# Effect of Vibration on Bone Density in Obese Stunted Children

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**Abstract:** Objective: of the current study was to investigate the effect of proprioceptive stimulation in the form of whole body vibration (WBV) on bone mineral density (BMD) and on body weight (BW) in obese stunted children. Subjects and methods: Thirty obese stunted children were selected from Governmental Primary Schools in Giza and National Nutrition Institute. Their ages ranged from 8 to 12 years with average age (10.5±1.1 year). They were divided randomly into 2 study groups of equal number. All the participated children of the study groups received a program of balanced diet regimen and aerobic exercise. Children of study group (II) received program of balanced diet regimen and aerobic exercise, in addition to whole body vibration (WBV). Results: revealed that there were statistically significant improvements in BMD in both groups after participation in the treatment program. Also there was statistically significant decrease in BW and BMI. These improvements were more significant in the study group (II). Conclusion: From the obtained results of this study, supported by a number of scientific research work, it can be concluded that WBV can be considered as a useful and important therapeutic modality to improve BMD and decrease BW and BMI at the same time in 8 to 12 years old obese stunted children.

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**Keywords:** Children, obesity, stunting, whole body vibration, bone mineral density, body mass index

## 1.Introduction:

Obesity means an excess amount of body fat. No general agreement exists on the definition of obesity in children as it does adults. Most professionals use published guidelines based on the body mass index (BMI), or a modified BMI for age, to measure obesity in children. Others define obesity in children as body weight at least 20% higher than a healthy weight for a child of that height, or a body fat percentage above 25% in boys or above 32% in girls [**1**].

Prolonged malnutrition during gestation and extending into early childhood is common in developing countries and causes stunting. The prevalence of stunting in children in the world nowadays is 33% [**2**]. An increased prevalence of obesity and abdominal fat; occurs in people with short stature [**3**].

The relationship between obesity and osteoporosis has been widely studied, and epidemiological evidence shows that obesity is correlated with increased bone mass. Previous analyses, however, did not control for the mechanical loading effects of total body weight on bone mass and may have generated a confounded or even biased relationship between obesity and osteoporosis [**4**].

Since physical activity is strongly osteogenic during growth, diminished participation in weight-bearing exercise by stunted obese children could affect bone development adversely. It is considered that this mismatch between high body weight and bone development during growth may place considerable strains on the bones and joints of overweight and obese children [**5**].

Statement of the problem: Does vibration has an effect on bone density in obese stunted children?

Advanced Vibration Technology is improving the quality of life for individuals who experience loss of bone density, muscle weakness, diminished range of motion and soreness, while recovering from injury [**6**]. Whole-body vibration (WBV) is a new type of exercise that uses an oscillating platform on which the individual stands or sits. In recent years, WBV has been used in research to determine if it can prevent osteoporosis and bone fractures in this population [**7**].

**Null hypothesis:**

1. There will be no effect of balanced diet regimen, aerobic exercise and WBV on bone density in obese stunted children.
2. There will be no effect of balanced diet regimen, aerobic exercise and WBV on weight reduction.
3. There will be no effect of balanced diet regimen, aerobic exercise and WBV on BMI.

**Purposes of the study:**

To investigate the effect of proprioceptive stimulation in the form of whole body vibration (WBV) on bone mineral density (BMD) and on body weight (BW) in obese stunted children.

## 2.Methodology :

**a- Subjects:** The study was delimited to 30 obese stunted children from both sexes, who were selected from Governmental Primary Schools in Giza and National Nutrition Institute, with the following criteria:

1. Obesity was determined according to: weight for height Z-scores> 2SD [**8**]
2. Age was ranged from 8-12 years old.
3. Children with other associated neurological or genetic disorders (e.g. Down's syndrome) were excluded from the study.
4. Children were selected with obesity due to nutritional deficiency who called stunted obese children.
5. Children with other causes of obesity were excluded from the study (e.g. diabetes, hypothyroidism, Cushing syndrome,---- etc.)
6. None of the children practicing regular sport activities.

The children were divided randomly into two groups of equal numbers (study group(I) and study group(II).

Study Group (I) :Fifteen obese stunted children received a balanced diet regimen for weight reduction, and a specially selected physiotherapy program based on aerobic exercise.

**Study group (II):**

Fifteen obese stunted children received the same regimen for weight reduction, the same selected physiotherapy program in addition to proprioceptive stimulation in the form of whole body vibration (WBV) training using a special device.

Written informed consent from all participant families was sort prior to their enrolment into the study.

**b- Venue:** The study was practiced by all children for weight reduction at home, for aerobic exercise and for WBV in outpatient clinic.

**b- Sessions time:** The study was conducted 3 days per week for 3 successive months for all children and instructed to repeat at home for 2 additional days. Each session lasted 30 minutes for aerobic exercise, and 5 minutes for WBV.

**Limitations:**

- In obligation of some children with the weight reduction regime and program.

**Basic assumptions:**

It was assumed that all children:

- Received the weight reduction program in the same and equal way.
- Followed the program of weight reduction and vibration.
- Were at the same socioeconomic level.

## 3.Results :

**Descriptive data of both groups (I and II):**

Group I were 10.59 ±1.18 years, 47.67 ± 7.9 6 Kg and 132.1 ± 4.59 cm; respectively and that of group II were 10.3 ± 1.1 years, 42.9 ± 7.3 Kg and 129.8 ± 5.9 cm. There were no significance differences between both groups in age, weight or height (p >0.05). As indicated from the pre treatment results of both groups (I and II), all subjects were homogenous concerning age, weight, height and sex.

### (A) Bone Mineral Density (BMD)

**I. Mean values of BMD before and after treatment for G(I):**

Table (1) showed that, there was an improvement in BMD in G (I) when comparing its results before and after application of balanced diet and aerobic exercises. The mean values ± SD of BMD before application of balanced diet and aerobic exercise was -1.69±0.38, while after application of balanced diet and aerobic exercise was -1.29±0.37. The mean difference was 0.4, which was statistically significant (*P*=0.0001).

**Table (1): Comparison between the mean values of BMD before and after treatment for G(I):**

| Item | BMD X ±SD | MD | % of improvement | t- value | *p*-value | Significance |
|---|---|---|---|---|---|---|
| Pre | -1.69±0.38 | -0.4 | 23.66 | -20.49 | 0.0001 | S |
| Post | -1.29±0.37 | | | | | |

**S**= Significant

**X** : Mean; **t value**= Paired t value; **SD**: Standard Deviation; ***P* value**= Probability value; **MD**: Mean difference

**II: Mean values of BMD before and after treatment for G(II):**

Table (2) revealed that, there was an improvement in BMD for G(II) when comparing its results before and after three months of treatment. The mean values ± SD was -1.73±032, while after treatment was -1.12±0.25. The mean difference was 0.61, which was statistically significant (*P*=0.0001).

**Table (2): Comparison between the mean values of BMD before and after treatment for G(II):**

| Item | BMD X ±SD | MD | % of improve-ment | t value | *P* value | Significance |
|---|---|---|---|---|---|---|
| Pre | -1.73±0.32 | -0.61 | 35.26 | -17.5 | 0.0001 | S |
| Post | -1.12±0.25 | | | | | |

**X** : Mean; **t value**= Paired t value; **SD**: Standard Deviation; ***P* value**= Probability value; **MD**: Mean difference. **S**= Significant.

**III: Mean values of BMD after treatment for both groups (I and II):**

It's evident from table (3) that, there was non significant difference in BMD when comparing post treatment mean values of both groups. The mean value ± SD of G(I) was -1.29± 0.37 while that of G(II) was -1.12±0.25. The mean difference was 0.17, which was statistically non significant (*P*=0.14).

**Table (3): Comparison between the mean values of BMD after treatment for both groups (I and II):**

| Item | BMD X ±SD | MD | % of improve-ment | t value | *p*-value | Significance |
|---|---|---|---|---|---|---|
| Group I | -1.29±0.37 | -0.17 | 13.17 | -1.49 | 0.14 | NS |
| Group II | -1.12±0.25 | | | | | |

**NS=** Non significant.
**X :** Mean; **t value=** Paired t value; **SD:** Standard Deviation; ***P* value=** Probability value; **MD:** Mean difference.

**(B)Body Weight (BW)**

**I. Mean values of BW (kg) before and after treatment for G(I):**

Table (4) revealed that, there was an improvement in BW in G(I) when comparing its results before and after application of balanced diet program, the mean values ± SD of BW before treatment was 47.67±7.96 (kg) while after treatment was 43.66±7.91 (kg). The mean difference was 4.01, which was statistically significant (P=0.0001).

**Table (4): Comparison between the mean values of BW (kg) before and after treatment for G(I):**

| Item | Body weight (kg) X ±SD | MD | % of improvement | t value | *p*-value | significance |
|---|---|---|---|---|---|---|
| Pre | 47.67±7.96 | 4.01 | 8.41 | 20.49 | 0.0001 | S |
| Post | 43.66±7.91 | | | | | |

**NS**= Non significant
**X** : Mean; **t value**= Unpaired t value; **SD**: Standard Deviation; ***P* value**= Probability value; **MD:** Mean difference

**II. Mean values of BW (kg) before and after treatment for G(II):**

Table (5) revealed that, there was an improvement in BW for G(II) when comparing its results before and after three months of using balanced diet program. The mean values ± SD was 42.93±7.39 (kg) while after using balanced diet program was 36.66±7.26 (kg). The mean difference was 6.27 which was statistically significant (*P*=0.0001).

**Table (5): Comparison between the mean values of BW (kg) before and after treatment for G(II):**

| Item | Body weight (kg) X ±SD | MD | % of improvement | t value | *p*-value | significance |
|---|---|---|---|---|---|---|
| Pre | 42.93±7.39 | 6.27 | 14.60 | 25.25 | 0.0001 | S |
| Post | 36.66±7.26 | | | | | |

**S**= Significant **X** : Mean. **%**: Percent of change. **SD**: Standard Deviation. **t value**= Unpaired t value. **MD**: Mean difference. ***P* value**= Probability value.

**III: Mean values of BW (kg) after treatment for both groups (I and II):**

It's evident from table (6) that, there was a significant difference in BW (kg) when comparing the post treatment mean values for both groups in favor to G(II). The mean values ± SD of BW for G(I) was 43.66± 7.91 (kg) while for G(II) was 36.66±7.26 (kg). The mean difference was 7 kg, which was statistically significant (*P*=0.01).

**Table (6): Comparison between the mean values of BW (kg) after treatment for both groups (I and II):**

| Item | Body weight (kg) | MD | % of improvement | t value | *P* value | significance |
|---|---|---|---|---|---|---|
| | X ±SD | | | | | |
| Group I | 43.66±7.91 | 7 | 16.03 | 2.52 | 0.01 | S |
| Group II | 36.66±7.26 | | | | | |

**X** : Mean. **%**: Percent of change. **SD**: Standard Deviation. **t value**= Unpaired t value. **MD**: Mean difference. ***P* value**= Probability value. **S**= Significant

**C: Body mass index (BMI)**

**I: Pre treatment mean values of BMI for both groups (I and II):**

As presented in table (7), there was no significant difference when comparing the pre treatment mean values of BMI for both groups (I and II). The mean value ± SD for G(I) was 7.14±3.19 kg/m² while for G(II) was 25.34±2.69 kg/m² (*P*= 0.10).

**Table (7): Comparison between pre treatment mean values of (BMI) for both groups (I and II):**

| Item | Patient's group | X ±SD | MD | t- value | *p*- value | sig |
|---|---|---|---|---|---|---|
| Body Mass Index (kg/m²) | Group I | 27.14±3.19 | 1.8 | 1.67 | 0.10 | NS |
| | Group II | 25.34±2.69 | | | | |

**NS**= Non significant. **X** : Mean. **t value**= Unpaired t value. **SD**: Standard Deviation. ***P* value**= Probability value. **MD**: Mean difference.

**Post treatment mean values of BMI for both groups (I and II):**

As presented in table (8), there was an improvement when comparing the post treatment mean values of BMI for both groups in favor to G(II). The mean values ± SD of BMI for G(I) was 24.04± 3.23 kg/m² while for G(II) was 21.59±2.70 kg/m². The mean difference was 2.45 Kg/m², which was statistically significant (*P*=0.03).

Table (8): Comparison between post treatment mean values of (BMI) for both groups (I and II):

| Item | Patient's group | X ±SD | MD | t- value | *p*- value | sig |
|---|---|---|---|---|---|---|
| Body Mass Index kg/m² | Group I | 24.04±3.23 | 2.45 | 2.25 | 0.03 | S |
| | Group II | 21.59±2.70 | | | | |

**X** : Mean. **t value**= Unpaired t value. **SD**: Standard Deviation. ***P* value**= Probability value. **MD**: Mean difference. **S**= Significant.

**Post treatment percentage of improvement**

Figure (1) shows the percentage of improvement of all measuring variables (BMD, BW, and BMI) after three successive months of treatment for both groups (I and II). Improvement was in favor to G(II) patients for BW and BMI, while there was no significant difference between both groups concerning BMD.

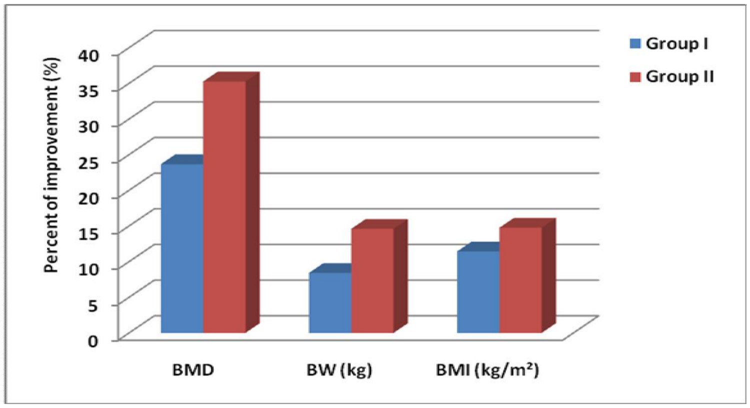


**Fig (1)**: Percentage of improvement in BMD, BW, and BMI for both groups (I and II).

**Correlation between bone mineral density (BMD) and body mass index (BMI) in both groups (I and II):**

Person Product Moment Correlation Coefficient was used to determine the relation between BMD and BMI after treatment. In G(I) there was very low inverse non significant correlation between BMD and BMI post treatment (r= -0.11, *p*=0.69) (Table 9, figs 2,3). In G(II) there was very low direct non significant correlation between BMD and BMI post treatment (r=0.41, *p*=0.12).

**Table (9): Correlation between BMD and BMI in both groups (I and II):**

| | BMD | r value | *p* value | significance |
|---|---|---|---|---|
| BMI (Kg/m²) | Group I | -0.11 | 0.69 | NS |
| | Group II | 0. 41 | 0.12 | NS |

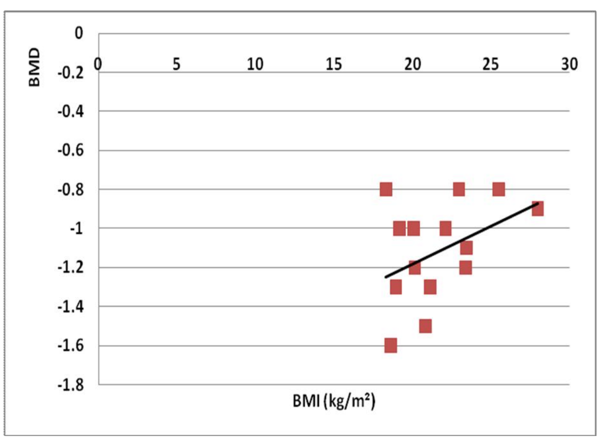


**Fig (2)**: Correlation between post treatment BMD and BMI (kg/m²) for G(I).

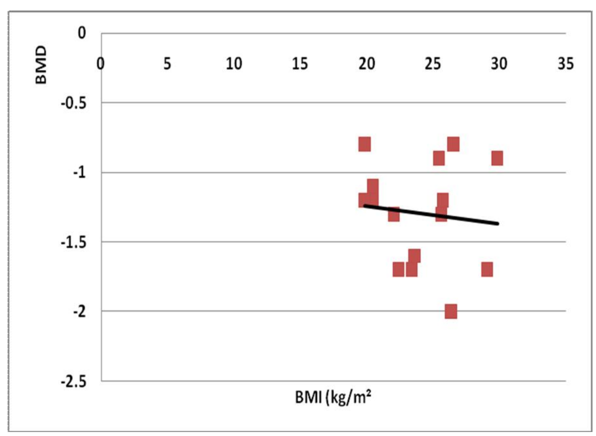


**Fig (3)**: Correlation between post treatment BMD and BMI (kg/m²) for G(II).

**4.Discussion:**

This study provided a direct investigation of the effect of proprioceptive stimulation in the form of whole body vibration (WBV) on bone mineral density (BMD) and on body weight (BW) in obese stunted children and also an investigation of the effect of balanced diet program and aerobic exercise on BMD and on BW in obese stunted children.

The idea beyond the current research was to find the most suitable method of controlling bone mineral loss during treatment of obese stunted children and also to find the most suitable method to control weight in those patients.

The present study was applied to the obese stunted children. This data was confirmed by Daniel *et al.*, (2000) **[9]** who reported that; childhood nutritional stunting is associated with impaired fat oxidation, a factor that predicted obesity in other at-risk populations. This finding may help explain recent increases in body fatness and the prevalence of obesity among stunted adults and adolescents in developing countries**.**

The measuring parameters in this study were: Bone mineral density (BMD), body weight (BW), and body mass index (BMI). Comparing the pre treatment mean values of study groups (GI and GII), showed no significant difference in all measuring variables (BMD, BW, BMI) as ($p > 0.05$). These findings clearly demonstrate the homogeneity between both study groups before starting the study; reflecting the validity of the sample collection and random classification of children between both study groups

The relationship between obesity and osteoporosis has been widely studied, and epidemiological evidence shows that obesity is correlated with increased bone mass. Previous analyses, however, did not control for the mechanical loading effects of total body weight on bone mass and may have generated a confounded or even biased relationship between obesity and osteoporosis [10].

In May 2004, the World Health Organization (WHO) issued the final draft of its "Global Strategy on Diet and Health." [11] Its main recommendations concerning diet include:

1. Achieve energy balance and a healthy weight.
2. Limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats and towards the elimination of trans-fatty acids.
3. Increase consumption of fruits and vegetables, and legumes, whole grains and nuts.
4. Limit the intake of free sugars.
5. Limit salt (sodium) consumption from all sources and ensure that salt is iodized.

The WHO also recommended at least 30 minutes of regular, moderate-intensity physical activity on most days.

The aims of the dietary approaches are twofold: first, to achieve a deficit in energy balance and second, to ensure that obese people are following a healthy balanced diet that is low in saturated fat and high in complex carbohydrate [12].

Weight loss typically reduces bone density. Exercise may preserve or increase BMD even while reducing fatness [13]. Although exercise remains the most readily available and generally accepted means of curbing weight gain. Aerobic exercise is recommended as a preventive measure for osteoporosis. Certain forms of exercise appear to stimulate bone gains [14].

Mayo Clinic (2008) [15] stated that, weight loss is typically recommended for children over age 7 or for younger children who have related health concerns. Weight loss should be slow and steady — anywhere from 1 pound a week to 1 pound a month, depending on child's situation. The methods for maintaining weight or losing weight are the same: child needs to eat a healthy diet and increase his or her physical activity. Success depends largely on commitment to helping the child make these changes. Think of eating habits and exercise habits as two sides of the same coin.

This study evaluated weather such a non invasive, low level mechanical signal, delivered via WBV is able to affect bone loss and weight gain that occur in obese stunted children.

The results of the current study at the end of treatment period, showed a significant improvement in the measuring variables in both study groups, but in favor to group II. Also the percentage of improvement of the measuring variables was higher in group II than group I.

**Study group I (GI):**

The post treatment results of the study G(I) showed significant improvement in BMD after using balanced diet and aerobic exercise ($P<0.0001$). The percentage of improvement was 23.66% as shown in table (1). The results also showed significant decrease in BW ($P=0.0001$) with the percentage of improvement was 8.41% as shown in table (4).

Improvement of BMD and decreased BW at the end of treatment period may be attributed to the aerobic exercise program. This is supported by the opinion of Gutin *et al.* (1999) **[16]** who stated that, regular exercise without dietary intervention; can enhance the body composition of children with obesity after 4-month periods of physical training detraining on percent fat and bone density of children with obesity.

Post treatment improvement of BMD for both groups may be caused by aerobic training and balanced diet program. This explanation is confirmed by Fritton ***et al.*** (2000) [17] who reported that, Bone adaptation that occurs after aerobic training is probably not due to the direct influence of mechanical loading, but to some phenomenon coupled to the mechanical loading process. Though mechanical loading doesn't appear to significantly affect skeletal adaptation, the nutritional and hormonal support is tenuously associated mechanical loading does have a profound influence on maintenance of bone tissue. Oxygen and low mass nutrients can diffuse from the capillaries directly to the cell population of even sparsely vascularized tissues such as bone. The flow of interstitial fluid through the bone tissue is therefore critical to the integrity of bone cells, and correspondingly, to the maintenance of bone mass. The extravasation of interstitial fluid is primarily dependent on transmural pressure (i.e. the difference between capillary and tissue pressures), but it can also be influenced by pressure gradients developed by the mechanical deformation of bone tissue during exercise. It is this process that provides the link between mechanical loading and bone adaptation.

The results of this study come in agreement with Barbeau ***et al.*** (2007) [18] who studied 10-months after-school physical activity program which lead to beneficial changes in body composition in young girls of varying levels of adiposity. Beneficial changes were also seen for BMC and BMD, such that a physical activity intervention program aimed at preventing the accretion of excess adiposity and play a role in improving bone health. This is important because it suggests that physical activity programs that aim at preventing overweight in young girls may also decrease the future risk of osteoporosis.

In the same context, the results of this study are confirmed by Lynn ***et al.*** (2006) [19] who reported that, comprehensive health care–based lifestyle intervention designed to control diet and increase physical activity; can effectively increase bone mineral gains in adolescent girls.

Moreover, improvement of BMD in this study may be due to aerobic training. This opinion comes in agreement with Pierce ***et al.*** (2008) [20] who reported that; the Interstitial fluid flow is essential for maintaining bone integrity. Non invasive approaches like aerobic training which enhance skeletal muscle pumping and thereby ensure sustained interstitial flow through bone; have the potential to improve BMD.

The results of the current study are in consistency with Pierce ***et al.*** (2008) [20] who suggested that, maintenance of bone mass requires adequate filtration and transport of nutrients and growth factors through the bone tissue. Adequate filtration, correspondingly, requires high capillary pressures. Sustained fluid transport through bone requires effective venous and lymphatic return, which serves to maintain low tissue pressures. Venous and lymphatic return, at least in the periphery of the body, is mediated primarily by skeletal muscle pumping. The lower limbs lack any explicit lymphatic pump, and so lymphatic fluid return is completely dependent on skeletal muscle activity. So, effective circulation is maintained through skeletal muscle pump activity.

The results of the present study are in agreement with those reported by Ryan ***et al.*** (2004) [21] and Kemmler ***et al.*** (2004) [22] who found aerobic training significantly increases lumbar spine and total hip BMD.

The results of this study come in agreement with Dennis ***et al.*** (2006) [23] who stated that, caloric restriction induced weight loss, but not exercise induced weight loss, is associated with reductions in BMD at clinically important sites of fracture. These data suggest that exercise should be an important component of a weight loss program to offset adverse effects of caloric restriction on bone.

Caloric restriction induced weight loss is accompanied by significant decreases in BMD. Results provided by Dennis ***et al.*** (2006) [23] evidenced that; aerobic exercise induced weight loss is associated with preservation of BMD at important clinical sites of fracture. Therefore, aerobic exercise has the important advantage over Caloric restriction by protecting against bone loss.

On the other hand, the present study results contradict with those of Ryan ***et al.*** (1998) [24] who found that 16 weeks of aerobic training caused small but significant decrease in BW and BMI.

Also, the findings of this study contrasts with those of Elliott ***et al.*** (2002) [25] who found after 8 weeks of aerobic training, non significant decrease in BMI, and percentage of body fat. The shorter treatment period may be the cause of this discrepancy.

**Study group II (GII):**

The vibration stimulus can be varied in multiple ways (including type, frequency, and duration), and different types of vibration loading are likely to result in different effects on bone mass and structure [26].

The post treatment results of the present study showed significant improvement in BMD after using balanced diet, aerobic exercise and WBV ($P<0.0001$). The percentage of improvement was 35.26% as shown in table (2). The results also showed significant decrease in BW ($P<0.0001$). The percentage of change was 14.6% as shown in table (5).

These findings come in agreement with **Jordan (2004)** [27] who stated that, low-level high-frequency mechanical signals have been studied as signals stimulating bone turnover.

Higher improvement of BMD in G(II) may be due to WBV. This agrees with Eisman (2005) [28] who stated that, without the addition of weight-bearing exercise however, no program for the treatment or prevention of osteoporosis can be considered complete. Climbing stairs, running, lifting weights - and to some extent walking - are all among those exercises considered beneficial in maintaining bone density contrast to activities such as swimming, which are less helpful for osteoporosis. The results of this study come in agreement with Flieger ***et al.*** (2005) [29] who studied the influence of nonphysiological mechanical stimulation, in the form of low intensity vibration (frequency: 50 Hz, 30 min/day for 5 days/week), on the prevention of bone loss in an animal model of postmenopausal osteoporosis. They found that, WBV is effective in preventing early postovariectomy bone loss in an animal model.

The present study results come in agreement with Rubin ***et al.*** (2004) [30] who studied the effect of WBV training from quiet standing position. The training protocol was more intense and for adults. They used twice 10 minutes treatments/day for one year. It is remarkable to mention that; the efficacy of their trial increased significantly with greater compliance, particularly in those women with lower BMI who exhibit a significant increase in BMD. The results of this study contradict with Russo ***et al.*** (2003) [31] who didn't find any improvement in bone characteristics after 2 months of WBV training with a reciprocating plate with two sessions per week. Therefore, the number of sessions and the treatment period accompanied with aerobic exercise seem to play an important role to obtain the desired effect.

The anthropometric results showing significant decrease in BW after using WBV in GII which was higher than that in GI which come in agreement with the results of Maddalozzo ***et al.* (2009)** [32] who reported that; 12 weeks of WBV reduced body fat accumulation and serum leptin levels in rats. Taken at face value, these results are potentially important to the treatment of obesity.

The present study results coincided with that of **Gusi et al. (2006)** [33] who reported a significant decrease of BW after WBV training at lower intensity for 8 months. The longer treatment period increase the effect of WBV on body weight.

**Conclusion:**

From the obtained results of this study, supported by a number of scientific research work, it can be concluded that WBV can be considered as a useful and important therapeutic modality to improve BMD and decrease BW and BMI at the same time in 8 to 12 years old obese stunted children.

**Recommendations:**

- According to the results of the present study, it can be recommended that:
- Using of WBV in to reduce weight in obese stunted children.
- Using of WBV in to improve BMD in obese stunted children.
- Using of balanced diet regimen and aerobic exercise to reduce weight in obese stunted children.
- Using of balanced diet regimen and aerobic exercise to improve BMD in obese stunted children.
- Increasing period of treatment more than 3 months to obtain more valuable results.
- Studying of other methods to decrease BW and improve BMD in obese stunted children.
- Using of WBV for other purposes rather than BW, BMD and for other ages.

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