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Effects of Harwin Balancer Training on Balance and Physical Function in Older Adults

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Executive Summary

Our research on the Harwin Balancer™ (aka, Balancer) supports the anecdotal claims from clinical settings that have been gathering over the past several years. We documented statistically significant improvements in the performance of sit-to-stand and both stair ascent and stair descent in a group of older adults with perceived balance and functional impairment while standing. These improvements were immediately following ~15 min of prescribed use of the Balancer. The statistical findings were of the level that there is less than a 5% chance that the improvements occurred due to random effects (i.e. $P<0.05$). Therefore, we are confident that appropriate use of the Balancer with its accompanying training progression is effective for combating deficits in balance and physical function.

METHODS: Sixteen participants, eleven (six training and five controls) in the originally designed protocol, and five in the subsequently adjusted training group volunteered for the study after having it explained to them. Each subject completed two laboratory visits within a ten day period after being screened for orthopedic and neurologic conditions, including medications, which might affect their abilities to respond to training. The two visits were designed to be identical, such that acute effects could be evaluated each visit as well as the longitudinal effect between visits. The originally designed balance and function tests at the beginning and end of each visit included the Short Physical Performance Battery (which includes standing with three differently sized base of supports, casual walking, and 5 repetitions of sit-to-stand performed as quickly as possible), force platform measures during four 20 s quiet standing trials (two with eyes open, two with eyes closed), three trials of self-paced sit-to-stand, and four stair ascents and descents at self-selected cadence, as well as bilateral handgrip.

Between testing each subject trained on the Balancer as clinically prescribed or on the Balancer with the springs removed and replaced by rigid spacers (aka, control group). Training included four repeated cycles of 90 s on the Balancer followed by 2 min of purposeful walking. While on

the Balancer the subjects attempted to widen the ball of the foot and place pressure on the ball of the foot. The purposeful walking was on an out-and-back course with frequent left and right turns. Subjects were instructed to keep their heads up as much as possible while walking. Participants were in stocking feet during testing and training and encouraged to stay standing as much as possible. The control group training was identical to the other group in order to clarify the importance of the springs, hoping to rule out foot widening and pressing as the sole cause for improvements. Subjects were randomized into each group with an attempt to keep an equal sex distribution between them.

Because no quantitative research had been conducted on the Balancer prior to this investigation, and it was completely novel to the researchers, it was decided that a brief statistical analysis of results be performed when approximately ten subjects had completed their two visits. Analysis of the first eleven subjects revealed no differences between groups along with learning effects appearing to exist in the post versus pre comparisons of the first visit. After discussions with Dr. Harwin as to why there might be no differences between groups, it was decided that fatigue may be responsible and the protocol should be modified for the remaining five subjects. To reduce fatigue all tests except for those using the force platform were removed. Also, the training was reduced to three cycles of Balancer and walking. Further, the duration of walking was reduced to 1 min and the speed reduced from purposeful to casual.

Subjects continued to be enrolled while data was being analyzed and course of action discussed. Four additional subjects completed their first visit before making the decision to adjust the training and testing. As a result of the previously observed learning effects during the first visit, and the completion of most first visits using the original protocol, the first visit of the last five subjects was used for the sole purpose of familiarization of the subjects to the testing and training. There were no control subjects within the last five participants, all used the Balancer with springs during their second visit. Ground reaction forces and related parameters (free vertical moment and center of pressure) were assessed during quiet stance, sit-to-stand, and stair ascent/descent immediately before and after a bout of Balancer training on their second visit.

RESULTS: For the last five subjects using the adjusted protocol on their second visit, significant improvements were documented in sit-to-stand, stair ascent, and stair descent related to postural control and function ($p<0.05$). For example, in sit-to-stand reduced peak forces were observed during seat unloading as well as during upward propulsion after Balancer training. From the center of pressure (COP) data there is evidence of improved control in both the medial/lateral (m/l) and anterior/posterior (a/p) directions when rising from a chair. During stair ascent the rate of loading was reduced during initial stance as was the motion of the COP in both the m/l and a/p directions. During stair descent more time was spent loading the foot during initial stance. There was also evidence within the m/l forces and COP that there was improved control in the frontal plane throughout the stance phase. While anecdotally several subjects reported increased awareness of their sway, no statistical changes were observed in their postural control during quiet stance post versus pre Balancer training on their second visit ($p>0.05$).

CONCLUSIONS: When conducting pre-post testing with Balancer training between in older adult subjects, care must be taken not to overly tax them and induce fatigue. Balancer training on its own is not too physically taxing, however, adding more activities at the time of Balancer training may quickly become too much. This is especially true when the goal is to keep them standing as much as possible during the testing and training. When appropriately administered and dosed, these results support the clinically reported improvements that have occurred immediately from a single bout of Balancer training. Suggesting that older adults may be able to reduce fall risk by training on the Balancer. Furthermore, considering that significant improvements were found in this highly functional group, Balancer training appears to be quite robust and those with greater impairment may experience greater gains. Additional research should be performed to understand the mechanisms responsible for these improvements, ailments/conditions that respond best to training, dose-response relationships to multiple exposures, and direct relationships between Balancer training and reduced risk for falls.

Detailed Results

Subjects. A total of 16 healthy older adults participated in the investigation, separated into three groups: initial training (n=6), initial control (n=5), and adjusted training (n=5). The adjusted training subjects were the last 5 that underwent both a modified testing and training protocol relative to the first 11 subjects. Training and testing was modified after analysis of the first 11 subjects suggested that Balancer training was not producing an affect different than that of the control subjects. Observations made during data collections suggested subjects might be fatigued by the number of pre/post-tests along with the vigorous walking between trials on the Balancer. To reduce the demands of the testing protocol, all tests were removed except for those using the force platforms. This left standing balance, sit-to-stand, and stair ascent/descent. To reduce the demands of the training we reduced the number of Balancer/walking cycles from four to three. The intensity of walking was further reduced by having them walk at a casual pace rather than the purposeful pace. The duration of walking was also reduced from 90 to 60 s. The three Balancer trials of the second visit were still 90 s long with the entire duration spent widening and pressing with the feet during their second visit. There are no adjusted control subjects to compare with the five adjusted training subjects. All subjects completed two visits within a 10 day period. Training and testing within each visit was identical for each subject except for the first four of the adjusted training subjects. Three of these first visits were as an initial control subject and one of these first visits was as an initial training subject, since they started their participation in the project before the decision was made to adjust the training and testing. The first visit of the last adjusted training subjects was similar to the second visit except for their first time on the Balancer which started with widening of the foot for the first 45 s and then widening and pressing for the remaining 45 s.

While the initial control subjects turned out to be older than the subjects of the other two groups (p=0.024), though all were within the set age range for the study, there were no differences between groups in anthropometrics, pain, or physical function prior to training on their first visit (Table 1). Subjects had very limited reported pain and were highly functional.

Based on their results they would not be considered at risk for falls or compromised in their abilities to perform activities of daily living. However, at least anecdotally, observing them perform tasks and move around the room, their balance and physical function was reduced compared to a young adult. Sex distribution between groups was relatively consistent: initial training (3 men, 3 women), initial control (3 men, 2 women), and adjusted training (1 man, 4 women).

Table 1: Subject Characteristics

	Initial Training		Initial Control		Adjusted Training	
	Mean	SD	Mean	SD	Mean	SD
Age (yrs)*	63.5	(7.1)	74.9	(5.2)	62.4	(8.2)
Mass (kg)	78.7	(19.4)	77.8	(23.5)	74.8	(11.0)
Height (cm)	169.5	(11.5)	164.1	(11.4)	165.1	(7.7)
Foot Length(cm)	25.3	(1.9)	25.2	(2.9)	24.2	(1.0)
Foot Width (cm)	9.9	(0.4)	9.4	(1.3)	9.3	(0.6)
Stance Width (cm)	42.0	(1.3)	40.9	(6.9)	38.5	(3.7)
Pain Score	0.5	(0.8)	0.8	(0.4)	0.8	(0.8)
ABC Scale	1442	(94)	1344	(306)	1466	(61)
SAFE Scale	4	(4)	4	(3)	4	(2)
S-by-S Balance (s)	10.0	(0.0)	10.0	(0.0)	10.0	(0.0)
S-T Balance (s)	10.0	(0.0)	10.0	(0.0)	10.0	(0.0)
T Balance (s)	10.0	(0.0)	10.0	(0.0)	8.2	(3.6)
4m Gait Speed (s)	3.5	(0.4)	4.0	(0.5)	3.5	(0.2)
5x Chair Stand (s)	8.4	(1.6)	8.5	(1.9)	8.3	(1.4)
Total Handgrip (kg)	56.4	(20.0)	60.6	(24.3)	55.9	(11.2)

*$p<0.05$ between Initial Control and both training groups

Pain Score: 0 = none, 10 = most possible

ABC (Activities-Specific Balance Confidence) Scale: 1600 = complete confidence

SAFE (Survey of Activities and Fear of Falling in the Elderly) Scale: 33 = very worried

S-by-S = Side-by-Side, S-T = Semi-Tandem, T = Tandem: 10 s = maximum

Total Handgrip is sum of right and left sides

Visit 1. The initial project design was to have two identical visits of data collection and training. This would allow acute assessment of Balancer training as well as an assessment of long-term effect by comparing the results at the start of the second visit with those of the first visit. However, after assessment of several parameters it appears that there was a learning effect taking place post versus pre on the first visit that did not take place on the second visit. For example, walking speed increased post versus pre when ascending and descending the stairs by 0.17 and 0.22 s, respectively, on the first visit, but by only 0.03 and 0.05 s, respectively, on the second visit ($p<=0.027$). Furthermore, in the sit-to-stand trials performed at a comfortable pace while on the force platforms, subjects stood up faster post training on the first day than pre training ($p<=0.097$), but at the same speed post training as pre training on the second day ($p>=0.123$). When examining parameters extracted from the force platforms for standing, sit-to-stand, and stair ascent/descent, all three tasks showed some differences post versus pre in the first visit. However, the changes that took place on the first visit tended to be different from those that took place on the second visit. In the few cases where changes occurred in the same variable post versus pre in both visits, they tended to be in the opposite direction as the change that occurred during their second visit. Based on these results it appears that a learning effect was taking place along with any potential effects of the training. Therefore, it would not be appropriate to assess any of the changes in the first visit solely as an acute effect of training. Furthermore, it would not be appropriate to compare data collected on the first visit with that on the second visit for examination of long-term effects of training. Finally, as previously indicated, four of the last five subjects in the adjusted training group participated in first visits under the original training and testing design (three as controls, one as a training subject), which lends itself to treating the initial visit as a learning/lab acclimation day.

Visit 2. Stair Ascent/Descent. A large number of variables were extracted from the force platforms for analysis of stair ascent/descent (90). These included the 3D force, the free vertical moment, and the center of pressure in anterior-posterior and medial-lateral directions. It also broke the stance into several phases (loading, mid, and unloading). The variables are consistent with those that have been examined within the literature along with a few additional that we thought might be relevant to physical function and force control. The two trials of the right foot contacting the force platform were averaged with those of the left foot to get a more stable representation of the overall effect. The adjusted training subjects were significantly different ($p<0.05$) post versus pre Balancer training during their second visit in 7 variables during ascent and 4 variables during descent (Table 2). The variables of significance were all unique to this group (i.e., the other two groups did not have changes in these). Also, the direction of change is suggestive of improved balance/stability after training on the Balancer. There were also 12 more variables in the adjusted training group subjects that were trending towards significance ($0.05<p<0.10$) during stair ascent, nine of which were unique to this group. During stair descent there were six more variables that were trending towards significance, all of which were unique to this group. These trending variables suggest that a few more subjects would further enhance the already existing statistically significant variables. However, with the current findings of significance in several variables, it is not necessary at this time to add additional subjects.

Variables that changed in the adjusted training subjects in first visit that were the same as their second visit were Loading Slope during ascent and Loading Phase duration during descent. In both cases direction of change was opposite to that of the second visit. All totaled, there were 9 variables that changed during their first visit post versus pre during ascent and 5 during descent. Six changes that occurred in the first visit also occurred in at least one of the other two groups. Again, we need to remember that 4 of these 5 adjusted training subjects performed a different protocol on their first visit compared to their second visit.

Visit 2. Sit-to-Stand. There were also a large number of variables extracted from the force platforms for analysis of sit-to-stand (63). Similar to stairs, these were force and center of pressure in all directions and within several phases. Phases included an initial unloading of the ground that occurs when leaning forward to initiate the movement followed by loading, secondary unloading, secondary loading and stabilization. The net ground reaction force and center of pressure were analyzed, not any individual foot contributions to the task. As with stair ascent/descent, the variables were consistent with the literature as well as adding several we thought would be telling of balance and physical function. The adjusted training subjects were significantly different ($p<0.05$) post versus pre during their second visit in 6 variables (Table 3). Again, these variables were unique to this group. However, it isn't immediately clear if all argue for improved balance and stability during the task after Balancer training, though at least a couple of them do. Additionally, there were six more variables that were trending towards significance ($0.05<p<0.10$). Three of these six were unique to the adjusted training group subjects. These results again suggest that a few more subjects would enhance the current findings, but with some statistical significance already it isn't necessary to add more subjects at this time.

All post versus pre differences in variables that occurred during their first visit were of different variables compared to their second visit. In total there were 12 variables where post versus pre differences existed in their first visit. Two of these were also different in one of the other two groups. These results again suggest that a learning curve may have been present during their first visit. We also need to remember that 4 of these 5 adjusted training subjects performed a different protocol on their first visit compared to their second visit.

Table 2: Visit 2 Stair Ascent/Descent Differences Post Balancer Training in Adjusted Group

Ascent
Decreased GRFv Loading Slope
Decreased COPap Velocity Standard Deviation during Loading Phase
Decreased COPap Path Length during Loading Phase
Increased COPml Velocity Minimum during Loading Phase
Decreased COPml Velocity Standard Deviation during Loading Phase
Decreased COPap Velocity Maximum during entire Stance Phase
Increased COPml Velocity Minimum during entire Stance Phase

Descent
Increased duration of the Loading Phase
Decreased GRFml Maximum during Loading Phase
Increased COPml Velocity Minimum during entire Stance Phase
Decreased COPml Velocity Standard Deviation during entire Stance Phase

GRFv and GRFml = Ground Reaction Force in vertical (v) and medial-lateral (ml) directions
COPap and COPml = Center of Pressure in anterior-posterior (ap) and ml directions

Visit 2. Postural Sway. There were 82 variables extracted from the force platforms for analysis of postural sway. Force and center of pressure data were assessed in all three directions, but there was no need to break quite stance into phases, since the task demands didn't change throughout the test. However, separate assessment of the contribution of the left and right foot was performed along with the overall combined effect. Variables extracted were consistent with the literature. No significant differences were found post versus pre during the second visit with the eyes open or closed in the adjusted training group ($p>=0.05$). When examining variables that might be trending towards significance ($0.05<p<0.10$), there were no variables in this category when standing with their eyes closed and only one variable with their eyes open. This single variable was unique to the adjusted training group. Based on these results, assessment of postural sway while standing does not appear to be affected by Balancer training in healthy older adults. Additional subjects will not change the findings in a substantial way.

Table 3: Visit 2 Sit-to-Stand Differences Post Training in the Adjusted Group

Decreased GRFv prior to initiating movement
Decreased GRFv Minimum during initial unloading
Decreased GRFv Maximum during loading
Increased COPml Sway (max-min) during initial unloading
Increased COPml Velocity Maximum during initial unloading
Decreased COPap Velocity Minimum during secondary loading

GRFv = Vertical Ground Reaction Force
COPap and COPml = Center of Pressure anterior-posterior (ap) and medial-lateral (ml)

There were five variables with differences post versus pre when the eyes were open during the first visit of the adjusted training group subjects. All five of these variables were specific to changes in their left foot (the left foot was described as the non-dominant foot in all the adjusted training group subjects). The direction of change in these five variables is suggestive of decreased control after standing on the Balancer. These differences were unique to the adjusted training group. It could be attributed to a learning effect, but there may be something more to it than that. The first visits of the adjusted training group were not consistent. Some performed the original training and testing, some were of the original control protocol, and one had an initial visit with the adjusted training and testing. This may have factored into the results.

I've concentrated my assessment here primarily to the adjusted training group. There were a few items that were different in the initial two groups that were not observed in the adjusted group. There also were differences in the initial training group that were not the same as the initial control group. Many of these changes are not in the direction of improved balance and physical function, suggesting that the original protocol was too demanding and they were fatigued. Therefore, additional detailed assessment of these differences is not warranted at this time.

Conclusions

Overall, it was definitely a good decision to reduce the testing and modify the training in the last 5 subjects. I think we were fatiguing them with the original battery of tests and vigorous purposeful walking. The purposeful walking may have been a little faster than anticipated due to the higher functioning of these subjects compared to those that normally use the Balancer. While the results of the last five adjusted training group subjects are promising, they are not perfect. We do not have any control subjects to compare directly to the last 5. Also, the last five subjects were not consistent in their first visit, since most had started before making the decision to adjust training and testing. However, Balancer training with the appropriate intensity of pre/post testing and walking appears to have a positive acute effect during dynamic tasks such as stair negotiation and sit-to-stand in older adults with perceived balance loss. Because of these limitations, we don't have something strong enough to publish in a manuscript, but we do have enough that could be presented in an abstract at a meeting or to use as pilot data with an appropriately targeted/identified grant proposal. I have produced a one page abstract at the end of the document that could be reformatted relatively quickly for a conference or used as is. I don't believe that adding more subjects to this original project would be of benefit. Instead, I believe that we should take what we can from this original project and start fresh.

If additional funding is available I would suggest a protocol with:

1) An initial familiarization/screening visit. Screening would be performed to ensure a pool of subjects with a minimum level of balance and function deficit. If they did not meet this minimum they would not be included in the study. This would ensure a cohort of subjects where everyone had potential for improvement. While you could visually tell that most of our subjects did have some balance and/or functional decline, there were others that did not. Without a deficit it is difficult to expect improvement. Familiarization would be performed by having the subjects perform all of the testing procedures. This would remove any potential for learning effect to confound the results in their subsequent visits.
2) There would then be two additional visits identical to each where subjects would perform pre and post testing with training on the Balancer or a control activity. While it is important to understand the contribution of the foot widening and pressing to the overall effect, for initial demonstration of efficacy it may be best to have a control activity that is not similar to the Balancer. I would suggest a commercially available device that is at the opposite end of the spectrum relative to the perturbation of balance. Instead of subtle springs providing perturbation it should be something more similar to a balance/wobble board. This control group would also not be asked to widen and press on the ball of their feet, as this is a unique attribute of Balancer training. The two groups should have 8-10 subjects each. As indicated, I still believe it is important to determine how the widening and pressing of the foot contributes with the hinges and springs of the Balancer. Since widening and pressing is unique to the Balancer, there will most likely be skeptics that believe the widening and pressing is causing the improvements, not the specifically designed hinges and springs of the Balancer. Therefore, assessment of the widening and pressing should be performed.
3) I would also recommend that the quiet standing test should be dropped from the protocol. It does not seem to add anything to our results. Stick with the dynamic tasks of stair negotiation and sit-to-stand. With stair negotiation we may want to control

their speed to ensure that they don't walk faster in one session compared to another. Speed alone can affect the results and would make it difficult to tease out the training effects on the force platform measures. With sit-to-stand we may want to have them perform the task as quickly as possible. Performing the task quickly challenges their balance more than when at a comfortable pace. Whether a third test is needed to replace the quiet standing is debatable. Instead adding 1-2 more trials of the other two tests and additional practice to ensure consistency may be more valuable.

Detailed Description of the Scope of Work

Subjects

Sixteen healthy older adult subjects between the ages of 55-80 yrs who were perceiving reduced balance and stability while on their feet were recruited for this study. Subjects were community living (not institutionalized), normally walked without a cane or walker, able to walk up and down a flight of stairs without assistance, stand unassisted for a minimum of 5 minutes, had no neurologic disorders (such as peripheral neuropathy), did not take any neurologically active drugs, and had not experienced more than two unexplained falls in the last year. Furthermore, subjects were injury free at the time of data collection. Any prior musculoskeletal injuries had healed at least 4 weeks prior to entering the study. Subjects were free of any lower-extremity joint replacements. Subjects were non-smokers. Exercise and physical activity were not controlled for. Most subjects were involved in an organized exercise program (CSU Adult Fitness 2-3x/wk). All subjects had been approved within the last year for physical exercise by a physician. Six of the first 11 subjects were randomly placed into a Balancer training group. The other five subjects were placed into a control training group. After the first 11 subjects had completed both visits, a preliminary analysis of their results was conducted. Based on these results, changes were made to the testing and training for the last five subjects, as described above. An approximately equal number of males and females were placed into each group, though the adjusted training group was mostly women. Subjects were reimbursed for their time at a rate of $10/hour during laboratory visits.

Protocol

Subjects were initially screened over the phone or by personal interview. Subjects visited the Human Performance/Clinical Research Laboratory on the Colorado State University Campus twice in a 10 day period (minimum 3 days between visits). At the start of the first session subjects were familiarized to the protocols and procedures, provided written, university-approved informed consent, and completed two brief validated questionnaires relative to their balance and fear of falling. They were also asked to assess their current level of pain based on a 10 point scale. Subjects then completed a battery of balance and physical performance tests followed by training (Balancer or control), repeated the battery of tests, and finished with a 10-15 min walk back to their car. The second session was identical to the first for the first 11 subjects and 1 adjusted training subject, but without familiarization, consent, or falling questionnaires. 4 subjects of the adjusted training group performed the originally designed testing and training on their first visit (3 as controls, 1 as Balancer training), but the adjusted protocol during their second visit. All tests and training were conducted in stocking feet. Additionally, all tests and training were conducted at the same time of day (within 2 hours) to control for any diurnal effects. Any caffeine consumption prior to the visit was consistent with daily use and similar for each visit. The first session lasted approximately 1.75 hours and the second session approximately 1.25 hours. Subjects were responsible for their transportation to and from CSU Campus.

Test Battery

1) Short Physical Performance Battery (SPPB). The SPPB is a validated set of three quick tests. It included 10 sec balance tests with the feet side-by-side, semi-tandem, and tandem as well as a 4 m gait speed test, and a 5 repetition chair stand test at maximum speed. A score was calculated for each test as well as an overall score that can be compared to national norms. The SPPB was removed in the adjusted training protocol.

2) Standing Postural Control. Subjects stood quietly with a comfortable width stance while ground reaction forces were measured under each foot. A total of four 20 sec trials were completed with standing rest between each unless fatigued. In a random order, two trials were conducted with the eyes open and two with the eyes closed. A padded guardrail surrounded the subjects to the front and sides and a spotter stood behind the subjects. Requirements were verbally given prior to each trial to ensure consistency (i.e., that they stood as still as possible). The stabilogram (tracing of the center of pressure under the feet) was analyzed with conventional measures as was the symmetry of the vertical ground reaction force. Stance width was determined prior to testing by having them assume a comfortable position of their own choosing in a separate location. The toe-to-toe distance of this stance was recorded and marked with tape on the force platforms. Toes were aligned with this tape during all trials pre/post and visit 1/2.

3) Self-Paced Sit-to-Stand. With the feet on the ground at the same width as that of the standing postural control trials, subjects performed three trials of comfortable, self-paced sit-to-stand while ground reaction forces were recorded under each foot. Subjects performed several practice trials to ensure proper seating and foot placement such that they did not need to use their arms, which were held across their chests. They sat still in an upright posture before leaning forward and standing up in a controlled manner. They were then instructed to stay standing for several seconds before being told to sit back down. Besides analyzing the forces and center of pressure while rising from the chair, the first second of data after reaching the upright position was analyzed for stability. A spotter stood behind the subjects. The previously described handrail was to their front and sides.

4) Stair Ascent & Descent. After appropriate familiarization (usually one ascent followed by one descent), subjects ascended and descended a custom built set of stairs containing four steps. Embedded in the second step was a force platform similar to those used in the Standing Postural Control tests. Four trials in each direction (2 right foot and 2 left foot contacting the platform) were completed at a comfortable pace without use of the safety rails. Foot order was randomized and determined by the foot they were told to initiate the stair ascent/descent with. One step was completed on the level before ascending or descending in a step over step manner. Ground reaction forces, the free vertical moment, and the center of pressure stabilogram were analyzed. A spotter stood nearby and subjects could use the handrail if they experienced any difficulty, but the trial would be discarded.

5) Bilateral Hand-Grip Strength. After appropriate warm-up and familiarization, maximal isometric hand-grip strength was measured bilaterally at the same time in the seated position. The upper arm was held alongside the body with elbows at 90 degrees. Wrists were extended with the forearm mid pronation/supination. Three maximal efforts were performed. Subjects were instructed to build force gradually, hold the maximum effort for several seconds, then reduce the force to resting levels gradually. They were also instructed to breath out slowly during the effort. Hand-grip strength was removed in the adjusted training protocol.

Groups

1) Balancer (aka, initial training group). After completing the previously described battery of tests, subjects immediately began training on the Balancer. They stepped forward onto the Balancer using the hand rails for safety. Once positioned with the toes passed the leading edge of the foot bed, 90 s of quiet standing was performed with the hands lightly touching the rails and eyes open with a horizontal view. During this time subjects attempted to put their weight on the ball of the foot while attempting to widen the foot across the ball area. To put their weight on the ball of the foot, they focused on a sense of lifting the ankles, hips, ribs, neck, and head (though the feet stay flat to the bed of the platform) rather than leaning forward. To widen their foot it was initially described as widening the toes, but then focusing on just the ball of the foot once the movement was understood. During the first Balancer training trial subjects started by just standing quietly on the device for 45s s and then spent the second 45 s attempting to widen the foot. During the second Balancer training trial subjects started by widening the foot for 45 s and then spent the second 45 s widening and pressing. Trials 3 & 4 were spent widening and pressing for the entire time. At the end of a trial, subjects used the hand rails to step backwards off of the Balancer and take a few seconds to replicate this feeling on solid ground before 90 s walking at a brisk pace. A total of four 90 s trials on the Balancer followed by four 90 s walks completed the training session. A spotter stood alongside the subjects at all times while on the Balancer. Spotters were also nearby when the subjects walked. Walking and Balancer training was performed in stocking feet. A second identical battery of tests was performed immediately after completing the last 90 s walk.

The adjusted training group subjects used the abbreviated testing and training as described previously. In short, their test battery only included the force platform measures and their training was reduced to 3 Balancer/walking cycles. Each walk was reduced to 60 s in duration at a slower "casual" pace.

2) Control (aka, initial control group). Training for the control group subjects was identical to that of the Balancer group except that Balancer training was performed on the Balancer with locked foot beds. Instructions were identical, attempting to widen and press the feet. Walks between Balancer trials were also performed.

Subjects were blinded to group until after completion of the second visit. Subjects were told at the start that there were two groups and the protocols of both groups were expected to improve balance and physical function. Thus, the goal was to see if one group improved more than the other.

Statistical Analysis

Overall balance and physical function was evaluated by comparing results of the initial measures of the first session against normative data. To assess the effect of Balancer training a 2x4 (training group x test battery number) repeated measures Analysis of Variance was conducted on the first 11 subjects. After determining that no differences were emerging between the two groups, the protocol was adjusted. Repeated measures t-tests were used to assess pre-post differences of visit 2. A 3x1 ANOVA was used assess the differences between the three groups in initial characteristics (Table 1). $P<0.05$ was set for significance, $0.05<p<0.10$ for trends.

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Harwin Balancer Training Improves Physical Function in Older Adults with Perceived Deficits

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The Harwin Balancer has been used successfully in clinical settings to improve balance and physical function. **PURPOSE:** The goal of this investigation was to quantify the acute improvements from a single training session in a group of healthy older adults with perceived reductions of both balance and function while performing tasks on their feet. **METHODS:** Five participants (4 women/1 man, age: 62.4±8.2 yrs, mass: 74.8±11.0 kg, height: 165±8 cm) completed two laboratory visits within a 10 day period after being screened for orthopedic and neurologic conditions, including medications, that might affect their abilities to respond to training. The first visit was used to familiarize the subjects to the testing and training. Ground reaction forces and related parameters (free vertical moment and center of pressure) were assessed during quiet stance, sit-to-stand, and stair ascent/descent immediately before and after a bout of Balancer training. Training included three repeated cycles of standing on the Balancer for 90 s followed by casual walking for 60 s. When standing on the Balancer subjects attempted to widen the balls of their feet while at the same time placing the majority of the foot pressure also on the ball of the foot. The casual walking was performed in an out-and-back course that required both left and right turns. Subjects were instructed to keep their heads up as much as possible while walking. All testing and training was performed in stocking feet. **RESULTS:** Significant improvements were documented in sit-to-stand, stair ascent, and stair descent related to postural control and function ($p<0.05$). For example, in sit-to-stand reduced peak forces were observed during seat unloading as well as during upward propulsion after Balancer training. From the center of pressure (COP) data there is evidence of improved control in both the medial/lateral (m/l) and anterior/posterior (a/p) directions when rising from a chair. During stair ascent the rate of loading was reduced during initial stance as was the motion of the COP in both the m/l and a/p directions. During stair descent more time was spent loading the foot during initial stance. There was also evidence within the m/l forces and COP that there was improved control in the frontal plane throughout the stance phase. While anecdotally several subjects reported increased awareness of their sway, no statistical changes were observed in their postural control during quiet stance post versus pre Balancer training on their second visit ($p>0.05$). **CONCLUSIONS:** These results support the clinically reported improvements that have occurred immediately from a single bout of Balancer training, and

suggest that older adults may be able to reduce fall risk by training on the Balancer. Furthermore, considering that significant improvements were found in this highly functional group, Balancer training appears to be quite robust and those with greater impairment may experience greater gains. Additional research should be performed to understand the mechanisms responsible for these improvements, ailments/conditions that respond best to training, dose-response relationships to multiple exposures, and direct relationships between Balancer training and reduced risk for falls.