

# Effect of Balance Training on Postural Stability in Obese Postmenopausal Women

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## ABSTRACT

*This study was conducted to determine the effect of balance training on postural stability in obese postmenopausal women. Twenty five obese postmenopausal women were participated in this study. Their ages ranged from 50 to 60 yrs old with a mean value  $56.03 \pm 2.52$  yrs., and their body mass index (BMI) ranged from 30-34 kg/m<sup>2</sup> with a mean value  $32.80 \pm 1.19$  kg /m<sup>2</sup>. They all were free from diabetes, severe hypo or hypertension, visual and vestibular system affection, marked skeletal deformities and previous surgeries at their back and/or lower limbs. All participants underwent a course of balance training program using Biodex Balance System, 3 sessions/week for six weeks and stability indices were evaluated before starting and after the end of 18<sup>th</sup> sessions of training. Results showed a statistically highly significant ( $P < 0.001$ ) decrease in stability indices (overall, Anterior/Posterior and Medial/Lateral) after the end of the balance training program. So, it could be concluded that balance training is an effective, safe and easy to perform modality that can be used for improving postural balance and decrease the risk of falling in obese postmenopausal women.*

**Key words:** Menopause, Obesity, Balance Training, Biodex Balance System.

## INTRODUCTION

Menopause is the spontaneous cessation of menstruation due to the absence of ovarian follicular activity. The most frequently used definition of natural menopause is amenorrhea for 6 continuous months without hysterectomy<sup>11</sup>. The estrogen loss that occurs with menopause has a significant impact on various body systems such as; vestibular, visual, musculoskeletal and nervous systems. These changes cause diminished or inappropriate feedback to the postural control<sup>7</sup>.

Postmenopausal women may have postural changes such as; forward head, rounded shoulders, increased kyphosis, decreased lumbar lordosis and flexed hips as well as, knees. These changes may be due to loss of elasticity in connective tissues, diminished ability to counteract gravitational forces and decline of muscles strength as well as, endurance. All of these postural changes affect daily living activities, balance and gait, hence; increase the risk of falling<sup>10,16</sup>.

It is believed that estrogen might prevent fractures by decreasing bone loss, stimulating postural balance, increasing well-being and

minimizing sleep disturbances thus, decreasing the risk of falling<sup>3</sup>. Loss of estrogen during menopause may impair protective reflexes<sup>2</sup>. as well as, increase bone resorption leading to accelerated bone loss which is a major risk factor for decrease postural balance and fracture<sup>5</sup>.

Menopause is also accompanied by reduction in resting metabolic rate, physical activities and energy expenditure leading to obesity, which is usually represented as an increase in fat mass and abdominal adipose tissue accumulation. Obesity is significantly associated with an endless list of diseases such as diabetes, hypertension, chronic heart diseases, stroke, osteoarthritis and sleep apnea<sup>6,14</sup>. Also, there are evidences to suggest that an increased body fat mass decreases postural stability and increases the incidence of falling, particularly when combined with low muscle mass<sup>26</sup>.

Balance is a somewhat ambiguous term used to describe the ability to move with a weight bearing posture without falling<sup>27</sup>. Also, balance is defined as, the ability to maintain the body's center of gravity (COG) over its base of support (BOS). Good balance exists when multiple systems (e.g. visual, vestibular, sensory and motor systems) interact automatically, providing accurate and exact information to the nervous system<sup>19</sup>. Several forms of peripheral sensory inputs contribute to balance control. However, accurate proprioceptive input is, in particular, a prerequisite for balance control and coordination of movement<sup>13</sup>.

Balance training and individualized muscle strength programs result in wide range of benefits. These include lower risk of falling, lower risk of moderate injuries, improve muscle strength and postural balance as well as, maintain physical activity level. Thus, physical programs for elderly subjects should

include muscle strength and balance training as an anti-falling components<sup>20</sup>.

Biodex Balance System (BBS) is a multi-axial device that objectively measures and records an individual's ability to maintain stability under dynamic stress. BBS has a movable platform that can be adjusted to provide varying degrees of stability and offers computer-based data. The balance measures provided by this device appear to be reliable measures of postural stability<sup>8</sup>.

As falls and injuries take older people close to or below thresholds of performance necessary for every day activities and, low strength, poor balance, poor gait and fear of falling seem to be risk factors for falls<sup>23</sup>.

Thus, this study was conducted to determine the effect of balance training program on increasing postural balance and consequently decreasing the risk of falling in obese postmenopausal women.

## SUBJECTS, MATERIAL AND METHODS

### Subjects

Twenty five obese postmenopausal women for at least five years after cessation of menstrual cycle from the Out Patient Clinic of Gynecology Department, at Kasr el-Ainie University Hospital were participated in this study. Their ages ranged from 50 to 60 yrs old with a mean value  $56.03 \pm 2.52$  yrs., and their body mass index (BMI) ranged from 30-34 kg /m<sup>2</sup> with a mean value  $32.80 \pm 1.19$  kg /m<sup>2</sup>. They all were free from diabetes, varicose veins, cardiopulmonary diseases, severe hypo or hypertension, visual and vestibular system affection, marked skeletal deformities and/or previous surgeries at their back and/or lower limbs. None of the participants were under hormonal replacement therapy (HRT) or any medications that may affect the neuromuscular

functions at least three months prior to entry in this study and/or during the study course. An informed consent form had been signed from each woman before participation in this study. Each woman underwent a balance training program for one hour, 3 times / week for 6 weeks (18 training sessions).

### **Instruments**

1. Recording Data Sheet
2. Weight-Height Scale
3. Biodex Balance System (BBS)

P.O. Box 702, Shirley, Ny 11967, is a unique dynamic postural control assessment and training system. It is consisted of Display Screen, adjustable Support Handle Rails, Platform, and Printer. It was used for the evaluation and training of postural balance for all participants in this study.

### **Procedures**

Full history was taken from each participant, then the weight and height were measured to calculate BMI according to the following equation:  $BMI = \text{Weight (kgs)} / \text{Height}^2 (\text{m}^2)^{15}$ . A simple explanation about the evaluation and training procedures was performed to every participant to increase her interest and motivation as well as, to obtain her confidence and cooperation. The balance evaluation and training were performed by using BBS at Balance Laboratory in the Faculty of Physical Therapy, Cairo University.

#### **A- Evaluative Procedures:**

Each participant was asked to evacuate her bladder (to be more relaxed) before starting the evaluative test which lasted for 20 seconds. The stability level of the BBS platform was adjusted to 8 (which mean maximum stability) and kept constant all over the test. The display screen shows a circle with a central cursor, and with open eyes, the woman was asked to achieve a central position on the platform by shifting her

feet position until she was able to keep the cursor (which represents the center of platform) centered on the circle that appeared on the display screen while grasping the support handle rails by both hands. Woman's feet position from the back of each heel in relation to X and Y coordinates, as well as the feet angles determined by a line parallel to the 2<sup>nd</sup> metatarsal bone of each foot were recorded into the BBS.

The woman was then asked to stand without grasping the support handle rails and her both arms beside her body, trying to centre the cursor on the screen, this test trial was done 3 times with 2 minutes rest in between. The mean of the 3 readings was taken to obtain the following data: Overall Stability Index (OSI), Anterior/Posterior Stability Index (APSI) and Medial/Lateral Stability Index (MLSI). This dynamic balance test was performed for each postmenopausal woman before starting and after 6 weeks of balance training ( after 18 training sessions).

#### **B- Training Procedures:**

The Biodex Balance Training program includes two balance training routines: Dynamic Balance (DB) and Dynamic Limit of Stability (DLOS) training for all participants. Each session of the balance training (DB and DLOS) was about 1 hour (20 minutes for DB divided into five sets, each set was subdivided into three minutes training and one minute rest, 35 minutes for DLOS divided into 5 sets, each set was subdivided into 5 minutes training and 2 minutes rest and 5 minutes rest in between both of DB & DLOS), 3 times per week, for 6 weeks. Starting the balance training (DB and DLOS) sessions with the easier stability level (level 8) and progressed toward the most difficult stability level (level 1) according to the ability of each woman.

### Statistical Analysis

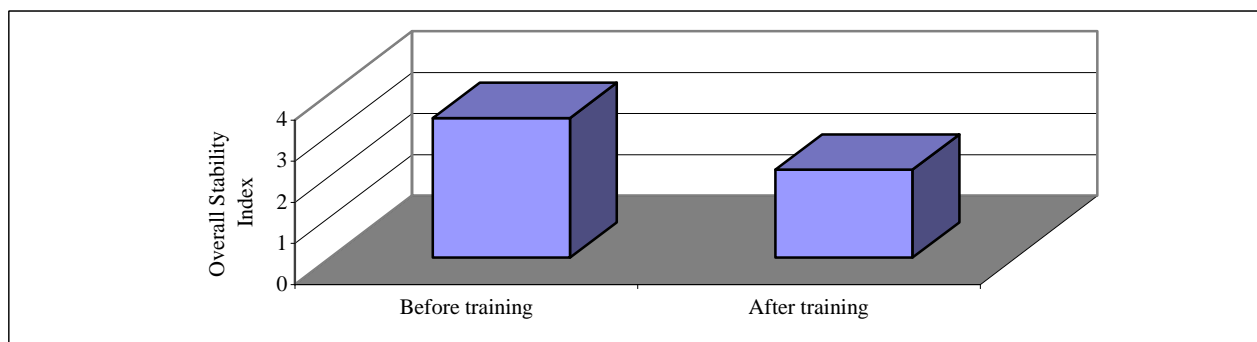
The collected data had been analyzed using paired t-test to describe the measuring variables in the form of mean, standard deviation and to compare between the pre and post balance training values. P-value  $>0.05$  indicates non significant results, while P-value  $<0.05$  indicates significant results and P-value  $<0.001$  indicates highly significant results<sup>9</sup>.

### RESULTS

- 1- The mean value  $\pm$ SD of Overall Stability Index (OSI) for all participants before starting the balance training program was  $3.40 \pm 0.40$  with maximum value of 3.90 and minimum value of 2.40, while it was decreased to  $2.14 \pm 0.37$  after the end of 18<sup>th</sup> balance training session with maximum and minimum values of 2.80 & 1.20 respectively. The comparison between mean values of OSI revealed a statistically highly significant decrease ( $P < 0.001$ ) with a mean difference of 1.26 which was equal 37.06 % as shown in table (1) and fig. (1).

**Table (1): The mean values of Overall Stability Index (OSI), Anterior/Posterior Stability Index (APSI) and Medial/Lateral Stability Index (MLSI) before and after balance training program.**

Variables	OSI		APSI		MLSI	
	Before training	After training	Before training	After training	Before training	After training
X	3.40	2.14	3.04	1.63	2.23	1.22
SD	$\pm 0.40$	$\pm 0.37$	$\pm 0.60$	$\pm 0.38$	$\pm 0.48$	$\pm 0.29$
Maximum	3.90	2.80	3.90	2.30	3.10	1.80
Minimum	2.40	1.20	1.80	1.10	1.20	0.70
MD	1.26		1.41		1.00	
% of change	37.06 %		46.38 %		44.84 %	
t- value	15.65		14.79		14.00	
P- value	P < 0.001		P < 0.001		P < 0.001	



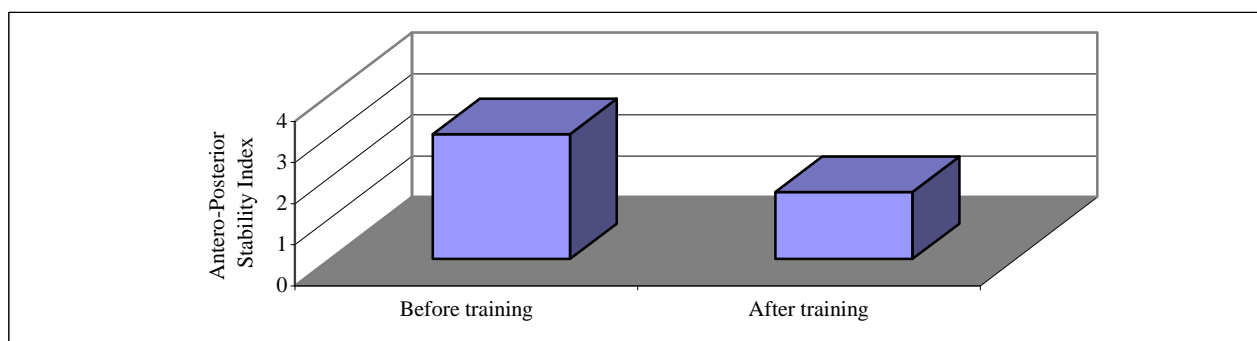
**Fig. (1): The mean values of Overall Stability Index (OSI) before and after balance training program.**

- 2- The mean value  $\pm$ SD of Anterior/Posterior Stability Index (APSI) before starting the

balance training program was  $3.04 \pm 0.60$  with maximum value of 3.90 and minimum

value of 1.80, while it was decreased to  $1.63 \pm 0.38$  after the end of 18<sup>th</sup> balance training session with maximum and minimum values of 2.30 & 1.10 respectively. The paired t-test revealed a

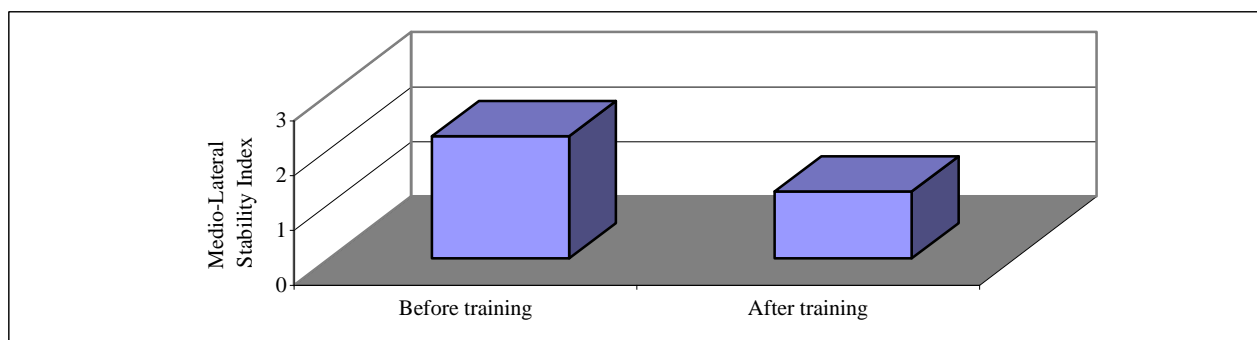
statistically highly significant decrease ( $P < 0.001$ ) with a mean difference of 1.41 which was equal 46.38 % as shown in table (1) and fig. (2).



**Fig. (2):** The mean values of Anterior/Posterior Stability Index before and after balance training program.

3- The mean value  $\pm$ SD for Medio/Lateral Stability Index (MLSI) before starting the balance training program was  $2.23 \pm 0.48$  with maximum value of 3.10 and minimum value of 1.20, while it was decreased to  $1.22 \pm 0.29$  after the end of 18<sup>th</sup> balance training session with maximum and

minimum values of 1.80 & 0.70 respectively. The paired t-test revealed a statistically highly significant decrease ( $P < 0.001$ ) with a mean difference of 1.00 which was equal 44.84 % as shown in table (1) and fig. (3).



**Fig. (3):** The mean values of Medio/Lateral Stability Index before and after balance training.

## DISCUSSION

Loss of estrogen during menopause may impair protective reflexes as well as, decrease balance and increase the risk of falling<sup>5</sup>. In

addition obesity produces important postural alternations (axial skeleton deviations) which are comparable with bone and joint related pain<sup>4</sup>. Balance training and individualized muscle strength programs result in wide range

of benefits as improve strength and balance measures as well as, maintain physical activity level<sup>20</sup>.

Twenty five obese postmenopausal women participated in this study to investigate the effect of balance training program on their postural balance. They had been received a balance training program for 6 weeks (3 sessions per week) using BBS. The Stability Indices (Overall, Anterior/Posterior and Medial/Lateral) of the dynamic balance test of BBS were used as a measurement for postural balance.

The results of this study revealed that Overall Stability Index (OSI) in all participated obese postmenopausal women was higher than the normal predictive values for their age before starting balance training and this means lower postural stability. This is consistent with Rozzi et al. (1999)<sup>21</sup>, who concluded that high stability indices indicate great platform motion during stance and therefore indicate less postural stability.

Increased OSI in the present study before balance training program can be attributed to the loss of estrogen which affects postural stability by slowing down the brain processing speed which is particularly significant to recognize any sensory input needed to initiate an appropriate physical response for postural stability<sup>22</sup>.

Also, increased OSI in this study can be attributed to the lack of muscle effectors that may decrease the capacity to respond appropriately to disturbances in postural stability. In addition, it can also be attributed to disturbed proprioception of the lower limbs and impaired visual as well as, vestibular mechanisms. This explanation comes in agreement with Hauer et al. (2001)<sup>7</sup> and Sung et al. (2002)<sup>25</sup>, who found that the vestibular, visual and somato-sensory systems, show changes with menopause due to loss of

estrogen and therefore, provide diminished and/or inappropriate feedback to the postural control.

In respect to the results of the present study, after the suggested period of balance training program (6 weeks), there was a statistically highly significant decrease in the mean values of all measuring variables of dynamic balance test. This significant improvement in balance may be attributed to the improvement in the proprioceptive sense which is responsible for most of the reflex movements necessary for the maintenance of the erect standing position. Also, developing weight shift and reciprocal coordinated movements of the lower limbs provide postural adaptation and alignment to improve equilibrium in all directions. These adaptable motor patterns are used as a basis for the development of skilled functional stabilities.

These findings come in agreement with Rozzi et al. (1999)<sup>21</sup>, who reported that the balance training program by using the BBS effectively stimulate the neuromuscular control mechanisms which are responsible for the maintenance of balance and posture. Also, they suggested that balance training is an effective mean of improving joint proprioception during standing. These results are also confirmed by Palmitier et al. (1991)<sup>18</sup>, who reported that, balance training which was performed in the weight bearing position considered as an appropriate method for re-establishing neuromuscular control and therefore, improving functional stability.

In addition, the improvement in balance ability of postmenopausal women after training may also be attributed to motor learning and practice, which is supported by O'Sullivan, (1994)<sup>17</sup>, who reported that improvements in balance occur as a result of practice and repetitions, that leads to, appropriate sequencing of movement

components, reduced effort as well as, concentration and improved timing and speed control. Also, these results are in agreement with Law et al. (2001)<sup>12</sup> who found that when the task is performed repeatedly, the relationship between movement capabilities, environmental conditions and the action goal become more refined, and the goal is achieved more successfully.

The six weeks of balance training program in this study at a rate of 3 times/week appears to be a sufficient period to promote reflex muscular activation patterns necessary for the maintenance of postural balance in obese postmenopausal women. This comes in consistency with Alexander and Lapier, (2000)<sup>1</sup>, who proved that balance training program for only 6 weeks decreased pain and improved static as well as, dynamic balance in patients with low back pain. Also, it come in agreement with Steadman et al. (2003)<sup>24</sup>, who found that balance training program for only 6 weeks significantly improve balance, mobility, confidence and quality of life in patients with balance problems.

The significant improvement in the results of the study concerning the balance abilities in all measured parameters strongly proved the effectiveness of BBS and denoted the value of feedback balance training program which in turn improved strength and proprioception, which are the main determinants of balance capabilities. These improvements in balance abilities of postmenopausal women after 6 weeks of balance training using BBS appear to reflect the improved neuromuscular ability of these women along with enhanced functional stability. Accordingly, it could be concluded that balance training program is an effective therapeutic modality which can be used successfully to improve postural balance and

reduce the risk of falling in obese postmenopausal women.

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### الملخص العربي

#### تأثير برنامج تدريبات الاتزان علي اتزان القوام لدي السيدات اللائي تعانين من السمنة بعد انقطاع الدورة الشهرية

تهدف هذه الدراسة إلي تقييم تأثير برنامج تدريبات الاتزان علي اتزان القوام لدي السيدات اللاتي تعانين من السمنة بعد انقطاع الدورة الشهرية . وقد أجريت الدراسة علي خمس وعشرين سيدة بعد انقطاع الدورة الشهرية ممن تراوحت أعمارهن ما بين خمسين إلي ستين عاما . وتم قياس معاملات الثبات (الثبات الإجمالي ، الأمامي الخلفي ، الجانبي) باستخدام جهاز قياس الاتزان الالكتروني (البيودكس) قبل و بعد برنامج تدريبات الاتزان التي أجريت لمدة ستة أسابيع بواقع ثلاث جلسات أسبوعيا . وقد أظهرت النتائج انخفاض ذو دلالة إحصائية عالية في معاملات الثبات بعد الانتهاء من برنامج تدريبات الاتزان وذلك عند مقارنتها بمعاملات الثبات التي تم قياسها قبل بداية البرنامج . ومن ذلك يمكن أن نستخلص من هذه الدراسة إن مزاولة السيدات البدنيات لتدريبات الاتزان بعد انقطاع الدورة الشهرية بصفة مستمرة لها تأثير ايجابي علي زيادة اتزان القوام والوقاية من السقوط المتكرر .

**الكلمات الدالة :** تدريبات الاتزان ، انقطاع الدورة الشهرية ، جهاز بيودكس ، السمنة .