The aim of the present study was to evaluate the association between Bone mineral density in lumbar spine and femoral neck with serum total levels of vitamin D, sun exposure and Consumption of vitamin D Supplement in obese Saudi females aged between 30 and 54 years old. Recent attention to the high prevalence of osteoporosis and its association with low vitamin D levels in adults has raised the importance of vitamin D evaluation. A low level of vitamin D is considered to be one of the most important risk factors for osteoporosis. In this study; 120 obese Saudi females with no diagnosed chronic diseases attending the Outpatient clinic at king Khalid University hospital in Riyadh. Saudi Arabia, recruited randomly in period of 12 months. In this study, Serum levels of total Vitamin D were considered to be severe deficient if it was lower than 25 ng/mL, mild to moderate deficient if it was between 25 and 60 ng/mL and optimum level if it was 61–200 ng/mL. The results showed that; sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects. In addition, daily consumption of Vitamin D supplement was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study. Moreover, the results showed that; 50% of the age group (40–49 years old) having severe deficiency of Vitamin D. While, 50% of the age group (50–59 years old) having optimal level of Vitamin D. And these results mean that age is not Correlated with vitamin D deficiency in subjects of this study.
Vitamin D deficiency is caused by many factors which could be related to either decreased synthesis and bioavailability, or increased catabolism and urinary loss (Holick, 2007). Saudi Arabia is one of the sunniest areas of the world and exposure to sunlight might be assumed to be sufficient to maintain adequate vitamin D status. However, according to some earlier studies, vitamin D deficiency is common among the Saudi population (Woodhouse & Norton, 1982; Sedrani et al., 1983, 1992). Recent attention to the high prevalence of osteoporosis and its association with low vitamin D levels in adults has raised the importance of vitamin D evaluation. In addition, among many other risk factors, a low level of vitamin D is considered to be one of the most important risk factors for osteoporosis and related fractures (Holick & Chen, 2008).

Osteopenia is a condition of bone mass thinning. While this decrease in bone mass is not usually considered “severe,” it is considered a very serious risk factor for the development of osteoporosis. The diagnostic difference between osteopenia and osteoporosis is the measure of bone mineral density. Osteoporosis, the “fragile bone disease,” is characterized by a loss of bone mass caused by a deficiency in calcium, vitamin D, magnesium and other vitamins and minerals.

Obesity, defined by the World Health Organization as a body mass index (BMI) of 30 kg/m² or more, is pandemic. The Kingdom of Saudi Arabia is one of the fastest-growing obesity rates in the world, according to a report published at 2014. The report also claims that 70–75% of Saudi adults are overweight, and around a third are obese (Ng et al., 2014). The association between reduced vitamin D concentrations and obesity is well-established. There is a consistent association in the published literature between obesity and lower serum vitamin D concentrations (Bell et al., 1985; Liel et al., 1988; Parikh et al., 2004, Lagunova et al., 2009). In addition, it has also been reported that body fat content is inversely related to serum vitamin D concentration (Arunabh et al., 2003).

Recent attention to the high prevalence of osteoporosis and its association with low vitamin D levels in adults has raised the importance of vitamin D evaluation. In addition to many other risk factors, a low level of vitamin D is considered to be one of the most important risk factors for osteoporosis. The aim of the present study was to evaluate the association between bone mineral density in lumbar spine and femoral neck with serum total levels of vitamin D concentrations and obesity is well-established. There is a consistent association in the published literature between obesity and lower serum vitamin D concentrations (Bell et al., 1985; Liel et al., 1988; Parikh et al., 2004, Lagunova et al., 2009). In addition, it has also been reported that body fat content is inversely related to serum vitamin D concentration (Arunabh et al., 2003).

This study included a random sample of 120 obese Saudi females with no diagnosed chronic diseases attending the outpatient clinic at King Khalid University hospital in Riyadh. Saudi Arabia, recruited randomly in period of 12 months; from January 2015 to January 2016.

2.2. Tools of the study

The study tools included an interview questionnaire, anthropometric measurements and blood biochemical tests.

2.3. Anthropometric measurements

Weight (kg), and height (cm) were selected for anthropometric evaluation as variables for calculating BMI.

2.4. Biochemical assessment

Blood (4 mL) was withdrawn by a nurse after an overnight fast (>12 h) and transferred immediately into non-heparinized tube. Serum samples were stored at −80°C until required for analysis. Serum total levels of Vitamin D were measured by radioimmunoassay using Wallac1470 Gamma Counter (Wallac Inc., Gaithersburg, MD, USA).

The serum levels of total Vitamin D were considered to be severe deficient if it was lower than 25 ng/mL, mild to moderate deficient if it was between 25 and 60 ng/mL and optimum level if it was 61–200 ng/mL.

2.5. Bone mineral density measurements

BMD (grams/centimeter square) was determined for the anteroposterior lumbar spine (L1-L4) and mean of proximal right and left femur (total and sub-regions) by dual-energy X-ray absorptiometry (DXA), according to standard protocol. BMD values were classified according to WHO criteria; a T-score between −1 and −2.5 is indicative of osteopenia, while a T-score <-2.5 reflects osteoporosis and a T-score >−1 is considered normal (WHO, 1994).

2.6. Statistical analysis

Quantitative data were statistically represented in terms minimum, maximum, mean, and standard division (SD).

Comparison between difference groups in the presents study was done using one-way ANOVA Test to compare between more than two parametric groups with (Dunnett test) as multiple comparison to compare each group with the control group using Kruskall-Wallis Test to compare between more than two nonparametric groups with (Mann-Whitney test) to compare each group with the control group.

Qualitative data were statistically represented in terms number and percent. Comparison between difference groups in the presents study was done using Chi-Square Test. A probability value (p value) less than or equal to (0.001) was considered significant. All statistical analysis was performed using statistical software SPSS (Statistical Package for Social Science) statistical program version (16.0).

3. Results and discussion

Among 120 selected subjects in this study, the ages were ranged from 30 to 54. Serum levels of total vitamin D were widely range from 9 to 111 ng/mL. BMI was ranged from 32 to 37 that indicates all subjects were obese as BMI over 30 is considered obese according to WHO. Minimum, maximum, mean and SD of all variables in this study are listed in Table 1.

Samples of the present study were categorized in each variable. According to age; 26.7% were 30–39 years old, 40% were 40–49 years old and 33.3% were 50–59 years old. Among the selected subjects; 66.7% are exposed daily to sun, 80% take vitamin D Supplement (1000 mg/day). According to serum total levels of Vitamin D (D2 & D3); 20% showed Severe Vitamin D deficiency (lower than 25 ng/mL), 66.7% have Mild to moderate Vitamin D deficiency (25–60 ng/mL), while 13.3% were in the Optimum level (61–200 ng/mL).

By measuring Bone mineral density in lumbar spine; 33.3% were normal (with t score bigger than −1), 46.7% showed Osteopenia (with t score −1 and −2.5), while 20% were recorded with Osteoporosis (with t score lower than −2.5) (Table 2).

According to age; 44.5 ± 6.7 mean age (years) were exposed to sun, 45.6 ± 6.0 were consume Vitamin D (1000 mg/day). Mean age (years) of 43.0 ± 5.5 suffer from Severe deficiency of Vitamin
D, 44.0 ± 7.0 have mild to moderate deficiency while 45.5 ± 7.5 were in the optimal level. Mean age 46.4 ± 5.1 showed Osteoporosis according to t score of Bone mineral density in lumber spine and 46.5 ± 4.3 were Osteoporosis according to t score of Bone mineral density in femoral neck (Table 3).

In the present study; according to serum levels of total Vitamin D, it was found that, there was a significant difference in the serum level of vitamin D between the group that exposed to sun and the group that not exposed to sun. In addition, there was a significant difference in the serum level of vitamin D between the group that consume daily supplement of Vitamin D (1000 mg/day) and the other group that did not consume daily Vitamin D supplement. Furthermore, there was a significant difference between the groups of different T score value of Bone mineral density in lumber spine. While no significant differences in serum levels of total Vitamin D were reported between age groups, and between the groups of different T score value of Bone mineral density in femoral neck (Table 4).

In the present study, three groups were classified according to age (Table 5). In the first group (30–39 years old), 50% were

| Variable | n | Minimum | Maximum | Mean | Std. Deviation |
|----------|---|---------|---------|------|-------|
| Age      | 120 | 30.0    | 54.0    | 44.0 | 6.8    |
| Serum total levels of vitamin D (D2 & D3) | 120 | 9.0     | 111.0   | 41.3 | 23.2   |
| BMD in Lumbar spine | 120 | 0.6     | 1.2     | 0.9  | 0.2    |
| BMD in Femoral Neck | 120 | 0.5     | 1.1     | 0.8  | 0.2    |
| BMI      | 120 | 32      | 37      | 30   | 3.4    |

BMD (Bone mineral density).
BMI (Body mass index).

Table 1
Variables of the study.

Table 2
General description of categorical variables.

| Variable | Category | n | % |
|----------|----------|---|---|
| Sun exposure | Yes | 80 | 66.7 |
| No | 40 | 33.3 |
| Consumption of vitamin D Supplement (1000 mg/day) | Yes | 96 | 80.0 |
| No | 24 | 20.0 |
| Serum total levels of vitamin D | Severe deficiency (lower than 25 ng/ml) | 24 | 20.0 |
| Mild to moderate deficiency (25–60 ng/ml) | 80 | 66.7 |
| Optimum level (61–200 ng/ml) | 16 | 13.3 |
| T-score BMD L | Normal (bigger than –1) | 32 | 26.7 |
| Osteopenia (–1 and –2.5) | 68 | 56.7 |
| Osteoporosis (lower than –2.5) | 20 | 16.7 |
| T-score BMD F | Normal (bigger than –1) | 40 | 33.3 |
| Osteopenia (–1 and –2.5) | 56 | 46.7 |
| Osteoporosis (lower than –2.5) | 24 | 20.0 |
| Age | 30–39 years old | 32 | 26.7 |
| 40–49 years old | 48 | 40.0 |
| 50–59 years old | 40 | 33.3 |

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).

Table 3
Mean patient age (years) for each of the Sun exposure, consumption of vitamin D supplement (1000 mg/day), serum total levels vitamin D, T-score BMD L and T-score BMD F categories.

| Subgroup | Category | n | Mean ± SD | p value* |
|----------|----------|---|-----------|---------|
| Sun exposure | Yes | 80 | 44.5 ± 6.7 | 0.271 |
| No | 40 | 43.0 ± 6.8 |
| Consumption of vitamin D Supplement (1000 mg/day) | Yes | 96 | 45.6 ± 6.0 | 0.000 |
| No | 24 | 37.3 ± 5.6 |
| Serum total levels of vitamin D | Severe deficiency | 24 | 43.0 ± 5.5 | 0.525 |
| Mild to moderate deficiency | 80 | 44.0 ± 7.0 |
| Optimum level | 16 | 45.5 ± 7.5 |
| T-score BMD L | Normal | 32 | 41.1 ± 7.4 | 0.011 |
| Osteopenia | 68 | 44.6 ± 6.6 |
| Osteoporosis | 20 | 46.4 ± 5.1 |
| T-score BMD F | Normal | 40 | 42.9 ± 7.6 | 0.107 |
| Osteopenia | 56 | 43.6 ± 6.9 |
| Osteoporosis | 24 | 46.5 ± 4.3 |

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).

* Student’s t test for independent samples or one-way Anova.
exposed to sun and also 50% were consume daily supplement of Vitamin D, 25% were suffered from severe deficiency of Vitamin D, 62.5% with mild to moderate deficiency and 12.5% were in the optimal level. By comparing T score value of Bone mineral density in lumber spine; 12.5% were diagnosed with Osteoporosis, 50% with Osteopenia & 37.5% were normal. While according to T score value of Bone mineral density in femoral neck; 62.5% with Osteopenia & 37.5% were normal and no reported Osteoporosis cases.

In the second group (40–49 years old), 83.3% were exposed to sun and also 83.3% were consume daily supplement of Vitamin D, 25% were suffered from severe deficiency of Vitamin D, 66.7% with mild to moderate deficiency and 2.5% were in the optimal level. By comparing T score value of Bone mineral density in lumber spine; 16.7% were diagnosed with Osteoporosis, 50% with Osteopenia & 37.5% were normal. While according to T score value of Bone mineral density in femoral neck; 25% with Osteopenia, 41.7% were normal and 20% with Osteoporosis.

In the third group (50–59 years old), 60% were exposed to sun and 100% were consume daily supplement of Vitamin D, 10% were suffered from severe deficiency of Vitamin D, 70% with mild to moderate deficiency and 20% were in the optimal level. By comparing T score value of Bone mineral density in lumber spine; 20% were diagnosed with Osteoporosis, 70% with Osteopenia & 10% were normal. While according to T score value of Bone mineral density in femoral neck; 50% with Osteopenia, 20% were normal and 30% with Osteoporosis.

The association between each of the variables and sun exposure was determined (Table 6). From this table, it was found that; the age group (40–49 years old) was significantly the most group exposed to sun in all the three groups. In addition, 85% from subjects were consumed daily supplement of Vitamin D and were exposed to sun, while 30% were neither consumed daily supplement of Vitamin D nor exposed to sun.

From the subjects that exposed to sun, there was 20% in the optimal level of serum Vitamin D, 60% with mild to moderate deficiency and 20% with severe deficiency. On the other hand, from the subjects that were not exposed to sun, there were 80% with mild to moderate deficiency and 20% with severe deficiency, it means that sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study.

Moreover, the results showed that; 80% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in lumber spine and 60% of subjects

### Table 4
Serum levels of total vitamin D (ng/mL) for each age group, Sun Exposure, consumption of vitamin D supplement (1000 mg/day), T-score BMD L and T-score BMD F categories.

| Variable                              | Category          | 30–39 years old | 40–49 years old | 50–59 years old | p value |
|---------------------------------------|-------------------|-----------------|-----------------|-----------------|---------|
|                                      | n     | Mean ± SD       | n       | Mean ± SD       | n       | Mean ± SD       |
| Age (years)                           |       |                 |         |                 |         |               |
| 30–39                                 | 32    | 42.4 ± 20.2     | 48      | 40.8 ± 25.0     | 40      | 41.0 ± 23.8     | 0.955   |
| 40–49                                 | 48    |                 |         |                 |         |               |
| 50–59                                 | 40    |                 |         |                 |         |               |
| Sun exposure                          |       |                 |         |                 |         |               |
| Yes                                   | 80    | 46.2 ± 25.8     | 40      | 31.6 ± 12.4     |         |               | 0.001   |
| No                                    | 40    |                 |         |                 |         |               |
| Consumption of vitamin D supplement (1000 mg/day) |       |                 |         |                 |         |               |
| Yes                                   | 96    | 43.8 ± 24.4     | 24      | 31.3 ± 14.4     |         |               | 0.018   |
| No                                    | 24    |                 |         |                 |         |               |
| T-score BMD L                         |       |                 |         |                 |         |               |
| Normal                                | 32    | 39.9 ± 13.2     |         |                 |         |               | 0.000   |
| Osteopenia                            | 68    | 35.6 ± 16.7     |         |                 |         |               |
| Osteoporosis                          | 20    | 63.0 ± 38.6     |         |                 |         |               |
| T-score BMD F                         |       |                 |         |                 |         |               |
| Normal                                | 40    | 37.4 ± 12.2     |         |                 |         |               | 0.320   |
| Osteopenia                            | 56    | 41.9 ± 25.4     |         |                 |         |               |
| Osteoporosis                          | 24    | 46.3 ± 30.7     |         |                 |         |               |

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
* Student's t test for independent samples or one-way Anova. P < 0.05.
** P < 0.001.

### Table 5
Association between each of the variables and age.

| Variable                              | Category                     | 30–39 years old | 40–49 years old | 50–59 years old | p value |
|---------------------------------------|------------------------------|-----------------|-----------------|-----------------|---------|
|                                      | n%                           | n%              | n%              |                 |         |
| Sun exposure                          | Yes                          | 16 50           | 40 83.3         | 24 60           | 0.005   |
|                                      | No                           | 16 50           | 8 16.7          | 16 40           |         |
| Consumption of vitamin D supplement (1000 mg/day) | Yes                          | 16 50           | 40 83.3         | 40 60           | 0.000   |
|                                      | No                           | 16 50           | 8 16.7          | 0 0             |         |
| Serum total levels of vitamin D       | Severe deficiency            | 8 25            | 12 25           | 4 10            | 0.249   |
|                                      | Mild to moderate deficiency  | 20 62.5         | 32 66.7         | 28 70           |         |
|                                      | Optimum level                | 4 12.5          | 4 8.3           | 8 20            |         |
| T-score BMD L                         | Normal                       | 12 37.5         | 16 33.3         | 4 10            | 0.065   |
|                                      | Osteopenia                   | 16 50           | 24 50           | 28 70           |         |
|                                      | Osteoporosis                 | 4 12.5          | 8 16.7          | 8 20            |         |
| T-score BMD F                         | Normal                       | 12 37.5         | 20 41.7         | 8 20            | 0.003   |
|                                      | Osteopenia                   | 20 62.5         | 16 25           | 20 50           |         |
|                                      | Osteoporosis                 | 0 0             | 12 33.3         | 12 30           |         |

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
* Chi-square test.
** P < 0.001.
that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in femoral neck. This means that sun exposure was significantly affect and Correlate with Osteopenia.

The association between each variables and consumption of vitamin D Supplement 1000 mg/day was carried out (Table 7). The obtained results showed that the age group (30–39 years old) was significantly the least group that consume daily supplement in all the three groups 66.7%. In addition, 70.8% of subjects that consumed daily supplement of Vitamin D were exposed to sun.

From the subjects that consumed daily supplement of Vitamin D, 100% were in the optimal level of serum Vitamin D. On the other hand, 85% with mild to moderate deficiency and 50% with severe deficiency of Vitamin D are exposed to sun. And it means that sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects of our study.

Moreover, the results showed that; 66.7% of subjects that were not consumed daily supplement of Vitamin D were having Osteopenia according to T score value of Bone mineral density in lumbar spine and 50% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in femoral neck.

Table 8 showed association between each variables and serum total levels of vitamin D. From this table, it was found that; 100% of subjects that exposed to sun have optimal level of serum Vitamin D. In addition, 60% of subjects with mild to moderate deficiency of Vitamin D are exposed to sun and 66.7% with severe deficiency of Vitamin D are exposed to sun. And it means that sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study.

From the subjects that consumed daily supplement of Vitamin D, 100% were in the optimal level of serum Vitamin D. On the other hand, 85% with mild to moderate deficiency and 50% with severe deficiency of Vitamin D were having Osteopenia according to T score value of Bone mineral density in femoral neck and 50% of subjects that consumed daily supplement of Vitamin D were having Osteopenia according to T score value of Bone mineral density in lumbar spine and 50% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in femoral neck.
deficiency were consumed daily Vitamin D supplement. And it means that daily consumption of Vitamin D supplement was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study.

Moreover, the results showed that; 50% of the age group (40–49 years old) having severe deficiency of Vitamin D. While, 50% of the age group (50–59 years old) having optimal level of Vitamin D. And these results mean that age is not Correlated with vitamin D deficiency in subjects of our study.

It was found that; 50% of subjects that with severe deficiency of Vitamin D were having Osteopenia according to T score value of both Bone mineral density in lumber spine and femoral neck. However; the results showed that 75% and 50% of subjects with optimal serum level of Vitamin D have Osteoporosis according to T score value of Bone mineral density in lumber spine and femoral neck respectively.

The association between each variables and T-score of Bone mineral density in lumber spine was determined (Table 9). From this table, it was found that; the age groups (30–39 & 40–49 years old) were more subjected to Osteoporosis (40% in each group), while 41.2% of the third age group (50–59 years old) are subjected for Osteopenia. In addition, there is a direct correlation between T-score of Bone mineral density in lumber spine and T-score of Bone mineral density in femoral neck.

Table 10 showed association between each variables and T-score of Bone mineral density in femoral neck. From this table, it was found that; the age groups (40–49 & 50–59 years old) were more subjected to Osteoporosis (50% in each group). Furthermore, in this study, subjects with Osteoporosis were 100% consumed supplement of Vitamin D, 66.7% were exposed to sun and 50% showed Mild to moderate deficiency of Vitamin D. In addition, there is a direct correlation between T-score of Bone mineral density in femoral neck and T-score of Bone mineral density in lumber spine.

Generally, it is believed that the Saudi Arabia are among countries with rampant Vitamin D deficiency. There was a study in 2011

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### Table 8
Association between each of the variables and serum total levels of vitamin D.

| Variable                                | Severe deficiency | Mild to moderate deficiency | Optimum level | p value* |
|------------------------------------------|-------------------|-----------------------------|---------------|----------|
|                                          | n                 | %                           | n             | %        | n        | %        |           |
| Sun exposure                             |                   |                             |               |          |          |          |           |
| Yes                                      | 16                | 66.7                        | 48            | 60       | 16       | 100      | 0.008*** |
| No                                       | 8                 | 33.3                        | 32            | 40       | 0        | 0        |           |
| Consumption of vitamin D supplement (1000 mg/day) |                   |                             |               |          |          |          |           |
| Yes                                      | 12                | 50                          | 68            | 85       | 16       | 100      | 0.000*** |
| No                                       | 12                | 50                          | 12            | 15       | 0        | 0        |           |
| Age                                      |                   |                             |               |          |          |          |           |
| 30–39 years old                          | 8                 | 33.3                        | 20            | 25       | 4        | 25       | 0.249     |
| 40–49 years old                          | 12                | 50                          | 32            | 40       | 4        | 25       |           |
| 50–59 years old                          | 4                 | 16.4                        | 28            | 35       | 8        | 50       |           |
| T-score BMD L                            |                   |                             |               |          |          |          |           |
| Normal                                   | 8                 | 33.3                        | 24            | 30       | 0        | 0        |           |
| Osteopenia                               | 12                | 50                          | 52            | 65       | 4        | 25       |           |
| Osteoporosis                             | 4                 | 16.4                        | 4             | 5        | 12       | 75       |           |
| T-score BMD F                            |                   |                             |               |          |          |          |           |
| Normal                                   | 8                 | 33.3                        | 32            | 40       | 0        | 0        | 0.005***  |
| Osteopenia                               | 12                | 50                          | 36            | 45       | 8        | 50       |           |
| Osteoporosis                             | 4                 | 16.4                        | 12            | 15       | 8        | 50       |           |

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
* Chi-square test.
** P < 0.05.
*** P < 0.001.

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### Table 9
Association between each of the variables and T-score BMD L.

| Variable                                | Normal | Osteopenia | Osteoporosis | p value* |
|------------------------------------------|--------|-----------|--------------|----------|
|                                          | n      | %         | n            | %        | n        | %        |           |
| Sun exposure                             | 28     | 87.5      | 36           | 52.9     | 16       | 100      | 0.001*** |
| No                                       | 4      | 12.5      | 23           | 47.1     | 4        | 20       |           |
| Supplement of vitamin D 1000 mg/day      |        |           |              |          |          |          |           |
| Yes                                      | 24     | 75        | 52           | 76.5     | 20       | 100      | 0.049**  |
| No                                       | 8      | 25        | 16           | 23.5     | 0        | 0        |           |
| Age                                      |        |           |              |          |          |          |           |
| 30–39 years old                          | 12     | 37.5      | 16           | 23.5     | 4        | 20       | 0.065     |
| 40–49 years old                          | 16     | 50        | 24           | 35.3     | 8        | 40       |           |
| 50–59 years old                          | 4      | 12.5      | 28           | 41.2     | 8        | 40       |           |
| Serum total levels of vitamin D          |        |           |              |          |          |          |           |
| Severe deficiency                        | 8      | 25        | 12           | 17.6     | 4        | 20       | 0.000***  |
| Mild to moderate deficiency              | 24     | 75        | 52           | 76.5     | 4        | 20       |           |
| Optimum level                            | 0      | 0         | 4            | 5.9      | 12       | 60       |           |
| T-score BMD F                            |        |           |              |          |          |          |           |
| Normal                                   | 24     | 75        | 16           | 23.5     | 0        | 0        | 0.000***  |
| Osteopenia                               | 8      | 25        | 40           | 58.8     | 8        | 40       |           |
| Osteoporosis                             | 0      | 0         | 12           | 17.6     | 12       | 60       |           |

BMD L (Bone mineral density in lumber spine).
BMD F (Bone mineral density in femoral neck).
* Chi-square test.
** P < 0.05.
*** P < 0.001.
that conclude a high prevalence of a vitamin D deficiency in sample of Saudi Arabians despite >65% of participants having adequate exposure to sunlight and >90% reporting adequate intake of dairy products (Elsammak et al., 2011). In the present study; from the subjects that were not consumed daily supplement of Vitamin D, there were 50% with mild to moderate deficiency and 50% with severe deficiency. And it means that daily consumption of Vitamin D supplement was significantly affect and Correlate with serum level of Vitamin D in the subjects of this study. Moreover, the results showed that: 66.7% of subjects that were not consumed daily supplement of Vitamin D were having Osteopenia. An early study at 1984 Correlated between the inadequate exposure to sunlight and vitamin D deficiency in Saudi Arabian women (Fonseca et al., 1984). Furthermore, Ardawi et al., at 2011 concluded that; vitamin D deficiency is rather highly prevalent among both pre- and post-menopausal otherwise healthy Saudi women. The main risk factors appear to be largely attributed to obesity, poor exposure to sunlight, poor dietary vitamin D supplementation, and age. Moreover, vitamin D deficiency is associated with low BMD values at both the lumbar spine (L1–L4) and neck femur and increased bone turnover as indicated by changes in BTMs (Ardawi et al., 2011).

These results are in agreement with the results of this study, as from the subjects that were not exposed to sun, there were 80% with mild to moderate deficiency and 20% with severe deficiency. And it means that sun exposure was significantly affect and Correlate with serum level of Vitamin D in the subjects of our study. Moreover, the results showed that; 80% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in lumbar spine and 60% of subjects that were not exposed to sun were having Osteopenia according to T score value of Bone mineral density in femoral neck.

In the current study it was found that; 50% of subjects that with severe deficiency of Vitamin D were having Osteopenia according to T score value of both Bone mineral density in lumbar spine and femoral neck. However; the results showed that 75% and 50% of subjects with optimal serum level of Vitamin D have Osteoporosis according to T score value of Bone mineral density in lumbar spine and femoral neck respectively. And these results mean that there is no association between Serum total levels of vitamin D and Bone mineral density in lumbar spine and femoral neck. These results are in agreement with previous study that reported no correlation between 25OHD level and BMD at any of the sites examined. Moreover, BMD in the subgroup with severe hypovitaminosis D did not significantly differ from BMD of the rest of the cohort (Ghannam et al., 1999).

Furthermore, in this study, subjects with Osteoporosis were 100% consumed supplement of Vitamin D, 80% were exposed to sun and 60% showed optimal level of serum vitamin D. This could be due to the Obesity-associated vitamin D insufficiency as obesity decreased bioavailability of vitamin D3 from cutaneous and dietary sources because of its deposition in the body fat compartments (Vimeswaran et al., 2013, Wortsman et al., 2000).

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Table 10

Association between each of the variables and T-score BMD F.

| Variable                          | Category     | Normal | Osteopenia | Osteoporosis | p value  |
|----------------------------------|--------------|--------|------------|--------------|----------|
|                                  |              | N %    | n %        | n %          |          |
| Sun exposure                      | Yes          | 32 80  | 32 57.1    | 16 66.7      | 0.064    |
|                                  | No           | 8 2    | 24 42.9    | 8 33.3       |          |
| Supplement of vitamin D 1000 mg/day | Yes          | 28 70  | 44 78.6    | 24 100       | 0.014*** |
|                                  | No           | 12 30  | 12 21.4    | 0 0          |          |
| Age                              | 30–39 years old | 12 30 | 20 35.7    | 0 0          | 0.003*** |
|                                  | 40–49 years old | 20 50 | 16 28.6    | 12 50        |          |
|                                  | 50–59 years old | 8 20  | 20 35.7    | 12 50        |          |
| Serum total levels of vitamin D  | Severe deficiency | 8 20 | 12 21.4    | 4 16.7       | 0.005*** |
|                                  | Mild to moderate deficiency | 32 80 | 36 64.3    | 12 50        |          |
|                                  | Optimum level | 0 0    | 8 14.3     | 8 33.3       |          |
| T-score BMD F                    | Normal       | 24 60  | 8 14.3     | 0 0          | 0.000*** |
|                                  | Osteopenia   | 16 40  | 40 71.4    | 12 50        |          |
|                                  | Osteoporosis | 0 0    | 8 14.3     | 12 50        |          |

BMD L (Bone mineral density in lumbar spine).
BMD F (Bone mineral density in femoral neck).
* Chi-square test.
** P < 0.05.
*** P < 0.001.
