

EVALUATION OF THE EFFICACY OF TRAINING PROTOCOLS OF THE SIT-TO-  
STAND ACTIVITY IN ELDERLY WOMEN

EVALUATION OF THE EFFICACY OF TRAINING PROTOCOLS  
FOR THE SIT-TO-STAND ACTIVITY IN ELDERLY WOMEN

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Abbreviated title: Interventions for the sit-to-stand in elderly women

## **Abstract**

The main purpose of this intervention study was to comparatively evaluate the efficacy of three sit-to-stand training protocols in elderly women. The 63 elderly chosen women were randomly divided into four groups: Group I – Traditional Muscular Strengthening (with the use of cuff weights to emphasize quadriceps, gluteus, anterior tibiae, triceps sural and ischiotibial); Group II – Functional Training (a circuit training format comprised of five functional situations using the sit-to-stand activity); Group III – Proprioceptive Neuromuscular Facilitation (techniques of rhythmic initiation and combination of isotonic used to facilitate the activity of sitting-to-stand) and Group IV – Control (including memory activities and participation in informative workshops on topics related to aging). Subjects participated in 30-minute sessions of their group activities, twice a week, for ten weeks. The evaluation criteria that were used before and after the intervention included: the *Sit-to-Stand-to-Sit Test*, the *Timed Up and Go Test*, the *Functional Reach Test* and the *Manual Muscular Strength Test* for hip and knee extensors on both sides. Comparing the efficacy of the three interventions with the control group on the performance of the sit-to-stand activity in 63 elderly females, the three intervention groups showed statistically significant improvement in all measured criteria compared to the control group, with exception to the right hip extensor strength which statistically improved in all four groups.

**Key words:** elderly, sit-to-stand, functional activity, therapeutic intervention

## **Abstract**

The main purpose of this intervention study was to comparatively evaluate, the efficacy of three sit-to-stand training protocols, in elderly women. The 63 elderly women selected were randomly divided into four groups: group I – Traditional Strength Training (use of cuff weights to emphasize quadriceps, gluteus, anterior tibial, triceps sural and hamstring muscle groups); group II – Functional Training (circuit training format composed of five functional situations utilizing the sit-to-stand activity); group III – Proprioceptive Neuromuscular Facilitation (techniques of rhythmic initiation and combination of isotonic used to facilitate the activity of sit-to-stand) and the group IV – Control (included activities for memory and participation in informative lectures on topics concerning aging). Subjects participated in 30 minute sessions of their group activity, two times per week for ten weeks. The evaluation criteria that were used pre and post intervention included: the *Sit-to-Stand-to-Sit Test*, the *Timed Up and Go Test*, the *Functional Reach Test* and *Manual Muscle Tests* for bilateral hip and knee extensors. In comparing the efficacy of the three interventions and one control on the performance of the sit-to-stand activity in 63 elderly females, the three intervention groups showed statistically significant improvement in all measured criteria compared to the control group, with the exception of right hip extensor strength which statistically improved in all groups.

**Key-words:** elderly, sit-to-stand, functional activity, therapeutic intervention

## **Introduction**

The ageing process can be accompanied by numerous bodily debilities originating from the biological ageing itself and, as recently proved by some authors, due to unuse and sedentarism [1]. Several physical disorders are commonly found in individuals over 60 years of age, such as weakness and decrease on the muscular mass, reduction of sensory information secondary to visual, hearing and tactile deficits, decrease of the flexibility and balance and coordination dysfunction [2]. Such alterations can influence the life quality of these people, limiting them in their functionality and social life.

Amongst the several activities carried out on the daily life, the ability to stand and sit is essential for the functional independence of any person. To stand up is a pre-requisite for carrying out all activities performed in standing position, as walking. There is evidence that the act of standing up is one of the functional tasks most executed on a daily basis [3] and that the loss of independence in this activity is one of the main factors associated to the risk of institutionalization [4].

It is frequently observed in the clinical practice with elderly, accounts of difficulty in getting up from bed in the morning, incapability of standing up from the chair, the bus seat or the toilet without help. Chamberlain and Munton, and Munton and others proved that 42% to 43% of the elderly individuals they interviewed had difficulties to stand up from a chair [5, 6]. Such individuals are limited in their independence, some times needing the constant help of a carer.

The act of standing up, performed in a functional form and in due time, requires muscular strength of the lower limbs, flexibility and balance to move the body mass forward – from a wide support basis (thighs and feet) to a narrower one (feet) [7]. These abilities may be extremely compromised in the elderly who are sedentary and ill.

Currently several studies endorse the efficacy of the physical activity in minimizing the deficiencies found in the elderly and, consequently, in their functional independence and quality of life. Several researches focus on the prevention of falls and improving roaming through strengthening, functional training and balance specific programs. It is not found, however, on current literature works that focus specifically on optimizing the act of getting up in elderly individuals.

This work was developed with the objective of evaluating, comparatively, the efficacy of some training protocols of the sit-to-stand activity in elderly women, aiming at optimizing their performance, preventing the functional limitations and, thus, improving their quality of life.

## **Material and Methods**

It is an intervention study, with a control group, randomized, non-masked, performed between March and August 2002. The participants were elderly women (as from 60 years of age), of any race, who reported some difficulty to perform the sit-to-stand activity, without, however, any functional disability that could objectively justify such activity. The sample was selected from a radio interview, followed by an information workshop and posterior selection and physical examination, resulting in the final sample of 63 elderly women.

The study was pre-approved, in its ethical aspects, by the Health Department of the city of Petrópolis and all subjects agreed in taking part voluntarily and signed a Free and Informed Consent Agreement.

The study included women as from 60 years of age who reported some difficulty to perform the sit-to-stand activity, being able to, though, perform it when requested. The subjects who presented any illnesses, either physical or psychological, that could hinder the proper execution of the training protocols were excluded, as well as the women who participated in intense physical activity programs, or the ones who had joined any physical activity program in the previous six months.

After the initial evaluation, the elderly were subject to a clinical interview comprised of a standardized questionnaire with identification data, clinical history and standardized physical examination. All subjects were weighed in a Lightex™ scale, model LHX-2016, and measured using a metrical measuring tape and a mark on the wall.

Functional tests involving the standing activity were selected, as well as specific tests for the deficiencies that probably caused the functional decline, such as the muscular strength and balance tests. The tests were performed by the author, in 3 phases: Before the interventions, soon after the 20 sessions, and 8 weeks after the end of the interventions to assess the learning retention. The following tests were used:

a) *Timed Up and Go Test*

Material utilized: A 38cm high armchair with armrests, a Mondaine™ chronometer, adhesive tape and a metal counter bell.

Description: With the subject sitting down on the armchair, away from the backrest, at the toll of the bell she is requested to stand, preferably without using their arms as a lever, walk towards the adhesive tape mark on the floor, placed at a 3 meter distance, return and sit down. The chronometer is started immediately after the bell sound, and stopped at the very moment when the subject sits down. The average amongst three attempts is then computed [8].

b) *Sit- to-Stand-to-Sit Test*

Material utilized: A standard size wooden chair, a Mondaine™ chronometer and a metal counter bell.

Description: The subject starts sitting down, with their arms crossed over her chest. When the bell tolls, she is requested to fully stand up and sit down ten times without interruption. The chronometer is started at the bell sound and stopped when she sits for the tenth time. The best average between two trials is computed [9].

c) *Functional Reach Test*

Material utilized: A metric measuring tape, adhesive tape and a plastic set square.

Description: The measuring tape was glued to the wall, parallel to the floor at a height of 135cm. The subject starts the test standing, with one of the shoulders rotated at approximately 90° and the elbow stretched, next to the wall where the tape is fixed, with the hands fisted, and in upright posture. The first measurement is then taken, at the head of the 5<sup>th</sup> metacarpus. Then the subject is requested to lean forward as much as possible, keeping the upper limb stretched. A new measurement of the 5th metacarpus is taken to calculate the motion. The average of 3 attempts is computed [10].

d) *Manual Muscular Strength Test*

Material utilized: A standard chair and a 1m high table.

Description: A strength graduation scale is used, as described on Chart 1 [11]:

Chart 1. Graduation scale used on the manual muscular strength test

Muscular grade	Definition	Points
5	Normal strength	10
5-	Hardly detectable weakness	9
4+	Same as 4, although stronger than the reference muscle	8
4	The muscle is weak, but moves the joint against a combination of gravity and some resistance	7
4-	Same as 4, although weaker than the reference muscle	6
3+	The muscle is able of moving the joint against the gravity plus a little resistance	5
3	The muscle is capable of moving the joint, in its full range, against the gravity	4
3-	The muscle is capable of moving the joint against the gravity, but not in its full range	3
2	The muscle moves the joint when gravity is eliminated	2
1	A trace of contraction is noted or felt on the muscle	1
0	Absence of muscular contraction	0

The hip and knee extensors are evaluated on both sides. To evaluate the hip extensors, the subject is in the standing position, supporting the forearms on a 1meter high table, with the knee to be evaluated bent, the subject is then requested to stretch the hip joint. Resistance is applied by the therapist on the lower third of the thigh, posteriorly.

To evaluate the knee extensors, the subject is in the sitting position, and the therapist applies the resistance on the distal part of the leg, anteriorly.

The 63 subjects were divided into 4 groups by block randomization, following the protocol Latin square [12], in which the conditional factor was the age. Three of the groups were subject to a specific training protocol, aiming at improving the performance of the standing up activity. Group 4 was the control group who participated in memory activities and informative workshops on themes linked to the elderly. The sessions happened twice weekly and lasted 30 minutes each, and the program was designed for 20 sessions. The interventions were performed by the author with the cooperation of 15 students of the final year of the graduation course in Physiotherapy of the Universidade Católica de Petrópolis.

#### Group I – Traditional Strengthening (17 subjects)

The session started with a 5 minute walk and a series of stretching exercises of the sural triceps, ischiotibial, quadriceps and gluteus, sustained for 20 seconds. At the end of the stretching exercises, the subjects sat on wooden chairs and performed 10 dorsiflexion and plantar flexion of the ankle movements.

The muscular strengthening series started using cuff weights, after determining the ideal initial weight (approximately 80% of the maximum weight). On the first two weeks it was performed a series of 10 repetitions for each muscular group. On the third week, it progressed to two series of 10 repetitions, with 3 minute rest intervals between them. On the sixth week there was a 1kg increase on the weight on the series and, on the ninth week, there was an increase on the number of repetitions to 12 in each series. Each repetition was

performed slowly throughout the range of movement, 2-3 seconds for raising the weight (concentric contraction) and 4-6 seconds for lowering the weight (eccentric contraction). The strengthening series were performed as follows:

a) Hip extensors: With the cuff weights on the lower part of the leg, in the standing position, the subject stretched the hip of a lower limb, keeping the knee extended. Then, the subject performed the same activity with the other limb.

b) Knee flexors: With the cuff weights on the lower part of the leg, in standing position, the subject bent the knee of a lower limb. Then, the subject performed the same activity with the other limb.

c) Ankle plantiflexors: With the cuff weights on the lower part of the legs, in standing position, the elderly tiptoed.

a) Knee extensors: With the cuff weights on the lower part of the leg, in sitting position, the subject stretched one of her knees. Then, the subject performed the same activity with the other limb.

c) Ankle dorsiflexors: With the cuff weights on the top of the foot, in sitting position, with one of the lower limbs crossed over the other, the subject dorsiflexed the ankle. Soon after, she performed the same activity with the other foot.

The strengthening series was followed by a 5 minute walk for warming down, and repetition of the stretching activities performed at the beginning of the session.

#### Group II – Functional Training (16 subjects)

The session started with the same warming up and stretching activities described on group I.

Then the functional training series started, which was comprised of a circuit of five functional situations involving the sit-to-stand move. The series consisted of five repetitions of each activity in the circuit, with a three-minute rest interval among them. The activities were performed in pairs, with the subjects facing each other. The subjects started the first week with one series, then progressed, if possible, to two series on the third week and up to three on the last weeks. The activities of the circuit were:

a) With two standard size chairs facing one another, at a distance of 185 cm, the subjects started the activity on the sitting position, with one of them holding a plastic ball. The two subjects then stood up partially, and handed the ball to the other one, bending the torso forward. Then the other subject, who then held the ball, performed the activity. Which was performed five times.

b) With two 38cm high armchairs facing each other at a 170 cm distance, the subjects started the activity in the sitting position. One of them starts holding a book. The subjects then stand up partially, and one hands the book to the other. They were both requested to lean forward. On the following repetition, the other subject holds the book and the activity is performed five times.

c) With two 36 cm high thinly padded wooden chairs facing each other, at a 185 cm distance, the subjects started the activity on the sitting position. The therapist places a magazine on the floor for one of them to pick up, still in the sitting position, then stand up holding the magazine and handing it back to the therapist. The magazine is placed in different positions each time, until the fifth repetition is done.

- d) Two standard size chairs are placed facing each other, with two 70 cm high tables (one over the other) between them. The distance between the chairs and the table is 80 cm. The subjects start the activity in the sitting position. One of them starts holding a folded blanket. Both subjects then stand up, the one holding the blanket places it on the shelf and the other, then, holds the blanket, requiring, thus, that both subjects stand up and reach the shelf. The activity is performed five times.
- e) With two standard size chairs facing each other, at a 150 cm distance, the subjects start the activity in the sitting position. One of them starts holding a face towel. The subjects stand up and stretch the upper limbs as if they were hanging the towel on a high clothes line. On the following repetition, the other subject has the towel and the activity is repeated five times.

The functional training was then followed by a five minute walk for warming down, and the same stretching exercises that were performed at the beginning were repeated.

#### Group III – Proprioceptive Neuromuscular Facilitation (PNF) (15 subjects)

The subjects were in the standing position, in front of the chairs, for the beginning of the two series. Each subject was seen by a therapist, five at a time. The following PNF techniques were used:

*a) Combination of isotonic:* The therapist places her hands over the ala ossis illii of the subject in the standing position. The therapist starts applying some gradual resistance (approximation) towards the subject's heels and she is requested to hold on to the position. The subject is then requested to allow to be pushed downwards, as if she was going to 'sit on air' (eccentric contraction). She is requested to sustain this intermediate position for five seconds, then she stands up (concentric contraction) and she is requested to sustain the new contraction. The sequence is repeated five times, stimulating the subject every time she goes down (eccentric contraction) to get closer to the chair seat every time she goes down.

*b) Rhythmic initiation:* The activity begins with the subject on the sitting position. The therapist places her hands over the ala ossis illii of the subject. With a modification of the technique to adapt it to the proposed activity, the initial passive moment is omitted. The activity is then started and the subject is requested to stand up 10 times, keeping the pace set by the therapist. The first repetitions are performed with certain assistance to the movement, that is gradually transformed into resistance. Soon after the 10 repetitions the subject continues performing 10 other elevations in a free and active way, keeping the same pace.

On the first weeks, the subjects performed one series of the two techniques, progressing to up to five series at the end of the 20 sessions, with three minute rest intervals among the series. As the subjects progressed in their performance, the resistance applied by the therapist increased, although always respecting the possibilities of performing the task appropriately.

#### Group IV – Control Group (15 subjects)

This group alternated memory activities by means of visual and audio memorization (once a week), with informative workshops on subjects related to the elderly (once a week).

On the statistic analysis, all data were subject to the unvaried Kolmogorov-Smirnov test to determine if they followed a normal distribution. Each variable was subject to a variance analysis (ANOVA) of two factors, where the main factors were: group (name of the groups) and time (pre and post), with measurement repeated on the time factor. In the case of significant *F*, the post-hoc Bonferroni test was used for the pair-to-pair comparisons. The magnitudes of the variations of each variable in each of the groups were compared by the ANOVA of one factor, followed by the Bonferroni test, when appropriate. All results are presented as a medium  $\pm$  standard error and the results of the analysis where  $P < 0.05$  were considered significant.

## Results

The sample was formed of 63 subjects, with an average of 71.56 years of age. After evaluating, comparatively, the efficacy of three training protocols of the sit-to-stand activity, in comparison with a control group, it was noticed a statistically significant improvement in performing the activity in three intervention groups, with no significant results in the control group in all variables, exception to the muscular strength of the right hip extensors.

The times for performing the 10 complete movements of sitting down and standing up, before (pre) and after (post) the intervention of different characteristics (group) are described on Table 1.

Table 1. Results before and after the Sit-to-Stand Test

Group	Pre	Post	Difference (%)
Strengthening (n=17)	26.9	22.7*	-14.8
Functional (n=16)	27.7	22.4*	-16.7
PNF (n=15)	27.3	19.8*	-25.5
Control (n=15)	25.8	26.0	0.8

\*  $P < 0,05$  vs. Pre

The times for performing a complete movement of standing up, walk 3 meters and sit down, measured before (pre) and after (post) intervention of different characteristics (group) are described on Table 2.

Table 2. Results before and after the Timed Up and Go Test

Group	Pre	Post	Difference (%)
Strengthening (n=17)	11.5	10.6*	-7.0
Functional (n=16)	12.2	9.8*	-17.9
PNF (n=15)	12.1	9.9*	-16.1
Control (n=15)	12.0	11.8	-1.4

\*  $P < 0,05$  vs. Pre

The reaching, distances, as balance measurement before (pre) and after (post) the intervention of different characteristics are described on Table 3.

Table 3. Results before and after the Functional Reach Test

Group	Pre (cm)	Post (cm)	Difference (%)
Strengthening (n=17)	26.5	28.4*	7.9

Functional (n=16)	26.7	29.7*	12.5
PNF (n=15)	27.1	30.1*	13.0
Control (n=15)	25.6	25.7	0.5

\* P<0,05 vs. Pre

The muscular strength of the knee extensors, both right and left, and the hip extensors, both right and left, is described on Tables 4, 5, 6 and 7.

Table 4. Muscular strength of the right knee extensors, before (pre) and after (post) the intervention of different characteristics (group).

Group	Pre (kg)	Post (kg)	Difference (%)
Strengthening (n=17)	8.5	9.8*	17.9
Functional (n=16)	8.4	9.9*	21.0
PNF (n=15)	8.8	10.0*	16.1
Control (n=15)	8.4	8.8	5.2

\* P<0,05 vs. Pre

Table 5. Muscular strength of the left knee extensors, before (pre) and after (post) the intervention of different characteristics (group).

Group	Pre (kg)	Post (kg)	Difference (%)
Strengthening (n=17)	8.5	9.8*	19.1
Functional (n=16)	7.9	9.9*	30.7
PNF (n=15)	8.9	10.0*	14.5
Control (n=15)	8.7	9.0	3.2

\* P<0,05 vs. Pre

Table 6. Muscular strength of the right hip extensors, before (pre) and after (post) the intervention of different characteristics (group).

Group	Pre (kg)	Post (kg)	Difference (%)
Strengthening (n=17)	6.6	8.8*	39.1
Functional (n=16)	7.4	8.8*	22.2
PNF (n=15)	7.2	9.5*	35.8
Control (n=15)	6.7	7.1*	5.8

\* P<0,05 vs. Pre

Table 7. Muscular strength of the left hip extensors, before (pre) and after (post) the intervention of different characteristics (group).

Group	Pre (kg)	Post (kg)	Difference (%)
Strengthening (n=17)	6.2	8.7*	43.4

Functional (n=16)	7.3	8.9*	26.9
PNF (n=15)	6.9	9.4*	39.4
Control (n=15)	6.7	7.0	4.6

\* P<0,05 vs. Pre

## Discussion

The Sit-to-Stand-to-Sit Test was considered the most important in the study, as it evaluated the act of standing up in a broader sense, involving the muscular strength of the lower limbs, balance (due to the speed) and resistance. The results found in the study were statistically significant in all 3 intervention groups, being more expressive (-25.5%) in the PNF group, followed by the Functional Training group (-16.7%), and, eventually, not so markedly, in the Traditional Muscular Strengthening group (-14.8%). The findings can be explained by the new Motor Learning and Control Theories, where the specificity and the variability of a task is commended as fundamental characteristics for optimizing the performance of an activity [13].

In their protocol, the PNF group used the act of standing up itself, initially modified by manual resistance and variation in the activity time, finishing, however, with the rhythmic initiation technique, that in its final phase stimulates the independent and uninterrupted performance of the activity, in the rhythm pre-established by the therapist [14]. The expected result was confirmed by the pre and post intervention evaluation.

The Functional Training group, through the use of sequenced tasks, all involving the act of standing up, also uses the specificity and variability criteria, justifying, thus, its results.

The Traditional Muscular Strengthening group, with the intervention that is mostly cited in literature, shows progress in the test in question, although with less significance, probably due to not presenting in its protocol the act of standing up as training and, thus, does not include fundamental characteristics of the task such as speed using the *momentum*.

In the *Timed Up and Go Test*, the three interventions showed significant results, being the PNF and Functional Training the ones with best results. The less significant result, from the Traditional Muscular Strengthening group, reinforces, once again, the basis of the current Motor Learning and Control Theories [13]. In this test, as simulating a functional situation, there are more aspects into it than only muscular strength, such as balance, gait, the act of going to a pre-established point and come back to sit down. Such aspects are more exploited in the PNF and Functional Training protocols. Although showed by several authors, the efficacy of the Traditional Strengthening of the lower limb muscles not only in gaining muscular strength, but also in the performance of functional activities [15, 16, 17] it was shown, in this study, that the protocols that involve the specific functional activity to be worked tend to be more efficient.

In the Functional Reach Test, again the results showed the higher efficacy of the protocols in the PNF and Functional Training groups, which involve the activity to be optimized in a functional manner. Although not so significant, the effects obtained by the Traditional Muscular Strengthening were also statistically significant compared to the results of the control group. Such results are probably due to the influence of the muscular strengthening of the large muscles of the lower limbs on balance when standing up, considering the test characteristics, as already described by other authors [15, 16].

In the Manual Muscular Strength Test the results obtained in the present study, for the right and left knee extensor muscles were statistically significant in all three intervention groups, in comparison with the control group.

The Functional Training Group showed the statistically most significant results, suggesting again the importance of repetition and variability of the task to optimize the activity [13]. Specifically in the increase of muscular strength of the right and left knee extensor muscles, it was observed a more expressive increase of this variable, when a protocol that includes standing from different surfaces associated to a functional activity, as it happens with the Functional Training group.

The PNF group showed less significant results than the Functional Training group. These results may be due to the use of manual resistance and independent training in its protocol, although without varying the surfaces in use, presenting, though, repetition without varying the environment.

In the evaluation of the muscular strength of the hip extensors, the results were equally significant in the Traditional Muscular Strengthening and in the PNF groups, although the Functional Training group also showed expressive results.

The evaluation of the right hip extensors was the only variable that showed statistically significant results in the groups subjected to the intervention and in the control group. Such results may be due to the fact that, although not subjected to any physical intervention, the subjects in the control group also had to go to the testing facilities regularly, showing they were as motivated as the other ones to perform the memory activities and the workshops.

Specifically in relation to the muscular strength, we shall also consider the characteristics of the test used as a possible explanation for the results, statistically significant, found in the groups subjected to the intervention and in the control group. Being a semi-quantitative test, we shall consider the possibility of some interference in the individual perception of the examiner.

As limitations to the study, it can be considered:

- a) Characteristics of the population: The restriction of the external validity by the exclusive use of people of the female sex.
- b) Analysis methods: The use of low technology and cost evaluation tools may have compromised the accuracy of the results. The impossibility of running a blind evaluation shall also be taken into consideration as a possible interference factor in the results.
- c) Retention analysis: The results collected to evaluate the retention could not be taken into consideration because most of the subjects did not remain inactive during the eight weeks after the interventions. Some joined new programs and others felt motivated to perform other activities such as walking medium length distances.
- d) Sample size: For the generalization of the findings of this experiment the sample should be bigger.

The present study opens new questions for future research studies in the functionality of the elderly, mainly in regards to the creation of simple and efficient protocols to prevent and rehabilitate functional activities in the elderly.

## **Conclusion**

The elderly women who were submitted to the protocols of Traditional Muscular Strengthening, Functional Training and PNF who participated in this study showed

significant improvements in the measure parameters of the sit-to-stand activity when compared to the control group. The Functional Training and the PNF protocols showed being the most efficient ones, reinforcing the new motor learning and control theories that commend the specificity and the variability of the task as fundamental characteristics for optimizing the performance of an activity.

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