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# Effects of Calcium and Vitamin D Supplementation on Body Mass Index and Parathyroid Hormone in Asian Young Women

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**Abstract:** The efficacy of calcium with vitamin D supplementation for preventing obesity and maintaining normal BMI and body weight in healthy young women remains equivocal. The objective of this study was to assess the 9-weeks effects of calcium-vitamin D supplementation on body mass index, body weight and parathyroid hormone in Asian young women. For this purpose, 22 young women participated in this study. Subjects were randomly assigned to experimental group (n = 11) and control group (n = 11). The experimental group was treated with 1000 mg $day^{-1}$ calcium carbonate and 200 IU $day^{-1}$ vitamin D. The blood samples collected and BMI, body weight and body fat percentage measured at baseline and the end of the 9-weeks. The results showed that 9 weeks Ca-vitamin D supplementation decreased significantly in both PTH and Body fat percentage ($p<0.001$). No significant difference found in both BMI ($p = 0.056$) and weight ($p = 0.267$). We conclude that calcium-vitamin D supplementation may play a substantial contributing role in reducing of PTH and the incidence of obesity in Asian young women.

**Key words:** Calcium, vitamin D, BMI, PTH, Asian young women

## INTRODUCTION

It is widely recognized that obesity (defined as an excess of body fat) and obesity-related diseases are an increasing global problem now reaching epidemic proportions (WHO, 2000). The cause of obesity is multifactorial with sedentary life-style and excessive energy intake as the most important contributors (Koh-Banerjee *et al*., 2003). Because of its general use and ease of measurement, Body Mass Index (BMI) is commonly used as a surrogate measure for obesity. The World Health Organization (WHO) cut-off point for classification of obesity as a Body Mass Index (BMI) above 30 kg $m^{-2}$ is intended as an internationally useful threshold for reflecting risk for all cause mortality. It is well known that optimal intake of dietary calcium is essential for bone health, but there is accumulating evidence that the dietary intake of calcium may also play an important role in body weight regulation. Abnormal calcium metabolism has also been linked to weight gain (Zemel *et al*., 2000a) and the high calcium intake may prevent obesity (Heaney *et al*., 2002). Many epidemiological studies have identified inverse relationships between calcium intake and body weight (Manson *et al*., 1995; Stevens *et al*., 1998; Davies *et al*., 2000). For example, Lorenzen *et al*. (2006) found that habitual dietary calcium intake in young girls were inversely associated with body fat, but a low-dose calcium supplement had no effect on body weight, height, or body fat over a period of 1 year. Ian *et al*. (2005) have recently reported that calcium supplementation of 1 g $day^{-1}$ does not produce biologically significant effects on body weight. Observational data from Davies *et al*. (2000) showed significant negative associations between calcium intake and weight; a 1000 mg difference in calcium intake was associated with an 8 kg difference in body weight. Calcium intake explained 3% of the variance in body weight. They concluded that calcium intake might play an important role in weight regulation. Because the principal physiological function recognized for vitamin D is enhancing calcium absorption, it is essential for calcium uptake and bone development and remodeling. The primary source of vitamin D is conversion in the skin, via exposure to UVB radiation, of 7 dehydrocholesterol to vitamin $D_3$, which then is metabolized sequentially in the liver and kidney to its active form, 1,25-dihydroxyvitamin D (Holick, 1996). On the other hand, Clinical trials in the elderly showed that supplemental calcium and vitamin D suppress bone turnover, slow bone loss and reduce

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fracture risks (Chevalley *et al*., 1994). Parathyroid Hormone (PTH) is a calcium regulating hormone which is secreted in response to a low serum calcium level. If a low calcium and/or vitamin D intake are related to obesity, one would expect the same to be true for serum PTH. Studies have shown that PTH levels are suppressed with Ca supplementation in weight-stable women (Dawson-Hughes *et al*., 1990) or during weight loss in obese women (Ricci *et al*., 1998). Since, most societies have calcium-vitamin D intakes well below the recommended amounts and no serious study has investigated the effects of calcium intake on changes in body composition in young women. The current study investigates the effects of 9-weeks supplementation intakes, including 1000 mg day$^{-1}$ Ca and 200 IU day$^{-1}$ vitamin D, on body weight, BMI and hormonal changes in Asian young women.

## MATERIALS AND METHODS

**Subjects:** In this study twenty-two healthy young females with regular menstruation aged (26.63±3.02 years) were randomly assigned to experimental group (n = 11) and control group (n = 11). Information on medication use (including calcium-vitamin D supplementation) was determined by questionnaire. None of the subjects had any disease or had been consuming any drugs that could affect hormonal and BMI changes (Table 1).

**Treatment:** Women in the calcium-vitamin D group were instructed to take 1 tablet/d of a supplement for 9 weeks, which provided 1000 mg day$^{-1}$ Ca (calcium carbonate), 200 IU day$^{-1}$ vitamin D. All subjects was instructed to discontinue consuming non study dietary supplements 30 days before baseline testing and to report any changes in medications taken during the study. Those in the supplement group were asked to maintain their dietary patterns during the study.

**Measurements:** At baseline and after 9-weeks, the subjects met with the investigators to have their heights, weights, BMI and body fat percentage measured and to provide fasting blood. Height was measured to the nearest 0.1 cm with a fixed stadiometer (Harpenden stadiometer, Holtain, Crymych, UK) and weight was measured with a regularly calibrated electronic scale (EKS Exclusive, EKS International, sweden) in light clothing and no shoes. BMI (kg m$^{-2}$) and Body fat percentage were assessed using a (Body logic/body fat analyzer, OMRON, Fanland). All blood samples were obtained in the morning after the subjects had fasted for 12 h. Hormone was analyzed in the laboratory of the senior investigator by methods that was validated and reported previously from that laboratory (http://WWW. hopeyearmed.com). Serum PTH was measured by an Enzyme-Linked Immonosorbent Assay (ELISA) (BioSource hPTH-ELISA Kit, Biosource Europe S.A. B-1400 Nivelles. Belgium).

Table 1: Physical characteristic of subjects

| Characteristics | Ca-vitamin D group (n = 11) | Control group (n = 11) |
|---|---|---|
| Age (Years) | 26.00±2.72 | 27.27±3.32 |
| Height (Cm) | 162.73±7.73 | 157.73±5.02 |
| Weight (Kg) | 59.18±6.24 | 54.18±6.31 |
| Body fat (%) | 25.01±6.87 | 24.58±3.92 |
| BMI (Kg m$^{-2}$) | 22.47±2.99 | 21.67±2.27 |

Values are means±SD

**Statistical analysis:** Data are presented as mean ± std in the text, Table and Fig. All data were analyzed for significance of differences between the control group and the experimental group using a paired t-test. The difference between before and after exercise was also compared. A two-way ANCOVA was used to determined if significant ($p<0.05$) differences existed among the group for PTH, BMI and body fat percentage variables between before and after exercise testing. The statistical software program SPSS for windows, Version 15 was used for all data analysis.

## RESULTS

The characteristic subjects at baseline condition into two groups are presented in Table 1, along with study results for primary outcomes. The PTH concentration of

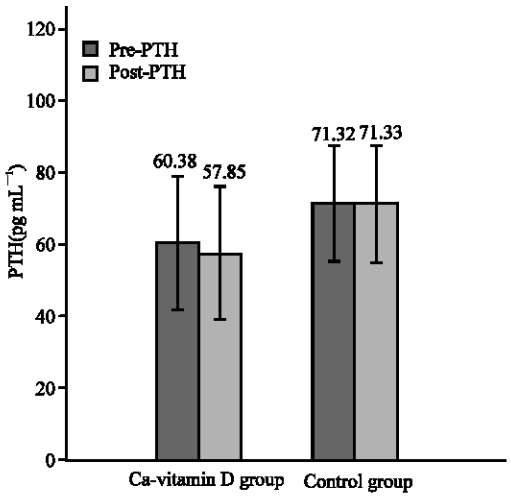


Fig. 1: Mean changes in serum concentration of parathyroid hormone (PTH) in experimental and control group pre and after 9-weeks consumption Ca-vitamin D program in young women

Table 2: Parathyroid hormone values (pg $mL^{-1}$)

| | Baseline (Mean±SD) | Week 9 (Mean±SD) | Paired t-test (Sig) | ANCOVA |
|---|---|---|---|---|
| Ca-vitamin D supplementation (n = 11) | 60.38±17.52 | 57.85±18.35* | 0.001* | 0.119 |
| Control (n = 11) | 71.32±16.14 | 71.33±16.23 | 0.942 | |

Comparison mean changes in serum concentration of parathyroid hormone (PTH) in experimental and control group pre and after 9-weeks consumption Ca-vitamin D program in young women were determined by using Paired t-test. Comparison significance different between groups after 9-weeks consumption Ca-vitamin D program in young women was determined by using the ANCOVA test. * $p<0.05$

Table 3: Body Mass Index values (Kg $m^{-2}$)

| | Baseline (Mean±SD) | Week 9 (Mean±SD) | Paired t-test (Sig) | ANCOVA |
|---|---|---|---|---|
| Ca-vitamin D supplementation (n = 11) | 22.47±2.99 | 22.29±2.96 | 0.056 | 0.095 |
| Control (n = 11) | 21.67±2.27 | 21.74±2.31 | 0.451 | |

Comparison mean changes in Body mass index (BMI) in experimental and control group pre and after 9-weeks consumption Ca-vitamin D program in young women were determined by using Paired t-test. Comparison significance different between groups after 9-weeks consumption Ca-vitamin D program in young women was determined by using the ANCOVA test. * $p<0.05$

Table 4: Body fat percentage values (%)

| | Baseline (Mean±SD) | Week 9 (Mean±SD) | Paired t-test (Sig) | ANCOVA |
|---|---|---|---|---|
| Ca-vitamin D supplementation (n = 11) | 25.01±6.87 | 24.07±6.74 | 0.001* | 0.014 |
| Control (n = 11) | 24.58±3.92 | 24.88±4.07 | 0.590 | |

Comparison mean changes in Body fat percentage values (%) in experimental and control group pre and after 9-weeks consumption Ca-vitamin D program in young women were determined by using Paired t-test. Comparison significance different between groups after 9-weeks consumption Ca-vitamin D program in young women was determined by using the ANCOVA test. * $p<0.05$

Table 5: Body weight values (Kg)

| | Baseline (Mean±SD) | Week 9 (Mean±SD) | Paired t-test (Sig) | ANCOVA |
|---|---|---|---|---|
| Ca-vitamin D supplementation (n = 11) | 59.18±6.24 | 58.82±6.19 | 0.267 | 0.533 |
| Control (n = 11) | 54.18±6.31 | 54.27±6.28 | 0.676 | |

Comparison mean changes in Body weight (kg) in experimental and control group pre and after 9-weeks consumption Ca-vitamin D program in young women were determined by using Paired t-test. Comparison different significance between groups after 9-weeks consumption Ca-vitamin D program in young women was determined by using the ANCOVA test. * $p<0.05$

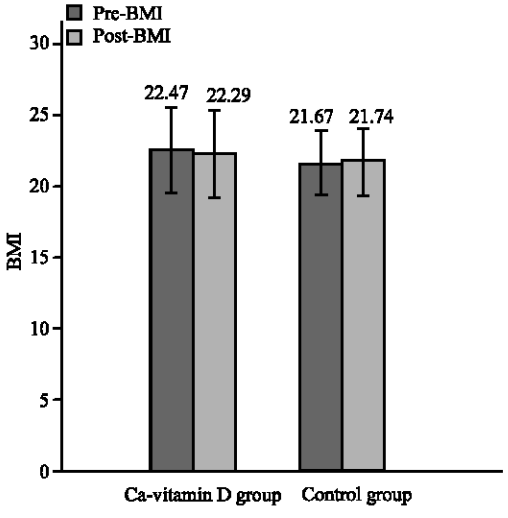


Fig. 2: Mean changes in BMI (kg $m^{-2}$) in experimental and control group pre and after 9-weeks consumption Ca-vitamin D program in young women

the Ca-vitamin D group indicated significant difference ($p = 0.001$) after 9-weeks and changes were interpreted by using ANCOVA trial which that this PTH concentration of the Ca-vitamin D group had decreased in comparison to the control group but no had significant difference between groups ($p = 0.119$) (Table 2 and Fig. 1). Mean values for BMI, showed a non significant trend reduced from baseline levels after 9 weeks for Ca-vitamin D group ($p = 0.056$). No significant differences between groups were found at any time point ($p = 0.095$) (Table 3 and Fig. 2). Analysis of paired t-test and ANCOVA on body fat percentage showed significant decreased after 9-weeks ($p = 0.001$) but no significant difference found in comparison to the control group ($p = 0.095$), (Table 4 and Fig. 3). Analysis of paired t-test and ANCOVA on weight change in the pooled data also showed no statistically significant differences between pre and post-test ($p = 0.267$) and control group ($p = 0.533$) (Table 5 and Fig. 4).

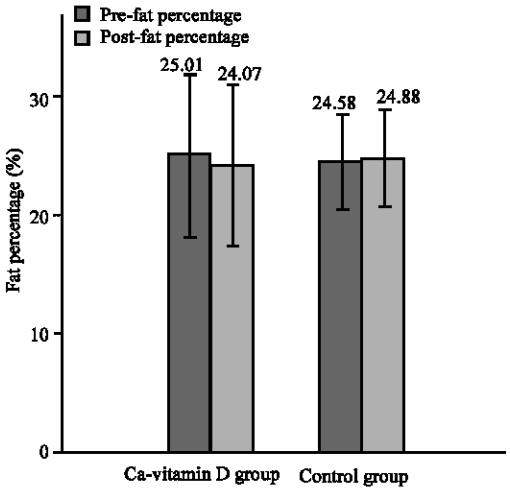


Fig. 3: Mean changes in Body fat percentage (%) in experimental and control group pre and after 9-weeks consumption Ca-vitamin D program in young women

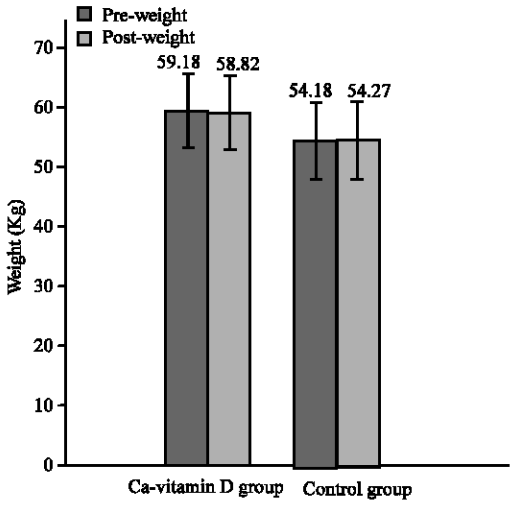


Fig. 4: Mean changes in weight (kg) in experimental and control group pre and after 9-weeks consumption Ca-vitamin D program in young women

## DISCUSSION

This study was designed to examine the efficacy of Ca-vitamin D supplementation, given as Ca-vitamin D in a single dose of 1000 mg day$^{-1}$ Ca and 200 IU day$^{-1}$ vitamin D, in maintaining normal BMI, body weight and body fat percentage in the young period. The important findings of the present study are that a daily of 1000 mg day$^{-1}$ calcium and 200 IU day$^{-1}$ vitamin D supplements does not reduce body mass index, but reduce body fat percentage and PTH concentration in young women. However, we confirmed the previously reported inverse association between habitual intake of dietary calcium and BMI. Zemel has commented that, in his 1990 study of hypertensive blacks, he observed substantial weight loss with calcium supplementation but did not report it because it did not seem to fit with what was known either about calcium metabolism or about obesity. However, the same investigator has recently shown that high blood PTH and 1,25$(OH)_2$ vitamin D levels, as would be evoked by a low calcium diet, increase cytosolic ($Ca^{2+}$) in human adipocytes in culture, switching their metabolism from lipolysis to lipogenesis (Zemel, 1998; Zemel *et al*., 2000a, 2000b). Chan and McNaught. (2001) found that increasing intake of dairy calcium by 400 mg day$^{-1}$ prevented fat gain during a period of 6 month in comparison to a control group of children who consumed their habitual diet. Lappe *et al*. (2004) examined the effect of high calcium intake on body weight and body composition in 9 year old girls randomly assigned either to a diet with a high content of calcium-rich foods. No difference in increase in body weight, height, or fat mass was observed between the 2 groups. The results of those studies all indicate that calcium has either no effect or that it has a positive effect on body weight and body composition. The present study differs from earlier studies in that we used calcium (1000 mg day$^{-1}$) with vitamin D (200 IU day$^{-1}$) supplementation according to dose recommended WHO for aged 20-35 years. Results shown, BMI didn't have any significant changes after 9 weeks. As the decrease was equaled 0.8% and so, didn't have any significant changes in the control group. In our study, Body fat percentage significantly decreased after 9 weeks consumption Ca-vitamin D. As the decrease was equaled 3.9% and also, didn't have any significant changes in the control group. After 9-weeks weight had decreased equaled 0.61% in Ca-vitamin D group, but no had significant difference. In agreement with the present study few intervention studies have examined the effect of a calcium supplement on body weight changes in adults. Some studies reported that calcium supplementation has no effect on body weight and body composition (Reid *et al*., 2002; Shapses *et al*., 2004). Jensen *et al*. (2001) found that 1000 mg calcium supplement made no difference to weight changes over a 3 month period in a randomized controlled trial of 62 obese women given low energy diets. All of these studies are small and are underpowered to detect small effects on weight that may still be of biological significance. However, taken together with the present study, they suggest that calcium supplementation holds little promise as a strategy for weight control. Furthermore, in a trial in

young women carried out by Teegarden *et al.* (1999), subjects with a high calcium intake had less fat tissue and failed to gain weight and in a study in young children, Skinner *et al.* (1999) found that dietary calcium had a negative relation to body fat mass. A possible mechanism to explain why calcium was a significant factor in predicting body fat (%) of young women in this study has been studied in transgenic mice and in human adipocytes. Using in vitro analysis, human adipocytes responded to both 1,25-$(OH)_2$-D and parathyroid hormone with does responsive increases in intracellular $Ca^{2+}$. As we know that low $Ca^{2+}$ diets increased adipocyte intracellular $Ca^{2+}$ while higher $Ca^{2+}$ diets suppress the calcitropic hormone response. The increased dietary calcium reduced intracellular $Ca^{2+}$ and decreased triacylglycerol accumulation through increased lipolysis (Zemel *et al.*, 2000a). Vitamin D is important for the intestinal absorption of calcium and the mechanism whereby a high intake of vitamin D could prevent weight increase should therefore theoretically be identical to that discussed above for calcium. However, this is not the case because we have found opposing effects of calcium and vitamin D intakes, in young women. On the other hand, results of the present investigation showed that PTH significant decreased after 9-weeks consumption Ca-vitamin D. In the form that the decrease was equaled 4.37% and so, concentration of PTH didn't have any significant changes in the control group. Lind *et al.* (1993) found no relation between BMI and PTH, but demonstrated a significant negative correlation between ionized calcium and BMI. Since, Brown (1991) demonstrated PTH is one of the crucial factors up-regulating ionized calcium, the absence of an association between PTH and BMI in the presence of a negative association between the latter and ionized calcium is surprising. Also, they found a positive relation between the ratio of total to ionized calcium and BMI. Kamycheva *et al.* (2004), reported serum PTH, adjusted for age, physical activity and serum calcium, is positively associated with BMI in both sexes and serum PTH is an independent predictor of obesity in their statistical model. Finally, results this study shows that daily consumption Ca-vitamin D supplementation can reduce of body fat percentage, weight, BMI and PTH.

## CONCLUSION

In conclusion, results this study suggested that daily consumption Ca-vitamin D supplementation according to dose recommended WHO for aged 20-35 years can development of body fat percentage, weight, BMI and PTH. And support this idea Ca-vitamin D intakes in the Asia may greatly contribute to reducing the growing epidemic of obesity in young women.

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