Effect of Ascending an Inclined Surface versus Backward Walking on Flat Surface on Dynamic Balance in Healthy Older Adult Males

ABSTRACT

Aims: Falls among elderly are major health problem. Practice of physical activities such as walking on regular basis improves balance and reduces falls. The objective of this study was to determine whether ascending an inclined surface (ISU) and backward walking on a flat surface (FSB) regularly could improve dynamic balance in healthy older adults and check the interaction of body composition, leg muscle strength and vital capacity.

Study design: Eight-week walk-training program with and without resistance.

Place and Duration of Study: Department of Field and Track Games, Faculty of Physical Education, Minya University, between July and September 2016.

Methodology: Sample: Twenty participants (males; 55-65 years old) and all of them practiced sports regularly. All participants continued with their regular exercise program, while adding walk training program either ISU or FSB for total of 24 training units and 1845 min. divided into three stages preparatory, foundation and development stages. Participants were tested pre-and post-training using - Body Composition Analyzer (Tanita SC240) and two tests; Leg press test and dynamometer for muscle strength and Modified Bass test of dynamic balance.

Results: We found statistically significant intervention effects of the walking program on dynamic balance ($P=0.0029$ ISU and $P=0.0054$ FSB post vs pretest). Decrease in fat mass ($P=0.0001$) and increase in bone mass ($P=0.001$) in ISU group post vs pretest. An increase in dynamic balance ($P=0.0215$), leg muscles’ strength ($P=0.0121$) and body muscle mass ($P=0.0139$) in the ISU group compared to FSB group on comparing the results of the posttest of both groups. Conclusion: We suggest that physically active elderly who exercise regularly can benefit from the addition of walk training to their current exercise program. We recommend practicing ascending an inclined surface more than backward walking on a flat surface to improve dynamic balance, lean body mass, muscle strength and pulmonary function.

Keywords: Walking program; Inclined surface; Dynamic balance; Older adults; Vital capacity, Lean body mass; Tanita SC240.
1. INTRODUCTION

American College of Sports Medicine and the American Heart Association (ACSM/AHA) recommended physical activity for older adults to improve and maintain health. A previous study reported that weight bearing and multicomponent training exercises for eight months decreased risk factors for falls and fractures in elderly women [1]. Another study suggested that walking program for three months with ankle weights might improve dynamic balance, bone metabolism, and reduce fall-related psychological factors [2]. A meta-analysis including thirty studies with 2878 participants including both men and women with mean age ranging from 68 to 85 years reported that planned, repetitive and goal-directed physical activity reduced fear of falling to some extent just after the intervention, without increasing the incidence of falls [3]. Another meta-analysis included 94 studies and 9,917 participants mostly aged females concluded weak evidence that exercise training including balance, coordination and multiple exercise types are effective immediately after intervention, in improving clinical balance outcomes in older people [4]. Both of the previous studies reported an insufficient evidence for the effects of walking, cycling or multicomponent exercise training on fear of fall and balance after the period of intervention. Moreover, they recommended further studies using high quality methods to establish set of outcomes including fear of falling and dynamic balance in elderly people living in the community [3, 4]. The previous preventive guideline does not specify an age cutoff, but there are insufficient data on the effects of physical activity on falls in older adults less than age 65 [5].

Center of mass of the human body changes according to the activity performed that is important to keep balance. Humans need to keep balance against multiple body segments over narrow support base [6]. Normal posture and locomotion including walking, running and hopping require bipedalism in humans in contrast to all other mammals [7]. Since walking over the two legs requires less stress against the whole body of humans, it has been prescribed as therapeutic and rehabilitation method for healthy young and old as well as...
patients suffering from obesity, diabetes or lung disease [8, 9]. The goal of the current study was to determine whether walking up an inclined surface or backward walking on flat surface regularly for eight weeks with or without resistance could improve dynamic balance of healthy older adult males. Moreover, we examined the interaction of body composition, leg muscles' strength and total vital capacity from the mechanistic point of view.

2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

2.1 Subjects: participants consisted of twenty of older adults, their ages range between 55-65 years, and all of them practiced sport regularly. The goal of study explained to the participants before experiment and they agreed voluntarily on participation in the study.

2.2 Experimental procedure

2.2.1 Methods: We used the pre-post two experimental groups' methodology.

2.2.2 Sampling equality: Researchers confirmed the uniform distribution of the two groups in the light of body composition, dynamic balance, legs muscles' strength and pulmonary function by calculating mean, median, standard deviation and variance for all participants before the start of the training program (table 1). We found the mean almost equals the median for all parameters measured indicating that the distribution is symmetric. The variance of the sample population participating in this study ranges between (1.10 and -0.29) indicating that the sample lies within the normal distribution (-3 – +3) (table 3).
Table 1. Means, median, standard deviation and variance of the body composition, dynamic balance, leg muscles’ strength and vital capacity of the sample population included in the study

<table>
<thead>
<tr>
<th>Variables</th>
<th>µ</th>
<th>Median</th>
<th>σ</th>
<th>σ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body components</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water mass</td>
<td>45.35</td>
<td>45.00</td>
<td>1.57</td>
<td>0.67</td>
</tr>
<tr>
<td>Fat mass</td>
<td>34.30</td>
<td>34.00</td>
<td>2.70</td>
<td>0.33</td>
</tr>
<tr>
<td>Bone mass</td>
<td>3.95</td>
<td>4.00</td>
<td>0.89</td>
<td>-0.17</td>
</tr>
<tr>
<td>Muscles mass</td>
<td>71.90</td>
<td>72.00</td>
<td>5.31</td>
<td>-0.06</td>
</tr>
<tr>
<td>Physical element</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic balance</td>
<td>43.00</td>
<td>40.00</td>
<td>11.29</td>
<td>0.80</td>
</tr>
<tr>
<td>Leg muscle strength</td>
<td>53.85</td>
<td>52.50</td>
<td>3.69</td>
<td>1.10</td>
</tr>
<tr>
<td>Functional</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vital capacity</td>
<td>2.97</td>
<td>3.00</td>
<td>0.31</td>
<td>-0.29</td>
</tr>
</tbody>
</table>

Body Composition Analyzer, Tanita SC-240, Bioimpedance operated; Spirometers T-20 Portable
Spirometer SKU; (μ) mean; (σ) standard deviation; (σ²) variance; (n = 20).

2.2.3 Tools:

- Adequate floor space, sticky tape for marking floor, measuring tape, stopwatch for the Modified Bass Test.
- Takei 5402 Leg Muscle Digital Dynamometer for measuring leg and backmuscle strength.
- Leveled road with “slope surface- flat surface” (300 meters).
- Body extracting belt “free and with weights”.
- Wrist and vest loaded with weights.
- Foot resistance rope.
- Sport walking shoes.
- Segmental Body Composition Analyzer (Tanita SC240 Bioimpedance operated, made in Japan).
- Smart cell phone “electronic steps application”.
• Spirometers T-20 Portable Spirometer SKU: SPMT20 used to measure total vital capacity (VC).

2.2.4 Test: Using Leg Press Test [10] as preliminary test to detect 1 repetition maximum (1RM) to plan for the walk exercise program with resistance and Modified Bass Test [11] for dynamic balance. We used Leg Dynamometer to evaluate leg muscle strength in the pretest and posttest.

2.2.4.1 Modified Bass Test of dynamic balance

2.2.4.1.1 Purpose of the test

Measurement of the ability for keeping balance during and after the movement

Tools: enough and suitable space- measurement tape- a stop watch- adhesive plaster to fix 11 signs on the ground, while each sign size is 1 inch multiplied by ¾ inches (1 inch = 54.2 cm)

2.2.4.1.2 Test description:

Standing on right leg at the start square (Fig.1). Then, jumping using the left leg to the first square keeping instep stationary for 5 seconds (s.), then jumping using the right foot to the second square keeping instep stationary for 5 s., so the performance continues with exchanging feet and keeping a stationary position until reaching the square number 10.

2.2.4.1.3 Test conditions

- Touching the square completely until the adhesive plaster or the square disappears.
- All ten squares should be touched.
- An advance training is preferred before the test.
- Jumping from a square to another without the heel touches the ground.
- Fixation for 5 s. inside each square before moving to the next square.

2.2.4.1.4 Test recording

The total mark is 100; 10 marks are calculated for each square, five of them for correct landing on the foot instep, and covering the sign at the ground completely, while the other
five marks are given for correct balancing for 5 s. The errors of this test can be categorized into landing error or balance error as follows:

2.2.4.1.4.1 First: the examiner denies one mark from the five marks related to falling, when it is made incorrectly according to the following factors:

- Failure to stand on the ground on landing.
- Touching ground with the heel or any other part of the body other than the instep on landing.
- Failure to cover the sign that is located on the ground.

In a case of any error occurring on landing, the five marks are deducted, then the examinee is allowed to stand at the correct place over the sign, to continue performing the test, then keeping stationary position for five seconds, then moving to the next sign.

2.2.4.1.4.2 Second: when the examinee fails to keep stationary position on the sign for five seconds, one mark deducted for each second, as follows:

- Any part of the body touching the ground other than the instep
- Moving the foot while the examinee should maintain stationary position.

In a case of any balance mistake, the examinee returned to the correct position, and he continued performing the test, then he moves to the next sign, and so on.
2.2.4.2 Leg muscles strength test

2.2.3.2.1 Test purpose

Measuring the extending muscles’ strength of the two legs.

2.2.4.2.2 Tools

Dynamometer, high stabilizer, suitable base with a graduated measure fixed with a 60 cm iron chain that ends with a steel bar from 50-55 cm.

2.2.4.2.3 Test description

The dynamometer is fixed at the base, and its top is connected to a steel chain that is fixed at the end to a steel bar. A wide leather belt is wrapped around the examinee waist in a manner that enables him to connect the ends of the belt with the steel bar. Then, the examinee stood on the base and holds the steel bar with his two hands, and then he flexes the two legs slightly until the steel bar reaches over the thighs, and the chain falls completely, as the waist belt is fixed with the steel bar while the examinee took that position. With the start sign, the examinee extends the two legs up to produce his maximum power.

2.2.4.2.4 Test conditions

- Keeping the back and the two arms at one alignment at a vertical position to the ground.
- No front or back bending with the head.
- The steel bar is tightened slowly by the dynamometer and without sudden push.

2.2.4.2.5 Test administration

- Controlling: the examiner observes the performance and gives the start signal.
- Recording: the examiner calls the examinee, reads and records the reading.

2.2.4.2.6 Test recording
The test evaluation is built upon comparing the examinee marks at varied times and stages or through other examinees, as each examinee is given two sequence trials, and the best and more accurate trial was considered, while approaching it to the nearest ½ kg.

2.2.4.3 Total vital capacity

2.2.4.3.1 Purpose of the test

Measuring the maximum exhalation after the maximum inhalation.

2.2.4.3.2 Tools

Dry spirometer- plastic mouth

2.2.4.3.3 Test description

The subject stood and held the spirometer, then he breathed twice, then he inhaled the maximal amount of air through the nose and then exhaled into the mouth piece of spirometer the maximal amount of air.

2.2.4.3.4 Test conditions

- Nose is closed by a clamp.
- Using a plastic mouth piece for each elderly to be put in the equipment port at the measurement for preventing infection.

2.2.4.3.5 Test administration

- Controlling: the examiner observes the performance and gives the start signal.
- Recording: the examiner calls the examinee, reads and records the reading.

2.2.4.3.6 Test recording

The subject is given three trials and the best reading was approximated to the nearest ½ Kg.

2.3 Inclusion criteria:

- Age: between 55 – 65 years old.
- Sex: males.
- Exercise: all practice exercise regularly.

2.4 Exclusion criteria:

History of diabetes, hypertension or disability.
2.5 The walking program details:

The training program include two groups; either walking up an inclined surface or backward walking on a flat surface three times per week for eight weeks with resistance, without resistance and with ensuring coordination.

2.5.1 Design:

2.5.1.1 Principles of planning:

- Starting with warm-up and finishing with relaxation.
- No walking directly after meals.
- Keeping breathing continuously and smoothly.
- Regular and active step, when one of the two feet touches the ground at walking.
- Using resistance with gradual weights from 30% to 50% of the maximum.
- Walking with a wide heel and flexible double sole shoes that provide more comfort and support.
- Selecting the suitable place concerning safety and cleaning which has slope and flat surface.
- Descending a slope surface after ascending and forward walking on a flat surface after backward walking, is a positive “active” rest period between ascending and descending.
- At backward walking, the person is allowed to look backward once each training session.
- The walking distance on the inclined or flat surface was between 250-300 meters.

2.5.1.2 Objective:

Using the positive influence of ground during walking whether on inclined or flat surface to improve the dynamic balance of the two research groups.

2.5.1.3 Content:

Walking plan includes ascending and descending an inclined surface and walking forward and backward on a flat surface without resistance, with resistance and with ensuring the
movement coordination of both the upper and lower limbs, muscle tone and improving the breathing ability, through considering the following criteria;

- Step frequency = number of steps divided by the total time.
- Step duration = total time divided by the number of steps.
- Step velocity = step length multiplied by step frequency.

### 2.5.1.4 Duration:

Eight weeks total duration, three sessions / week, starting at 17th of July 2016 and ending at 8th of September 2016, as 6 training units in the preparatory stage, 60 minutes each, 9 training units in the foundation stage 75 minutes each and 9 units in the development stage 90 minutes each with the total of 24 training units, and total time of 1845 minutes or 110700 seconds (table 3).

#### Table 3. Walking plan of the two walk groups on inclined surface “upward” and on a flat surface “backward”.

<table>
<thead>
<tr>
<th>Training stages</th>
<th>No. of Training weeks</th>
<th>No. of training units/ week</th>
<th>Total training units/ period</th>
<th>Total time in minutes</th>
<th>Walking styles Ascending slope surface and backward walking on a flat surface</th>
<th>Training functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>180</td>
<td>Free walking</td>
<td>Increasing the movement transferring effectiveness.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Walking with resistance</td>
<td>Increasing flexibility of muscles and ankles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Walking with movement coordination</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>75</td>
<td>225</td>
<td>%</td>
<td>Min</td>
</tr>
<tr>
<td>Preparatory</td>
<td>2</td>
<td>3</td>
<td>60</td>
<td>6</td>
<td>360</td>
<td>20</td>
</tr>
<tr>
<td>Foundation</td>
<td>3</td>
<td>3</td>
<td>75</td>
<td>9</td>
<td>675</td>
<td>37</td>
</tr>
<tr>
<td>Developmental</td>
<td>3</td>
<td>3</td>
<td>90</td>
<td>9</td>
<td>810</td>
<td>43</td>
</tr>
<tr>
<td>SUM</td>
<td>8</td>
<td></td>
<td>675</td>
<td>24</td>
<td>1845</td>
<td>100</td>
</tr>
</tbody>
</table>

ISU: inclined surface “upward”; FSB: flat surface “backward”. % = time (min) of the stage/ total time (min)*100, Min: minimum walking distance.
2.5.2 Application:

2.5.2.1 Training performance: through follow up and observing the extent of progress for amending and developing the sport walking performance according the body composition including; “water content, fat mass, bone mass, muscle mass” the training load was defined according to the following biomechanical parameters; step frequency, step duration and step velocity.

2.5.2.2 Distributing loads and durations of “walking up an inclined surface and backward on a flat surface according to the three training stages” (table 4).

The strength of performing during the three training stages ranged between 25-45%. Step frequency equal 0.83 for the preparatory stage, 0.64 for the foundation stage and 0.70 for the developmental stage. Step duration equal 1.2 for the preparatory stage, 1.6 for the foundation stage, 1.4 for the developmental stage. Step velocity equal 42 preparatory stage, 52 the foundation stage, 56 for the developmental stage.

Table 4. Distributing loads and durations of “walking up an inclined surface and backward on a flat surface according to the three training stages.

<table>
<thead>
<tr>
<th>Walking style</th>
<th>Preparatory stage</th>
<th>Foundation stage</th>
<th>Developmental stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without resistance</td>
<td>12600 ST 15120 s.</td>
<td>5216 ST 8100 s.</td>
<td>3402 ST 4860 s.</td>
</tr>
<tr>
<td>With resistance</td>
<td>1800 ST 2160 s.</td>
<td>18256 ST 28620 s.</td>
<td>6804 ST 9720 s.</td>
</tr>
<tr>
<td>With coordination</td>
<td>3600 ST 4320 s.</td>
<td>2608 ST 3780 s.</td>
<td>23814 ST 34020 s.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size Performance method</th>
<th>Preparatory stage</th>
<th>Foundation stage</th>
<th>Developmental stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group type</td>
<td>One training group with ensuring dynamic transfer and extent</td>
<td>Two training groups with legs and arms resistance</td>
<td>Three training groups with ensuring muscle tone and movement coordination</td>
</tr>
<tr>
<td>Frequency</td>
<td>6 times X 6 days = 36 times</td>
<td>4 times X 9 days = 36 times</td>
<td>4 times X 9 days = 36 times</td>
</tr>
<tr>
<td>%</td>
<td>25</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>Distance</td>
<td>300</td>
<td>275</td>
<td>250</td>
</tr>
<tr>
<td>ST length</td>
<td>60</td>
<td>75</td>
<td>80</td>
</tr>
<tr>
<td>Condensatio</td>
<td>Total No.</td>
<td>500 ST * 36 times = 18000 ST * 1 groups = 18000 ST</td>
<td>365 ST * 36 times = 13140 ST * 2 groups = 26080 ST</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>-------------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Training units/week</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>ST frequency</td>
<td>0.83</td>
<td>0.64</td>
<td>0.70</td>
</tr>
<tr>
<td>ST duration</td>
<td>1.2</td>
<td>1.6</td>
<td>1.4</td>
</tr>
<tr>
<td>ST velocity</td>
<td>42</td>
<td>52</td>
<td>56</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th>ST frequency = 78100 steps ÷ 110700 second = 0.70</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ST duration = 110700 ÷ 78100 = 1.4</td>
</tr>
</tbody>
</table>

*ST: step; m: meter; cm: centimeter; s.: second; Step frequency: number of steps divided by total time; Step duration: total time divided by number of steps; Step velocity: step length multiplied by step frequency.*
3. RESULTS

3.1 Effect of upward walking on inclined surface and backward walking on a flat surface on body water mass:

We found statistically significant decrease in the body water mass in both groups ISU ($P = 0.0001$) and FSB ($P = 0.0001$) upon comparing the results of posttest with pretest (Fig. 2).

![Figure 2. Changes in the body water mass in the two walk groups (ISU) upward walking on inclined surface and (FSB) backward walking on a flat surface](image)

Body Composition Analyzer; Tanita SC-240; data represent mean ± standard deviation; difference was detected using Student's two tailed t-test ($**P = 0.0001$ ISU post vs pretest; $###P = 0.0001$ FSB post vs pretest; $N = 10$ in each group).
3.2 Effect of upward walking on inclined surface and backward walking on a flat surface on body fat mass:

We found statistically significant decrease in the body fat mass in ISU group ($P = 0.0001$). Statistically insignificant difference in the body fat mass in FSB group found in the posttest compared with the pretest ($P = 0.071$). No statistically significant difference in the body fat mass between the two groups in the pretest was found ($P = 0.156$) (Fig. 3).

![Figure 3. Changes in the body bone mass in the two walk groups (ISU) upward walking on inclined surface and (FSB) backward walking on a flat surface]

Body Composition Analyzer; Tanita SC-240; data represent mean ± standard deviation; difference was detected using Student's two tailed t-test ($P$ value = 0.156 ISU vs FSB pretest; $P = 0.123$ ISU vs FSB posttest; $+++P = 0.0001$ ISU post vs pretest; $P = 0.071$ FSB post vs pretest; $N = 10$ in each group).
3.3 Effect of upward walking on inclined surface and backward walking on a flat surface on body bone mass:

We found statistically significant increase in the body bone mass in ISU group ($P = 0.001$).

Statistically insignificant difference in the body bone mass in FSB group found in the posttest compared with the pretest ($P = 0.052$). No statistically significant difference in the body bone mass between the two groups in the pretest was found ($P = 0.808$) (Fig. 4).

Figure 4. Changes in the body bone mass in the two walk groups (ISU) upward walking on inclined surface and (FSB) backward walking on a flat surface

Body Composition Analyzer; Tanita SC-240; data represent mean ± standard deviation; difference was detected using Student’s two tailed t-test ($P$ value = 0.808 ISU vs FSB pretest; $P$ = 0.319 ISU vs FSB posttest; $++P = 0.0011$ ISU post vs pretest; $P = 0.052$ FSB post vs pretest; $N = 10$ in each group).
3.4 Effect of upward walking on inclined surface and backward walking on a flat surface on body muscle mass:

We found statistically significant increase in the body muscle mass in ISU group ($P = 0.0139$) compared to FSB group on comparing the posttest results. Statistically insignificant difference in the body muscle mass in both the ISU ($P = 0.131$) and FSB ($P = 0.636$) groups was obtained in the posttest compared with the pretest. No statistically significant difference between the two groups in the pretest in the body muscle was found ($P = 0.489$) (Fig. 5).

**Fig. 5. Changes in the body muscle mass in the two walk groups (ISU) upward walking on inclined surface and (FSB) backward walking on a flat surface**

Data represent mean ± standard deviation; Body Composition Analyzer; Tanita SC-240; difference was detected using Student’s two tailed t-test ($P$ value = 0.489 ISU vs FSB pretest; $^aP = 0.0139$ ISU vs FSB posttest; $P = 0.131$ ISU post vs pretest; $P = 0.636$ FSB post vs pretest; $N = 10$ in each group).
3.5 Effect of upward walking on inclined surface and backward walking on a flat surface on leg muscles' strength:

We found statistically significant increase in the leg muscle strength in both ISU group (\(P = 0.0002\)) and FSB group (\(P = 0.0224\)) in the posttest compared with the pretest. Statistically significant increase in the leg muscle strength in ISU group (\(P = 0.0121\)) compared to FSB group on comparing the posttest was shown. No statistically significant difference (\(P = 0.725\)) in the leg muscle strength between the two groups in the pretest was found (Fig. 6).

Fig. 6. Changes in the leg muscle strength in the two walk groups (ISU) upward walking on inclined surface and (FSB) backward walking on a flat surface

Data represent mean ± standard deviation; Leg dynamometer was used to detect muscle strength; Kg: kilograms; difference was detected using Student's two tailed t-test (\(P\) value = 0.725 ISU vs FSB pretest; \(^{\#}P = 0.0121\) ISU vs FSB posttest; \(^{+++}P = 0.0002\) ISU post vs pretest; \(^{\&}P = 0.0224\) FSB post vs pretest; \(N = 10\) in each group).
3.6 Effect of upward walking on inclined surface and backward walking on a flat surface on body dynamic balance:

We found statistically significant increase in the dynamic balance in both the ISU group ($P = 0.0029$) and the FSB group ($P = 0.0054$) in the posttest compared with the pretest. Statistically significant increase in the dynamic balance in ISU group ($P = 0.0215$) compared to FSB group on comparing the posttest was shown. No statistically significant difference ($P = 0.443$) in the leg muscle strength between the two groups in the pretest was found (Fig. 7).

![Graph showing dynamic balance and leg muscle strength comparison between ISU and FSB groups](image)

**Fig. 7.** Changes in the leg muscle strength in the two walk groups (ISU) upward walking on inclined surface and (FSB) backward walking on a flat surface

*Modified Bass test was used to detect dynamic balance; data represent mean ± standard deviation; difference was detected using Student’s two tailed t-test ($P$ value = 0.443 ISU vs FSB pretest; $^P = 0.0215$ ISU vs FSB posttest; $^P = 0.0029$ ISU post vs pretest; $^P = 0.0054$ FSB post vs pretest; $N = 10$ in each group).*
3.7 Effect of upward walking on inclined surface and backward walking on a flat surface on total vital capacity:

We found statistically significant increase in the total vital capacity in both the ISU group ($P = 0.0009$) and the FSB group ($P = 0.0001$) in the posttest compared with the pretest (Fig. 8).

Fig. 8. Changes in total vital capacity in the two walk groups (ISU) upward walking on inclined surface and (FSB) backward walking on a flat surface

TVC: total vital capacity; L: liters; Spirometers T-20 Portable Spirometer SKU: SPMT20 used to measure TVC; data represent mean ± standard deviation; difference was detected using Student’s two tailed t-test ($+++P = 0.0009$ ISU post vs pretest; $###P = 0.0001$ FSB posttest vs pretest; $N= 10$ in each group).
4. DISCUSSION

Physical exercise has preventive and therapeutic benefits against decreased muscle mass, bone mass and increased fat mass induced by aging. The results of the current training program showed statistically significant decrease in body water mass and statistically significant increase in body muscle mass, leg muscles’ strength, dynamic balance and vital capacity in both walk groups on doing the posttest compared to the pretest. In line with our results, Yoo et al found that walking program for three months with ankle weights improved aerobic endurance and body composition, increased strength of upper body and legs, reduced trunk fat and fear of falling [2]. Recent study showed that resistance and balance training for three months decreased fat mass and improved walking ability as well as insulin sensitivity in older adults one year after recovery from stroke [12]. Regular physical activity and balance exercise three times weekly are effective in reducing falls and fall related injuries by about (35–45%) in older adults at risk for falls [13]. Meta-analysis including 28 randomized controlled trials and 2646 participants of postmenopausal women showed that half an hour of daily moderate walking combined with a resistance training twice weekly decreased bodyweight, fat % and improves bone mineral density, muscular strength, flexibility, balance or coordination, maximal aerobic power, blood pressure, lipid profile and glucose homeostasis [14]. Exercise training twice weekly for eight months designed to load bones with intermittent and multidirectional compressive forces and to improve physical function reduced fat mass, waist circumference, improved handgrip strength, dynamic balance, and increased bone mass density at the femoral neck [1].

The results of the current study showed statistically significant decrease in fat mass and statistically significant increase in bone mass in the ISU group only in the posttest compared to pretest. Moreover, we found statistically significant increase in dynamic balance, leg muscles’ strength and body muscle mass in the ISU group compared to FSB group on comparing the results of the posttest. Unfortunately, no previous studies compared the effects of walking on inclined surface and backward walking on flat surface on dynamic
One study done by Cromwell studied the effects of walking on an inclined surface on head stability [15]. They showed statistically significant improvement of dynamic stability in the frontal, sagittal and horizontal directions after Oreum trekking exercise program. They concluded that to keep balance of head over trunk and accommodate gravito-inertial changes during walking on the inclined surface, movement strategies adjustment of head-neck and neck-trunk patterns should develop by regular training. Two previous studies reported that control of the center of mass while walking on inclined or irregular surface needs efficient reactive and proactive response strategies to keep balance [16, 17]. A recent study investigated the relation between core body stability and body mass index (BMI) in healthy adults [18]. They found that decreased BMI improved balance and core stability through better foot posture alignment. Taken together, we may speculate that ascending an inclined surface gave better results concerning dynamic balance compared to backward walking on flat surface because it developed better reactive and proactive response strategies and better foot posture alignment through decreasing fat mass, increasing bone mass, muscle mass and muscle strength.
5. CONCLUSION

The main goal of the current study was to investigate the effect of walk training program on dynamic balance and examine the interaction of different factors as body composition, leg muscles' strength and total vital capacity (VC) in older adult males at the age range between 55 to 65 years. The training program include two groups; either walking up an inclined surface or backward walking on a flat surface three times per week for eight weeks with resistance, without resistance and with ensuring coordination. We found statistically significant increase in muscle mass, leg muscles' strength and vital capacity in both walk groups upon comparing the results of posttest to the pretest. The present study showed statistically significant decrease in fat mass and statistically significant increase in bone mass in the ISU group only in the posttest compared to pretest. Moreover, we found statistically significant increase in dynamic balance, leg muscles' strength and body muscle mass in the ISU group compared to FSB group on comparing the results of the posttest of both groups. Finally, we recommend ascending inclined surfaces such as walking uphill, ascending mountains or ascending stairs more than backward walking on a flat surface to improve dynamic balance, lean body mass, muscle strength and pulmonary function in healthy older adults.

COMPETING INTERESTS

No competing interests exist.
CONSENT (WHERE EVER APPLICABLE)

"All authors declare that 'written informed consent was obtained from all participants of the current study for publication of this study. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal."

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

REFERENCES


