IJSPT

ORIGINAL RESEARCH

FUNCTIONAL VS. STRENGTH TRAINING IN ADULTS: SPECIFIC NEEDS DEFINE THE BEST INTERVENTION

Matheus Maia Pacheco[1]
Luis Antonio Cespedes Teixeira[1]
Emerson Franchini[1]
Monica Yuri Takito[1]

ABSTRACT

Background/Purpose: Studies that have aimed to compare different strategies to improve functional capacity have produced controversial results. Furthermore, such studies have focused solely on dependent individuals. In contrast, the present study aimed to compare traditional training to functional training for independent individuals. The purpose of this study was to compare traditional training to functional training in healthy and independent middle-aged adults (40-60 years old) and elderly subjects (older than 60 years old).

Methods: One hundred and one subjects (54.75 ± 8.84 years) were divided into two groups that each performed 24 sessions of a training protocol twice per week. The subjects were assessed using quantitative (Y-Balance Test) and qualitative methods (Functional Movement Screen™). The individuals were compared by observing changes between pretest and posttest according to their intervention group, sex and age.

Results: When the entire sample was considered, the results showed that there were no differences in improvement between the training protocols. However, when specific groups were analyzed, functional training was less effective for women compared to men in the same group ($Z = -2.598$; $p = 0.009$; effect size = 0.43) and compared to women in the conventional group ($Z = -2.704$; $p = 0.007$; effect size = 0.41).

Conclusions: There were no differences between the two protocols in their ability to improve functional capacity as measured by the two chosen outcome measures. However, each subject's condition before the intervention must be considered. Some individuals may require additional basic training or specific training. In the current study, the women may have needed to improve their basic capabilities before practicing more specific training protocols.

Level of evidence: 2b. This is a pre- and post-intervention analysis using within-group and between-groups comparisons.

Keywords: Activities of daily living, adults, functionality, specificity.

CORRESPONDING AUTHOR
Matheus Maia Pacheco
Department of Pedagogy of Human Movement,
School of Physical Education and Sport,
University of Sao Paulo (EEFE-USP), Brazil.
Av. Prof. Mello Moraes
65 - Cidade Universitária
CEP: 05508-030 - São Paulo
Phone number: (5511) 3091-2306
E-mail: matheus.lacom@gmail.com

[1] University of Sao Paulo (EEFE-USP), Brazil

INTRODUCTION

Recently, functional capacity – defined as the capacity to act on, influence and/or change the surrounding environment[1] – has been studied as one important aspect of late adulthood and elderly life. Its increasing importance can be explained by the discovery that other capacities, such as strength, have a non-direct relationship with quality of life and the activities of daily living.[2] Functional capacity can be assessed in relation to its absence. As Rosa et al[3] state that what is actually measured with regard to functional capacity is the difficulty that subjects have in performing certain gestures or movements that are related to the activities of daily living, such as bathing, eating, or walking.

Many authors have attempted to identify factors that are related to functional capacity and the most commonly identified factor has been physical activity level.[4-11] In addition, researchers have also attempted to determine the best way to improve functional capacity. Different training methods have been assessed for their effectiveness in improving functionality,[12-19] however, no definitive conclusions have been reached with regard to the type of training that is most effective. Some studies have found that strength training can increase functional capacity,[18,19] even with only modest gains[17] or gains in a few measures.[12] On the other hand, some authors[1,15,16] argue in favor of a specific intervention with directed exercises, known as functional training. Papí[1] described this type of intervention as the next step after conventional training (i.e. strength training). For instance, Krebs et al[16] compared functional training to regular strength training and presented evidence to support the potential benefits of functional training.

Nevertheless, most studies reported in the literature were conducted with a dependent sample – individuals who need the assistance of another person to perform the activities of daily living. For example, Krebs et al[16] studied disabled elderly people. Also, some studies[15] have addressed sports performance in young adults rather than activities of daily living. In other words, few studies have been conducted that analyze the ability of independent, aging individuals to perform the activities of daily living. Studying the functional capacity of independent subjects could provide different interpretations about the utility of functional and strength training to improve functional capacity; these studies could reveal predictive factors that interfere with improvements and indicate which individuals need certain training. Studies with independent individuals should be conducted, considering that diminished capabilities can be treated when they are identified earlier, in order to prevent problems that occur as people age and to verify the effectiveness of each protocol in improving capabilities.

Therefore, the purpose of the present study was to compare traditional training to functional training in healthy and independent middle-aged adults (40-60 years old) and elderly subjects (older than 60 years old). Additionally, the authors aimed to identify if performance is influenced by associated factors such as age and gender.

METHODS

This study is a clinical trial of an intervention using a pre- and post-test design with both within-group and between-groups comparisons. A total of 101 volunteers agreed to participate after signing an informed consent form describing the methods, requirements and risks of this study. This study was approved by the Institutional Review Board of the School of Physical Education and Sports at the University of São Paulo. The sample included 56 women (age: 53.55 ± 7.95 years) and 45 men (age: 56.24 ± 9.71 years) greater than 50 years of age who were participants in a physical activity program at the School of Physical Education and Sports at the University of São Paulo. The participants were excluded from the sample if they reported any case of dependence of another person to perform any activity of daily living. This program met two times per week for seventy-five minutes per session.

A questionnaire was used to obtain information about age, gender, the participants' time in the program, participation in other types of training specifically related to function (e.g., yoga, pilates, functional training), pathologies related to balance (labyrinthitis) and joint pain.

Before the study, the participants had a vacation period of two months and an initial, one-month period with performance of a conventional general training protocol, while any exercise related to the functional training was avoided. This initial period offered time to become familiar with the researchers and the time was also utilized to collect the informed consent forms. No subject reported dependence for any the activities of daily living (i.e., personal hygiene; eating; walking; working) and therefore none were excluded from participating in the research protocol.

The participants were divided into two groups based on the individuals' preferences for attending classes on different days: one group (n = 50), the conventional group (CG), performed regular strength training and the other (n = 51) performed specific functional training (FG). Both groups performed 24 training sessions (two times per week for 12 weeks). Each training session was individualized for each participant in terms of intensity and equalized for each group in terms of the volume of exercises executed and the major muscles activated. For example, the conventional training group performed an exercise (e.g., barbell bench press) with the pectoralis major muscle as the main agonist muscle group for a maximum of 10 to 15 repetitions. The functional group performed a different exercise (e.g, push-up), but their exercise used the same muscle group (pectoralis major). The difference in the chosen exercises was related to the necessity of co-activation required for stabilizing the posture or the position during the exercise.

The resistance was determined during the familiarization period and it was characterized by the individual's capacity to perform the exercise for 10 to 15 repetitions at his or her maximum in each series. The exercise progression for the functional group followed a sequential three-phase structure (Table 1). First, the exercises emphasized stability – defined in this study as the ability to maintain a posture or body position utilizing the core muscle groups. Performing dynamic movements and isometric movements simultaneously was also avoided. Second, the subjects performed exercises that included combinations of dynamic movements and isometric stabilization of the trunk. Last, exercises combining balance, stability and dynamic force were performed. The progression for the conventional group was based on the intensity (resistance used) during each exercise (dumbbell fly, abdominal, reverse fly, leg extension, etc.), maintaining the number of repetitions and the interval between sets (with no emphasis on stability). All exercise parameters were determined based upon ACSM guidelines.[20]

For both groups, large muscle groups were emphasized during training. The conventional group also trained the muscles of the trunk. However, they were trained utilizing dynamic movements with no requirement for isometric stability, which is the main difference from the functional group.

Each training session was divided into segments: 10 minutes for the warm up, 20 or 25 minutes of aerobic training (the same for both groups), 30 or 35

Table 1. *Schedule training structure of the Functional Group. Dosage of exercises is described within text.*

Exercises \ Weeks	1	2	3	4	5	6	7	8	9	10	11	12
Isometric Exercises (e.g., plank, side plank)	X	X	X	X	X	X		X				
Small-Base of Support Exercises (e.g., squat with feet together, lunge in line)	X	X	X	X	X		X	X	X	X		X
Isometric Exercises + Dynamic Exercises (e.g., side plank with leg suspension, push up)					X	X	X	X	X	X	X	X
Balance (e.g., postural control in an instable surface)						X	X					
Balance + Dynamic Exercises (e.g., squat in an instable surface)								X	X	X		X
Balance + Isometric Exercises (e.g., plank with the legs supported by a ball)									X		X	
Balance + Isometric + Dynamic (e.g. push up with the legs supported by a ball)										X	X	X

minutes of the main training protocol, and 10 minutes for the cool down. The main training protocol consisted of six to ten exercises in a circuit. Each exercise was repeated in three sets and executed for a maximum of 10 to 15 repetitions.

All subjects completed pre- and post-tests to measure their functional capacity. These tests were the Functional Movement Screen[21] (FMS™) and the Y-Balance Test (YBT).[22] The FMS™ is a test battery that involves seven movement patterns (deep squat, hurdle step, inline lunge, shoulder mobility, active straight-leg raise, trunk stability pushup and rotary stability) that evaluate flexibility, stability and strength qualitatively, and arrive a numerical score. The test is conducted in a circuit and the score is calculated based on defined criteria related to the individual's performance. The score on each test ranges from zero (pain during performance of movement, or its associated clearing test) to three (perfect execution of movement). Each movement pattern was executed three times per side in order to obtain the best score. The score obtained during best trial on each side and the worst score between the two sides (in the case of tests that are performed bilaterally) were recorded for each test. The total FMS™ score is the sum of all seven scores and the highest achievable score is twenty-one points.

The YBT quantitatively assesses balance, lower body strength, and flexibility, concurrently. The test is performed at the intersection of three lines: an anterior line and two posterior diagonal lines with a 90° angle between them, with a 135° angle in relation to the anterior line (Figure 1). These lines are marked with the distance between the intersection and the tip of lines. The test begins with the participant in single limb stance at the intersection of the lines, with the great toe joint above the intersection of the lines. The other foot does not touch the floor. The foot that is suspended must attempt to reach as far as possible down the three lines (separately and successively) without transferring weight to the foot in motion. Each subject was given six practice trials in each direction with each leg in order to assure that they understood the test. During the test itself, the individuals had three trials for each direction to reach the farthest point on the line. The farthest point reached on each line for each foot was recorded. To

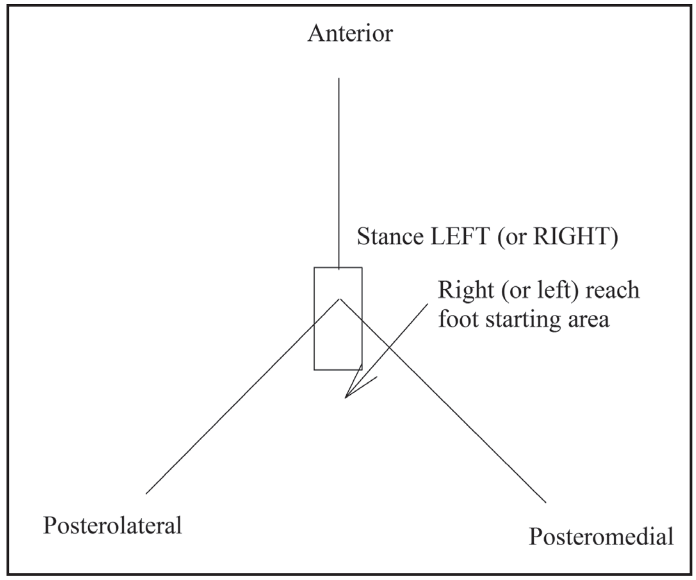

Figure 1. *Y Balance Test diagram. The participant task was to maintain one foot in the central intersection of the lines (shown here as a box) and then to reach as far down each of the three vectors (shown here as lines).*

have a single score from this test, the test score was calculated by using the mean of the three best scores for each of the lower extremity reaches. To guarantee that the measures would not be influenced by the participants' height, the YBT scores were normalized by using an anthropometric measure (the length from the iliac crest to the patella). To match the methods used to score the FMS™, the worst score between the two sides of YBT was used for analysis.

Both tests were utilized because of their high reliability. The agreement of the FMS™ test was substantial to excellent[21] (at least 83% agreement between raters) and the YBT has demonstrated 0.91 intra-rater reliability and 0.99 inter-rater reliability[22] (acceptable use for this age group).[23-28] Furthermore, the tests were used because it was necessary to have both qualitative and quantitative tests to represent the types of changes that may occur.

STATISTICAL ANALYSIS

A Komogorov-Smirnov test was conducted and it showed a non-normal distribution for both groups on both tests. Therefore, all comparisons were made utilizing non-parametric analyses.

Two steps were used to assess the changes in functional capacity: a) both groups were analyzed using a Wilcoxon test to compare the effects of training between the pre-test and the post-test and a Mann-Whitney test was used to analyze the difference between the groups; b) the individuals were analyzed according to group (CG and FG), age and sex. We analyzed the interaction of these independent variables on the change in the FMS and YBT (i.e., the difference from the pretest to the posttest).

In the second step described above, the subjects in the both groups were divided into the two groups, defined as adult and elderly (as typically defined in the authors country). The CG group was divided into adult women (n = 19; age = 50.15 ± 5.12), elderly women (n = 6; age = 61.66 ± 1.21), adult men (n = 16; age = 48.22 ± 9.67) and elderly men (n = 9; age = 62.55 ± 2.35). The FG was divided into the following groups: adult women (n = 25; age = 51.04 ± 6.34), elderly women (n = 6; age = 66.66 ± 6.83), adult men (n = 12; age = 54.83 ± 3.09) and elderly men (n = 8; age = 67.5 ± 4.56).

The latter part of the analysis was conducted with sequential Mann-Whitney tests corrected using the Bonferroni correction procedure. Because of the small number of individuals in the comparisons that considered the interaction of all independent variables, significant differences could only be found if there was a large effect size. Thus, all of the comparisons with $p < 0.05$ are presented. The effect size was calculated from the z-statistic resulting from the analysis divided by the square root of the number of observations.

RESULTS

Based on the results of the questionnaire, it was determined that 28.7% of the sample met the authors definition of elderly (older than 60 years old). 22.8% of the participants started the program in the year of the study and the average time in the program was approximately five years (5.5 ± 7.73). In addition, 45.5% of the subjects took at least one recreational walk per week, 21.8% of the participants reported that they had participated in an exercise program related to functional training and 38.6% reported at least one joint injury (the most common injuries were knee-related; 15.8%). No statistically significant differences were found between intervention groups, gender and age on extra physical activities, participation in an exercise program related to functional training before the intervention, and injuries ($p > 0.05$).

The descriptive results are presented in table 2.

The results of the FMS™ and YBT comparisons are presented in Figure 2. Both groups significantly improved their scores on the FMS™ (CG: $Z = -5.294$; $p < 0.001$; effect size = 0.53; FG: $Z = -5.294$; $p < 0.001$; effect size = 0.42). The Mann-Whitney tests indicated that there were no differences between the groups at

Table 2. *Descriptive results by group.*

Control Group				Functional Group			
Y Balance Test		FMS		Y Balance Test		FMS	
Pre-test	Posttest	Pre-test	Posttest	Pre-test	Posttest	Pre-test	Posttest
1.36±0.23	1.39±0.18	11.6±1.66	13.2±1.69	1.27±0.25	1.34±0.17	11.4±2	12.7±1.62
Adults				Elderly			
1.35±0.22	1.39±0.16	11.8±1.77	13.3±1.7	1.23±0.3	1.31±0.2	10.6±1.71	12.1±1.17
Men				Women			
1.32±0.3	1.38±0.18	11.1±1.8	12.9±1.64	1.31±0.2	1.36±0.17	11.8±1.82	13±1.69

Note: YBT scores are normalized data (the mean of three measures, divided by the length of the limb from the iliac crest to the patella in centimeters).

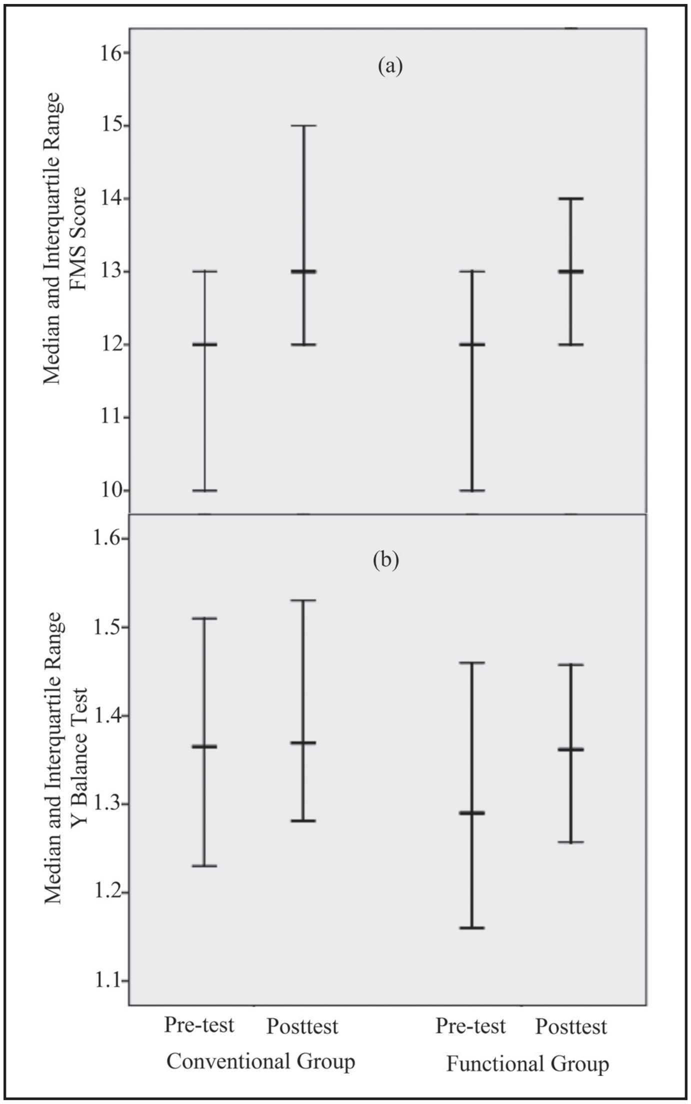

Figure 2. *Pre- and post-test data for both groups. The error bars represent the median and the first and third quartiles of the (a) Functional Movement Screen™ score and (b) Y Balance Test.*

the beginning or the end of the intervention (pre-test: p = 0.594; posttest: p = 0.234). Thus, both protocols improved functional capacity as measured by these two outcome measures.

Only the FG group demonstrated significant improvement (Z = –3,302; p = 0,001, effect size = 0.38) on the YBT. For the CG group, there was no effect of the intervention (p = 0.474). There were no differences between the groups before the intervention (pre-test: p = 0.164) or after the intervention (post-test: p = 0.326).

In the first set of comparisons, the intervention-group, age-group and sex-group interactions showed no effects on the changes in the scores for the FMS™ test or the YBT.

Figure 3 presents the results for the second set of comparisons between the groups when analyzed by age and gender, for both outcome measures. As shown, in the second set of comparisons, the FMS™ scores for men and women differed significantly in the functional group (Z = –2.58; p = 0.010; effect size = 0.36). Men showed more improvement than women.

Figure 4 presents the results for the third set of comparisons between the groups, when analyzed for age and gender, for both outcome measures. In the third set of comparisons, adult men had higher performance scores than the women in the functional group (Z = –2.598; p = 0.009; effect size = 0.43). For both protocols, the adult women in the CG had higher performance scores than the women in the FG (Z = –2.704; p = 0.007; effect size = 0.41). The only differences occurred on the FMS™.

DISCUSSION

This study aimed to analyze the impact of two types of training on functional capacity and to understand the different factors that could predict greater improvement for a particular group. Although improvement occurred in both intervention groups; neither groups' improvements were statistically significant for the FMS™. Only the functional group demonstrated improvement on the YBT. However, the between-groups analysis showed that both groups had no statistically significant differences. The latter analysis and the moderate power effect observed in the within-group analysis confirmed that the improvement for the functional group was small, and therefore the authors are unable to make inferences about the meaning of this improvement.

Although there were some differences observed in the FMS™ and YBT results, it is possible to note congruent patterns (e.g., women had less improvement in the functional group than in the other group). The analyses on the FMS™ indicated that both groups started at the same point, developed their functional capacity during the intervention and demonstrated improvement on the post-test. This finding is not compatible with the results found by Krebs et al[16].

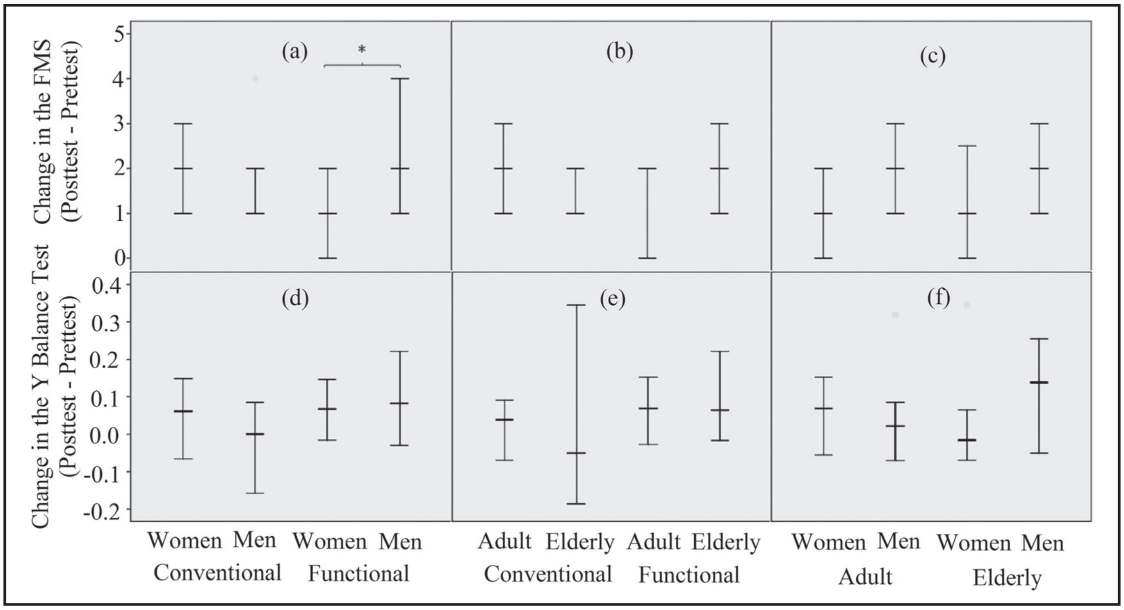

Figure 3. *The change (Posttest minus Pretest) of the groups analyzed in the second comparisons: (a and d) sex and intervention group; (b and e) age group and intervention group; and (c and f) age group and sex. The error bars represent the median and the first and third quartiles of the change on (a, b, and c) Functional Movement Screen™ and (d, e and f) Y Balance Test. The asterisk means the significant difference ($p < 0.05$).*

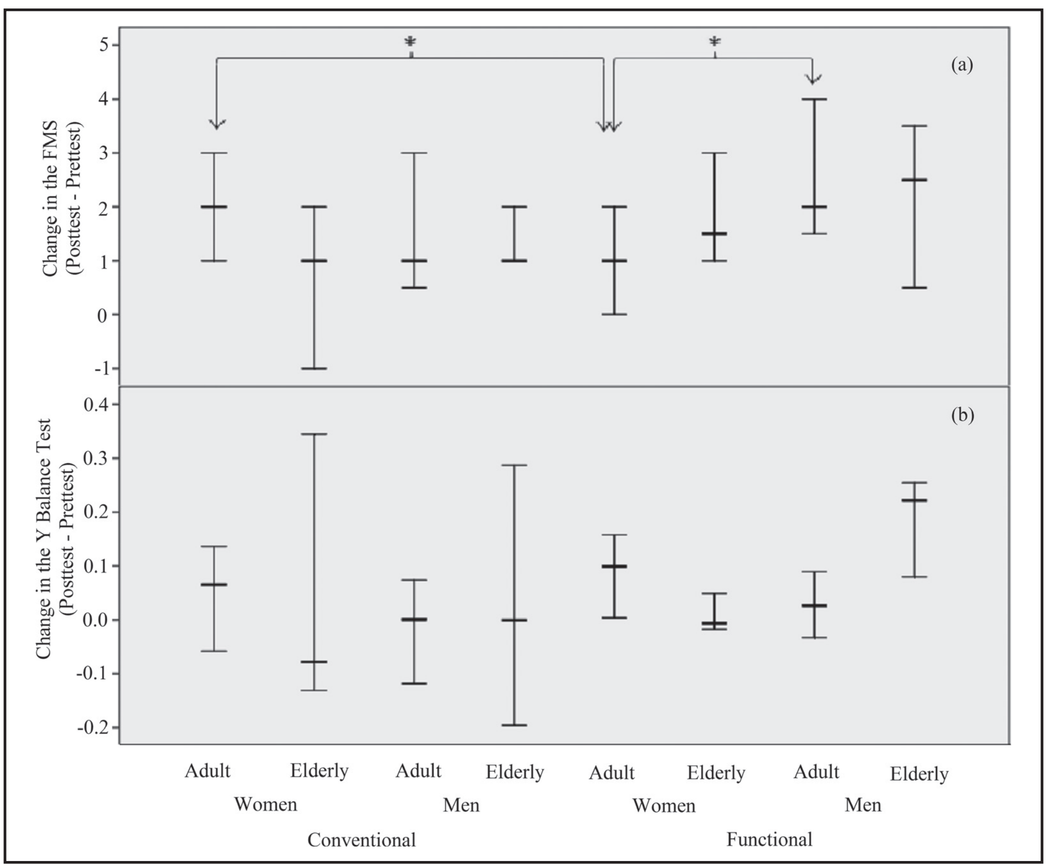

Figure 4. *The change (Posttest minus Pretest) of the groups analyzed in the third comparisons. The error bars represent the median and the first and third quartiles of the change on (a) Functional Movement Screen™ and (b) Y Balance Test. The asterisks mean the significant differences between groups pointed by the arrow ($p < 0.05$).*

In their study, the group that performed the specific protocol (similar to the functional training protocol) performed better on their tests compared to the group that performed the conventional protocol. Nonetheless, it is possible that this result occurred because their study used a different sample (i.e., their participants were dependent individuals with some type of pain and lower-limb arthritis). In the current study, however, all of the individuals were participants in a physical activity program. Therefore, it is possible to imagine that the difference between the groups in the two studies may have influenced the outcomes; the group studied by Krebs et al[16] was physically dependent, whereas our subjects were physically independent.

Kibele and Behm[15] found results similar to those found in the current investigation. They compared two types of training – traditional stable training and unstable training – using tests that were based on functional tests related to sport performance. Neither group showed any differences on any measures after training. Despite the differences in the samples used (university students vs. adults) and in the tests (functional tasks related to running, hopping and balance vs. the FMS™ and YBT), it seems that both training protocols were capable of improving function in sports performance or in the quality of many movement patterns.

The YBT results indicated that the functional group intervention had a statistically significant effect on performance of this measure. This result could support the specific impact of functional training on functional performance, because only the specific functional training group showed improvement.

It is important to consider that there may have been a ceiling effect on the YBT. No improvements are possible under this condition. It is likely that higher scores can only be reached with specific training for the test. Indeed, both groups achieved the same score on the post-test. However, this ceiling effect was not found in other studies.[23-27] Other factors may have contributed to these results. Other protocols were utilized in the other studies (e.g., whole body vibration, aquatic training), which could be the reason for the different results of those studies.

Observing the interaction results, the most noticeable result is that the women in the functional group improved less than the men in the same group and the women in the conventional training group. Considering the FMS™ results, when compared to the adult women in the conventional group, the adult women in the functional group showed less improvement. In addition, compared to the adult men in the same group, the adult women improved less.

However, there were no differences between elderly women and elderly men in the functional group. This group only had a few subjects in the last set of comparisons and larger effects would be necessary to reach significant differences.

The reason for this contradictory result – if functional training should be specific to functional tests – it might be that women in this period of life have less developed basic capabilities (e.g., strength). Consequently, specific training did not enhance their basic capabilities enough in order to improve function. Another hypothesis could be that women have no problems executing the gestures or movements needed for activities of daily living (or such movements performed on the FMS™ and YBT) when they have basic levels of strength. The true problem may be that their capabilities decrease with age. Thus, the conventional group training targeted precisely these capabilities and produced sufficient improvement on both tests. Considering the initial performance in basic capabilities as the principal interfering factor in this study, the current results align with the results of Holviala et al,[14] who determined that the initial status of the subjects was a critical factor in their results, for example the participants were physically active before the intervention and had no changes in the static balance tests.

This hypothesis aligns with the idea that functional training may be a "next step" after conventional training.[1] The present argument is that basic capabilities should be developed with conventional training before trying a more specific protocol. Thus, fitness status before the intervention is an important factor to consider when choosing a training protocol.

The current study has some limitation that should be considered. The authors did not measure strength or flexibility directly. These factors should be addressed in future studies in order to avoid speculation on the relation between the scores and initial and final conditions. Additionally, the present study did not have a measure of performance of ADL's. Although the movement patterns in the tests utilized in the current research may be associated with performance of an ADL, there is a gap between such measures and ADL's that must be addressed in order to comprehend the relation between intervention and improvement on functional capacity and any specific ADL.

CONCLUSION

The present study attempted to analyze the differences between two types of training that emphasized different aspects of training: conventional training and functional training. The authors of the current study also observed the impact of each type of training according to age and sex. Both interventions produced improvements, although few were statistically significant. Certain groups of subjects showed varied improvements associated with the different training protocols.

The results of this study point to a difference between the sexes in terms of the benefit they receive from functional training. The authors hypothesized that this difference could be due to the fact that women may need to develop basic strength capabilities using a conventional training protocol before moving to a more specific one, however more research is needed to explore this hypothesis as the current study did not examine measurements of strength.

REFERENCES

1. Papí JD. *Entrenamiento funcional en programas de fitness*: INDE Publicaciones; 2007.
2. Bross R, Storer T, Bhasin S. Aging and Muscle Loss. *Trends Endocrinol Metab.* Jul 1999;10(5):194-198.
3. Rosa TE, Benicio MH, Latorre Mdo R, Ramos LR. [Determinant factors of functional status among the elderly]. *Rev Saude Publica.* Feb 2003;37(1): 40-48.
4. Adedoyin RA, Adeyanju SA, Balogun MO, Adebayo RA, Akintomide AO, Akinwusi PO. Prediction of functional capacity during six-minute walk among patients with chronic heart failure. *Niger J Clin Pract.* Dec 2010;13(4):379-381.
5. Bouchard DR, Heroux M, Janssen I. Association between muscle mass, leg strength, and fat mass with physical function in older adults: influence of age and sex. *J Aging Health.* Mar 2011;23(2):313-328.
6. de Souza Santos CA, Dantas EE, Moreira MH. Correlation of physical aptitude; functional capacity, corporal balance and quality of life (QoL) among elderly women submitted to a post-menopausal physical activities program. *Arch Gerontol Geriatr.* Nov-Dec 2011;53(3):344-349.
7. Hebert R, Brayne C, Spiegelhalter D. Factors associated with functional decline and improvement in a very elderly community-dwelling population. *Am J Epidemiol.* Sep 1 1999;150(5):501-510.
8. Marshall SC, Berg K. Cessation of exercise in the institutionalized elderly: effects on physical function. *Physiother Can.* Summer 2010;62(3):254-260.
9. Sulander T. The association of functional capacity with health-related behavior among urban home-dwelling older adults. *Arch Gerontol Geriatr.* Jan-Feb 2011;52(1):e11-14.
10. Torres Gde V, Reis LA. Assessment of functional capacity in elderly residents of an outlying area in the hinterland of Bahia/Northeast Brazil. *Arq Neuropsiquiatr.* Feb 2010;68(1):39-43.
11. Tsubota-Utsugi M, Ito-Sato R, Ohkubo T, et al. Health behaviors as predictors for declines in higher-level functional capacity in older adults: the Ohasama study. *J Am Geriatr Soc.* Nov 2011;59(11):1993-2000.
12. Buchner DM, Cress ME, de Lateur BJ, et al. The effect of strength and endurance training on gait, balance, fall risk, and health services use in community-living older adults. *J Gerontol A Biol Sci Med Sci.* Jul 1997;52(4):M218-224.
13. Hallage T, Krause MP, Haile L, et al. The Effects of 12 Weeks of Step Aerobics Training on Functional Fitness of Elderly Women. *J Strength Cond Res.* Aug 2010;24(8):2261-2266.
14. Holviala JHS, Sallinen JM, Kraemer WJ, Alen MJ, Hakkinen KKT. Effect's of strength training on muscle strength characteristics, functional capabilities, and balance in middle-aged and older women. *J Strength Cond Res.* May 2006;20(2):336-344.
15. Kibele A, Behm DG. Seven Weeks of Instability and Traditional Resistance Training Effects on Strength, Balance and Functional Performance. *J Strength Cond Res.* Dec 2009;23(9):2443-2450.
16. Krebs DE, Scarborough DM, McGibbon CA. Functional vs. strength training in disabled elderly outpatients. *Am J Phys Med Rehabil.* Feb 2007;86(2):93-103.
17. Latham NK, Bennett DA, Stretton CM, Anderson CS. Systematic review of progressive resistance strength training in older adults. *J Gerontol A Biol Sci Med Sci.* Jan 2004;59(1):48-61.
18. Miszko TA, Cress ME, Slade JM, Covey CJ, Agrawal SK, Doerr CE. Effect of strength and power training

on physical function in community-dwelling older adults. *J Gerontol A Biol Sci Med Sci.* Feb 2003;58(2):171-175.

19. Seguin R, Nelson ME. The benefits of strength training for older adults. *Am J Prev Med.* Oct 2003;25(3 Suppl 2):141-149.
20. Garber CE, Blissmer B, Deschenes MR, et al. Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults: Guidance for Prescribing Exercise. Medicine and Science in Sports and Exercise. Jul 2011;43(7): 1334-1359.
21. Minick KI, Kiesel KB, Burton L, Taylor A, Plisky P, Butler RJ. Interrater reliability of the functional movement screen. *J Strength Cond Res.* Feb 2010;24(2):479-486.
22. Plisky PJ, Gorman PP, Butler RJ, Kiesel KB, Underwood FB, Elkins B. The reliability of an instrumented device for measuring components of the star excursion balance test. *N Am J Sports Phys Ther.* May 2009;4(2):92-99.
23. Hosseini SS. The effect of aquatic and mental trainings on balance in elderly males. *Middle-East Journal of Scientific Research.* 2011;7(3):296-302.
24. Hosseini SS, Asl AK, Rostamkhany H. The effect of strength and core stabilization training on physical fitness factors among elderly people. *World Applied Sciences Journal.* 2012;16(4):479-484.
25. Sarvestani H, Tabrizi HB, Abbasi A, Rahmanpourmoghaddam J. The effect of eight weeks aquatic balance training and core stabilization training on dynamic balance in inactive elder males. *Middle-East Journal of Scientific Research.* 2012;11(3):279-286.
26. Sarvestani H, Tabrizi HB, Abbasi A, Rahmanpourmoghaddam J. The effect of ten weeks aquatic balance training and functional training on dynamic balance in inactive elder males. *Middle-East Journal of Scientific Research.* 2012;11(3):296-303.
27. Bashiri J, Hadi H. The effect of aquatic, whole body vibration and concurrent (aquatic and whole body vibration) training on dynamic balance in elderly females. *Annals of Biological Research.* 2011;2(5): 269-274.
28. Bhk FP, Koehle MS. Normative Data for the Functional Movement Screen(TM) in middle-aged adults. *Journal of Strength & Conditioning Research.* In press.