 2006 (58)	Physical activity*	9.58	11.60	4.45	-	42.78	-
Paula et al. 2008 (59)	Physical activity*	6.43	9.50	3.58	-	34.10	-
Pereira et al. 2007 (20)	Strength training	5.65	8.28	2.77	8.75	37.8	22.16
Silva et al. 2009 (34)	Strenght training	5.48	8.30	2.60	8.48	37.10	21.70
Vale et al. 2009 (60)	Inactive	7.21	11.50	3.49	11.30	45.30	27.68

Values in seconds - W10 m: walking 10 m; RSP: rising from the sitting position; RVDP: rising from ventral decubitus position; PTTs: putting on and taking off a t-shirt; SRWC: sitting in, rising from, and walking around a chair; AI: GDLAM autonomy index in scores; Flex: maximum stretching exercise flexibility; * Walking, stretching and resistance training.

Comparing Table 5 to Table 4 distinct results shows as a function of intervention type and sample characteristics; however, the studies in Table 5 are limited to G1 and G2 ages. W10m times varied from 9.58 (58) to 5.17 seconds (28), representing classifications that are "Insufficient" and "Very good" for G1 and G2, respectively. These time differences are explained by the intervention proposed in each study, but both are considered satisfactory for an elderly individual to safely cross the street. RSP times varied between 18.80 (57) and 6.65 seconds (28), representing classifications that are "Insufficient" and "Very good" for G1 and G2, respectively. This score indicates how easy or hard it is for an elderly individual to lift himself out of a chair, which is a common ADL movement. RVDP times varied between 5.73 (57) and 2.24 seconds (28), which are "Insufficient" for G1 and "Regular" for G2 at the slower time and "Very good" for both at the faster time. The PTTs test was developed more recently and was less commonly used in the studies listed in Table 5. Times varied between 16.19 (54) and 8.48 seconds (34), representing "Insufficient" and "Very good" for G1 and G2, respectively. The SRWC test lasts the longest and therefore has the largest range of possible results. Times varied between 50.07 (57) and 34.10 (59) seconds, representing "Insufficient" and "Very good" for G1 and G2, respectively.

Given that functional autonomy is associated with ADL performance, we proposed that AI represents ADL performance in the elderly as the nature of the movements in these tests and their correspondence to daily activities seem to provide a global view of an elderly individual's autonomy. In Table 5, AI scores vary between 38.62 (57) and 21.70 (34), which are "Insufficient" and "Very good" in G1 and G2, respectively. If one test from the battery is not completed because of the restriction of a particular movement, or any other reason, the AI score cannot be calculated. In that case, the reference pattern can be applied to each test separately to analyze ADL performance (28, 55, 58, 59).

Studies with elderly individuals who are institutionalized (18, 56) are not included in Table 5, as - due to these subjects low activity - spending long time to perform the GDLAM protocol's test battery; their results show are far different from those reported in non institutionalized elderly individuals studies.

5. Conclusions

The proposed GDLAM protocol classification, stratified by age, constitutes a reliable instrument for classifying functional autonomy standards in elderly individuals. The protocol can be used as a reliable instrument for evaluating functional autonomy because it is consistent in its classification of elderly ADL performance by age group. The battery is easily administered, and the AI formula can express the functional autonomy of an elderly individual. Furthermore, its dimensions measure related systems, which yield a highly reliable pattern of classification when applied to multiple samples.

6. Recommendations

The present approach constitutes an important and unique approach, which should be considered in future studies. We recommend more G4 and G5 age groups studies, as well as studies comparing male and female subjects.

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