

**Vasper Training System to Improve Functional
Balance and Decrease Fall Risk in Independent
Living Seniors: A Quality Assurance Report**

VASPER 

INTRODUCTION

“Population aging” is the success story of modern medicine with average life expectancy rapidly approaching 80. However, the challenge now is “quality aging” with profound consequences on our healthcare system. In the US, one out of every three seniors will fall every year. Falls are the leading cause of both fatal and nonfatal injuries in the 60 and older population (Center for Disease Control). Falls can cause moderate to severe injuries, such as hip fractures and head traumas, and can increase the risk of early death. Falls are a public health problem that should be preventable.

In Hawaii, falls related injuries represent 83% of all hospitalization for the 60 plus population with average medical expenses of \$32,000 per incident. Falls related hospitalizations have increased by eight percent from 2008 to almost 2,000 incidences in 2013. This does not include the over 6,000 incidences of senior falls treated in the ER every year (1). The urgency of this problem has led the Hawaii Department of Health, Executive Office on Aging to issue a 5 year Falls Prevention State Plan which includes education, interventional programs and engagement of medical professionals. This community based project was designed to begin documenting how independently living “healthy” seniors currently rank against age matched fitness standards and what fall risks looks like for this group.



To remain independent and healthy, the maintenance of skeletal muscle strength are important considerations for the elderly population as they are prone to progressive muscle mass loss associated with the natural aging process. The American College of Sports Medicine recommends resistance training of at least 70% of one repetition maximum to achieve strength improvements as lower intensities do not produce significant muscle growth (2). This intensity level of mechanical stress on the body is often prohibitive for the elderly due to issues with arthritis, body pain, diffuse weakness, and compromised systems from cardiovascular disease or previous orthopedic surgeries.

The Vasper Training System integrates compression training with continuous cooling to deliver accelerated muscle strength gains with minimal mechanical loads while simultaneously optimizing the body for cardiovascular efficiency and comfort. It's ergonomic system is designed to be fully accessible to anyone regardless of age, physical ability or exercise affinity.

Compression or blood flow restriction (BFR) training provides a unique beneficial mode of training for many in and out of the clinical setting. Many studies have demonstrated low intensity BFR training to be quite beneficial for cardiac rehabilitation and the elderly (3-15) and even showed strength gains to be systemic (7).

The Vasper System was utilized as the exercise-training tool for this quality assurance project to evaluate its ability to effectively improve leg strength and functional balance in the senior population. This project will also be evaluating the safety of this program, as well as participant compliance and satisfaction.

Our goal for this project is to evaluate an effective falls prevention program that addresses the inherent physiological muscle strength and balance decline that is commonly associated with natural aging. Most fall prevention programs address external environmental factors. Common exercise solutions to address falls such as tai chi classes or gentle weight training classes often lack the intensity required for meaningful strength changes against the ongoing physiological decline that accompanies aging.

METHODS

Standard clinical tools and methods were used to measure physical strength, balance, fall risk, stability, and endurance. These measurements were taken prior to training and repeated after the completion of 12 sessions. The pre-training and post-training measurements were compared to assess the effectiveness of this fitness program. An anonymous survey was utilized to evaluate participant experience. Participation was voluntary and each participant obtained medical clearance from his or her physician prior to training. Each participant was encouraged to continue his or her daily routines but not add anything new during the training period.

| | |
|---------------------|--|
| PARTICIPANTS | 30 enrolled - 27 completed full program, 3 dropped out due to planned surgery, planned vacation and one with an unrelated back pain flair up. Gender - 77% females 23% males Age – 61% in 80s, 23% in 70s, 10% in 60s, and 6% in 90s |
| PROGRAM | 12 sessions with physical therapist supervision using the Vasper Training System. Each session included a 20 min interval training exercise session on a recumbent cross trainer followed by 10 minutes of laying on a cooling mat. A pre-training evaluation and post-training evaluation was preformed on each participant - completed by a physical therapist not involved with training to eliminate any potential bias |
| CRITERIA | All participants met the following basic criteria <ul style="list-style-type: none">• 60 years or older• Functions independently without assistance• Cognitively without impairments• Medically cleared by their physicians to participate in supervised exercise program |
| MEASUREMENTS | <ol style="list-style-type: none">1. Knee Extension Strength using JTECH Dynamometer2. Balance / Fall Risk Evaluation with Berg Balance Test3. Balance / Stability / Endurance Evaluation with 10TSTS Test4. Physiological Vital Signs - standard blood pressure, oxygen saturation, resting heart rate5. Average Power and Speed output – measured via Vasper System |

RESULTS

LEG MUSCLE STRENGTH

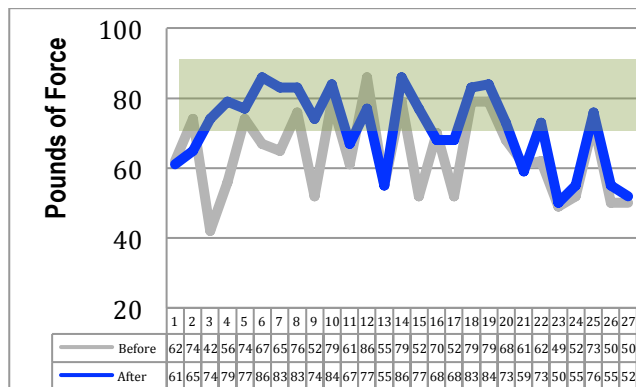
Adequate knee extension strength is critical for functional mobility as it is a key muscle group for stability during upright activities. Knee extension strength was measured with the JTECH Commander ECHO Muscle Testing Dynamometer in a seated position. Target strength output for this age group is between 70 to 85 lbs. of force.

FINDINGS

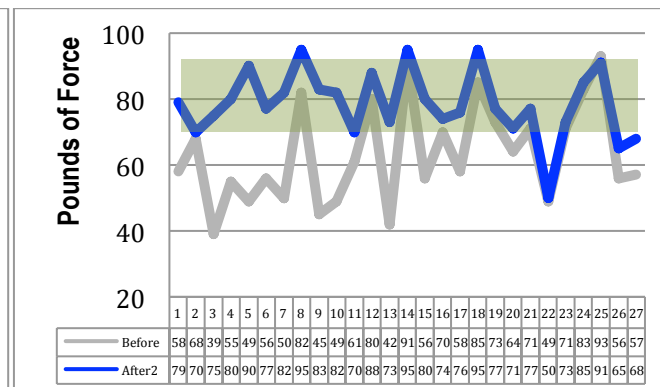
- Prior to the program 39% of participants right leg strength was within the ideal range. After training, 89% of participants right leg strength was within the ideal range. Of those with identified right knee weakness, 89% achieved ideal strength after training. Overall, participant's right leg strength increased by an average of 14 pounds of force.
- Prior to the program 36% of participants left leg strength was within the ideal range. After training, 63% of participants left leg strength were within the ideal range. Of those with identified left knee weakness, 24% achieved ideal strength after training. Overall, participants left leg strength increased by an average of 8 pounds of force.

These results appear to indicate that a significant majority of our “healthy” seniors actually have significant leg weakness despite being independent and high functioning. With this specific anaerobic training program, they were able to make significant strength gain towards much higher “preventive” standards. The value of this increased strength may not be immediately obvious as its impact on daily function is subtle especially if the participants lead a more sedentary lifestyle. However, the increased strength becomes valuable by providing a “margin of safety” when accidents inevitably occur. The results also appear to reveal a strong right leg bias during exercise training which is common as most people are right side dominant in their movement patterns.

LEFT KNEE EXTENSION STRENGTH



RIGHT KNEE EXTENSION STRENGTH



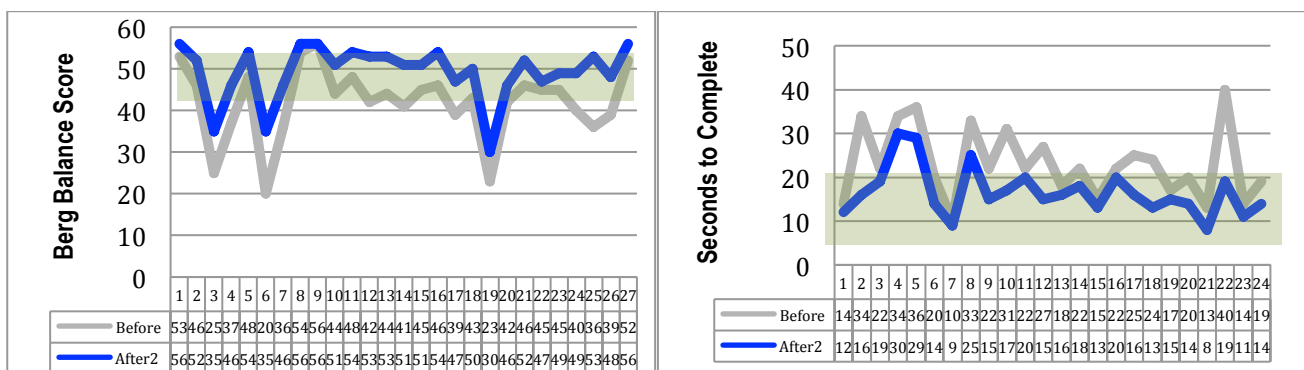
*green shaded area = age matched ideal strength range

BALANCE, STABILITY AND FALL RISK

Balance and stability goes beyond muscle strength to encompass neurological muscle coordination and reaction, joint proprioception, and muscle endurance. Fall risk is directly associated with the ability to balance and stabilize in various upright positions. Standardized tests widely used by rehabilitation professionals such as the Berg Balance Test has been validated to accurately predict fall risk (*Berg K, Wood-Dauphinee S, Williams JJ, Maki B: Measuring balance in the elderly: validation of an instrument. Can. J. Pub. Health July/August supplement 2:S7-11, 1992*) The TSTS (Timed Sit To Stand) tests are additional alternatives to evaluating balance, dynamic stability and fall risk and adds the valuable component of muscle endurance. For this project, we utilized the Berg Balance Test and the modified Ten Times Timed Sit to Stand Test as it is more challenging and thus more sensitive to change for the healthy senior population.

FINDINGS

- Prior to the program 63% of all participants tested at low fall risk scoring higher than 41 points on the Berg Balance Test. After training, 89% of all participants tested at this low fall risk level. Of those initially tested at moderate to high fall risk, 70% changed to low fall risk after the program. Overall, participant improved their Berg Balance Score by an average of 8 points with 9 points being the test standard for “significant” functional improvements.
- Prior to the program 33% of all participants tested at the “no intervention needed” level. This translates to completion of task in less than 20 seconds on the 10XSTS Test. Three participants were unable to perform the test due to inability to stand up from a standard chair without use of arms. After training, 63% of all participants tested at “no intervention needed” with two still unable to perform the test. Of those initially tested at needing intervention, 42% improved to the “no intervention needed” level after the program. Overall, participants improved their speed to complete the test by an average of 6 seconds. The 10XSTS Test is harder than the Berg Test in that it requires muscle endurance in addition to stability and dynamic power.
- To date, 50% of the subjects were randomly tested 2-3 months after the program completion and all showed either a maintenance of their fall risk improvements or further improvements indicating the successful incorporation of improved strength and stability into their daily function.
- These overall findings indicate a significant proportion of “healthy” seniors are slipping towards moderate risk for falls. There is often a false sense of security given their ability to function independently. Fall vulnerability is physically complex as it is a dynamic interaction between strength, endurance, coordination and proprioception in space. It has strong neurological implications; which naturally declines if not “exercised”. The Vasper System appears to significantly address strength, endurance, and to a mid degree, coordination.



*green shaded area = target low fall risk range

SUBJECT EXPERIENCE AND COMPLIANCE

Physical improvements depend solely on program compliance. For this population, compliance results from ease and comfort of program, safety, and self perceived benefits. Of the 360 sessions scheduled for the 30 participants, there was a 90% compliance rate with only three participants not finishing all 12 sessions due to unrelated events (vacation, scheduled surgery, etc.). Anonymous participant surveys taken upon completion of the program demonstrated the following:

- 95% felt the program was comfortable, appropriate- not too hard, and had no discomforts the next day
- 100% felt the program was a good workout and no discomfort immediately after the sessions
- 100% felt the therapists were knowledgeable and felt medically safe during the sessions
- 47% felt 12 sessions was enough to make a difference in strength
- 84% indicated they would like to continue the training
- 68% felt this program increased their commitment to exercising
- 63% increased the level of exercise they were doing before
- 95% would recommend this program to others
- 63% can feel their strength improved as a result of this program
- 53% can feel their balance improved as a result of this program

The safety of the program was monitored via vital signs before, during and after each session including blood pressure, oxygen saturation, and resting / exercising heart rates. Of the 324 sessions completed, there were no negative incidences of abnormal vital signs from the training. In fact, over 50% of the participants demonstrated improvements in blood pressure immediately after the sessions compared to before. Two minor adverse incidents were noted including a blister on the right hand from the handles on the first session, which was mitigated by wearing gloves, and the other was a knee scrape on the second session from bumping the equipment during the exercise, which was addressed with padding. Both participants completed all 12 sessions.

VASPER COMPARED TO OTHER FALLS PREVENTION EXERCISE PROGRAMS

A literature review on fall prevention exercise programs was done to compare the results of this project with three traditional types of fall prevention exercise programs – a multi-modal “comprehensive” program that includes stretching, aerobic and resistance training, a tai chi program and a strength training program (see attached chart). These studies were chosen based on the similarities of the subject’s age and functional status. The common outcome measure used in all of the studies was the Berg Balance Score, a widely used clinical tool to predict fall risk. The programs varied in number of sessions, frequency, duration and exercises completed. Despite the variability in program parameters, traditional fall prevention exercise programs had a consistent rate of fall risk improvement between 5-7% compared to Vasper’s 18% improvement in fall risk. This indicates Vasper training had significantly stronger results in lowering fall risks in the healthy senior population.

A few factors to note is the Vasper study group had a lower average Berg Balance Score at the beginning of the study compared to other studies indicating their fall risk was higher than the other study groups. Also, all of the traditional fall prevention exercise programs were 60 minutes in duration compared to Vasper’s 30 minutes sessions. This may contribute to the overall high compliance and satisfaction rate for the Vasper training program as it may be perceived as “easier” to commit to.

COMPARISON OF VASPER WITH FOUR PUBLISHED “FALLS PREVENTION EXERCISE PROGRAM” STUDIES

| Title | # of Subjects in Study Group | Average Age of Subjects | Functional Status of Subjects | Exercise Program | Total Sessions / Frequency | Berg Balance Score % Improvements |
|---|--|-------------------------|-----------------------------------|---|----------------------------|--|
| Vasper Training System to Improve Functional Balance and Decrease Fall Risk in Independent Living Seniors: A Quality Assurance Report <i>(Publication TBD)</i> | 30 90% completed program | 82 (SD =8) | Healthy & Independent Living | 30 mins program with 20 mins on Vasper System 10 mins on cooling bed | 12 2-3x week | BBS Before = 41.9 ± 9 BBS After = 49.4 ± 6. Improvement = 17.7% |
| The Effects of 15 Weeks of Exercise on Balance, Leg Strength, and Reduction in Falls in 40 Women Aged 65-89 Years. <i>Ballard, JE, et. al., J Am Med Women's Assoc. 2004 Fall;59(4):255-61.</i> | 20 95% completed program | 73 (SD = 5) | Healthy & Independent Living | 60 mins program with 5-10 mins warm up 20-30 mins aerobic exercise 5-10 mins leg strength and balance training 5-10 mins of full body resistance band exercise 5 mins cool down | 45 3x week | BBS Before = 50.6 ± 4 BBS After = 54.1 ± 2 Improvement = 6.8% |
| Effect of an Exercise Program on Risk Factors of Falls in Elderly Women <i>Trelha, C., et. al., Acta Scientiarum 2012; 34:257-61.</i> | 20 60% completed program | 77 (SD = 13) | Healthy with No Disability | 60 mins program with 6 mins warm up 5 mins stretching 14.5 mins strengthening with weights 4.5 mins of balance training 20 mins aerobic exercise 10 mins relaxation | 10 1x week | BBS Before = 51.8 ± 2 BBS After = 53.5 ± 1 Improvement = 4.9% |
| Tai Chi: Improving Functional Balance and Predicting Subsequent Falls in Older Persons <i>Li F., et. al. Med. Sci. Sports Exerc. 2004 Dec; 36(12):2046-52</i> | 256 69% completed program | 77 (SD = 5) | Healthy Community Dwelling | 60 mins program with 5-10 mins warm up 30 mins tai chi 5-10 mins cool down (additional time for instructions) | 72 3x week | BBS Before = 45.7 BBS After = 48.6 Improvement = 6.3% |
| Effects of High Intensity Strength Training on Functional Measures of Balance Ability in Balance Impaired Older Adults <i>Hess J, et al. J of Manipulative and Physiological Therapeutics Oct 2005 Vol 28 No. 8</i> | 13 (no attrition rate reported) | 81 (SD = 6) | Healthy Independently Functioning | 60 mins program with Resistive strength exercises to four major muscle groups in the legs working at an increasing % of 1 rep max. Each exercise done for 8-10 repetitions. | 30 3x week | BBS Before = 48.8 ± 2 BBS After = 51.2 ± 4 Improvement = 4.9% |

SUMMARY

The findings from this project support the premise that “healthy” and “safe” are not interchangeable when it comes to the enormous problem of senior falls. In fact, “healthy” as commonly indicated by the ability to function independently often provides a false sense of safety that may prohibit the recognition of developing fall risk factors by our healthcare system. What we know is falls are preventable and what is exciting are these risk factors can be effectively addressed by new technologies designed to facilitate higher levels of fitness without the physical stress on the body making meaningful strong physical changes suddenly accessible. Future plans for this project will include looking at the “assisted living” senior population to understand their risk levels and how this higher risk group will respond to a similar interventional fitness program. We expect the rates of change to be much higher in a lower functioning group where their margin for improvement is much greater. This is important as their risk is also much higher.

The increasing rate of senior falls in Hawaii point to significant social and economical consequences if no real action is taken. Meaningful change begins with raising the standards towards a “prevention model” where the goal is not simply independent function but appropriate standards of age appropriate physical fitness. With new fitness technologies, “population aging” will reflect not just the extension in lifespan but more important, a high quality of life.

REFERENCES

1. Galanis D. *Overview of injuries among seniors in Hawaii*. Injury Prevention and Control Section, Hawaii Department of Health. July 2013
2. American College of Sports Medicine. *Position stand: progressive models in resistance training for healthy adults* Med Sci Sports Exerc 34: 364-380, 2002
3. Ozaki H, Miyachi M, Nakajima T, Abe T. Effects of 10 weeks walk training with leg blood flow reduction on carotid arterial compliance and muscle size in the elderly adults. *Angiology* 2011;62:81–86.
4. Madarame H, Kurano M, Fukumura K, Fukuda T, Nakajima T. Haemostatic and inflammatory responses to blood flow-restricted exercise in patients with ischaemic heart disease: a pilot study. *Clin Physiol Funct Imaging* 2013;33:11–17.
5. Loenneke JP, Wilson JM, Marin PJ, Zourdos MC, Bemben MG. Low intensity blood flow restriction training: a meta-analysis. *Eur J Appl Physiol*. 2012;112:1849–1859.
6. Abe T, Loenneke JP, Fahs CA, Rossow LM, Thiebaud RS, Bemben MG. Exercise intensity and muscle hypertrophy in blood flow-restricted limbs and non-restricted muscles: a brief review. *Clin Physiol Funct Imaging*. 2012;32(4):247–252.
7. Sakamaki M, Bemben MG, Abe T. Legs and trunk muscle hypertrophy following walk training with restricted leg muscle blood flow. *J Sports Sci Med*. 2011;10:338–340.
8. Hoppeler H, Kleinert E, Schlegel C, et al. Morphological adaptations of human skeletal muscle to chronic hypoxia. *Int J Sports Med*. 1990; Suppl 1:S3–S9.
9. Abe T, Kearns CF, Sato Y. Muscle size and strength are increased following walk training with restricted venous blood flow from the leg muscle, Kaatsu-walk training. *J Appl Physiol*. 2006;100(5):1460–1466.
10. Yokokawa Y, Hongo M, Urayama H, et al. Effects of low-intensity resistance exercise with vascular occlusion on physical function in healthy elderly people. *Biosci Trends*. 2008; 2(3):117-123.
11. Patterson SD, Ferguson RA. Enhancing strength and post occlusive calf blood flow in older people with training with blood-flow restriction. *J Aging Phys Act*. 2011; 19(3):201-213.
12. Nakajima T, Kurano M, Sakagami F, et al. Effects of low-intensity KAATSU resistance training on skeletal muscle size/strength and endurance capacity in patients with ischemic heart disease. *Int J KAATSU Training Res*. 2010; 6(1):1-7.
13. Sakamaki M, Fujita S, Sato Y, et al. Blood pressure response to slow walking combined with KAATSU in the elderly. *Int J KAATSU Training Res*. 2008; 4(1):17-20.
14. Fahs CA, Rossow LM, Loenneke JP, et al. Effect of different types of lower body resistance training on arterial compliance and calf blood flow. *Clin Physiol Funct Imaging*. 2011; 32(1):45-51.
15. Karabulut M, Abe T, Sato Y, et al. The effects of low-intensity resistance training with vascular restriction on leg muscle strength in older men. *Eur J Appl Physiol*. 2010; 108(1):147-155.