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An increase in body mass index and vitamin D increases fasting insulin levels which further correlates with ferritin levels

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Abstract
Introduction: Although obesity, particularly visceral obesity is associated with insulin resistance (1), the mechanism by which adipose tissue modulates insulin sensitivity is controversial. Increase in body mass index has been reported to increase insulin level and ferritin at the iron stores. Vitamin D has also been found to influence insulin secretion insulin secretion and ferritin at the iron stores.
Objectives: Analysis of variance (ANOVA) of vitamin D and body mass index on fasting insulin was done to understand their influence on insulin level.
Materials and methods: Four groups were formed including low vitamin D-low body mass index (X1), low vitamin D-high body mass index (X2), high vitamin D- low body mass index (X3) and high vitamin D-high body mass index (X4). In the high vitamin D - high body mass index group there was marked increase in fasting insulin. Calculated F - ratio for Analysis of variance showed a value of 6.48 which was much higher than the table value of 2.76. Mean differences of two ANOVA pairs were found to be significantly different (X1 - X4 and X3 - X4). In this study, the groups X1 and X4 were further analyzed and compared. Insulin and ferritin was found to have a positive correlation in group X4, X1 - X4 and in the total sample (all four groups).
Result: The results showed that increase in vitamin D and body mass index increases fasting insulin level and ferritin at the iron stores. The standard deviation of fasting insulin was almost 50% of mean in group X4 and the standard deviation of ferritin was more than the mean ferritin in X4 groups.
Conclusion: These results showed that vitamin D and body mass index increases fasting insulin level and ferritin at iron stores.

Keywords: vitamin D, insulin, body mass index, ferritin

Introduction

Bone metabolism is found to be altered in both type 1 and type 2 diabetes. Increased blood sugar levels decrease the levels of markers of bone turnover. The relationship between diabetes mellitus and osteoporotic fractures is well established [1]. A decrease in bone mineral density and (BMD) and an increased risk of osteoporotic hip and other fractures are seen in association with type 1 diabetes mellitus [3,4]. Though there is no reduction in BMD with type 2 diabetes mellitus, some patients shows an increased risk of fractures of approximately 1.5 fold at the hip, proximal humerus, forearm, and foot [4, 6], suggesting that there may be bone fragility that is not defined by BMD. Therefore, detecting osteoporosis much earlier to prevent osteoporotic fractures is important. This study is towards that direction to clinically understand factors that influence bone turnover.

The continuous remodeling of bone is achieved and regulated through the action of various systemic hormones including vitamin D. The endocrine action of vitamin D includes the maintenance of mineral and skeletal homeostasis. An optimal level of 25(OH)D level of at least 30 to 32 ng/mL (75-80 nmol/L) is required for maintaining normal bone metabolism[7, 8].Vitamin D may have a beneficial effect on insulin action either directly by stimulating the expression of insulin receptors an thereby enhancing insulin responsiveness for glucose transport [9] or indirectly via its role in regulating extracellular calcium and ensuring normal calcium influx through cell membrane and an adequate intracellular cytosolic calcium pool because calcium is essential for insulin-mediated intracellular process in insulin responsive tissue such as skeletal muscle an adipose tissue [10]. Insulin resisstance is also associated with systemic inflammation but for the βcell dysfunction elevated cytokine found to play a key role. By directly modulating the generation and effects of these cytokines, vitamin D could improve insulin sensitivity.

After BMI serum ferritin is the second strongest determinant of blood glucose and after BMI and age it is the third stongest determinant of serum insulin. Some studies have shown that serum ferritin can be used as a marker of insulin resistance [11]

In this study, we are analysing the influence of vitamin D and BMI on fasting insulin levels in individuals over 18 years of age. BMI is known to increase insulin resistance through cytokines originating from adipose tissue. But the influence of vitamin D on insulin over and above the influence of BMI is evaluated in this study.

Aim and objectives
In this study, we propose to evaluate the influence of vitamin D over and above the influence of BMI on serum fasting insulin.

a. Analysis of variance of the influence of vitamin D and BMI on fasting insulin will be evaluated.
b. The total sample will be divided in to lower and higher vitamin D groups. Each of these groups was further divided in to low and high BMI groups.
c. The results obtained will be further analyzed by correlation with ferritin.

Materials and methods
The sample were collected from individuals below 30 years of age..For this work, serum samples was prepared from 10 ml of fasting blood collected from donors who have fasted over night. Serum samples were collected by observing routine precautions for venipuncture. The sample was allowed before centrifugation. Then centrifuged for five minutes at 3000 rpm. Within two hours after centrifugation, transferred atleast 500 µL of cell free sample to a storage tube.
Vitamin D was estimated using a Competitive immunoassay (Liaison Immunochemistry auto analyser from Diasorin, Italy). Serum fasting insulin was estimated using Sandwich or immunometric immune assay (Beckman Coulter Access 2 Immunochemistry Analyser). Serum ferritin was estimated by enzyme immuno assay (Beckman Coulter Access 2 Immunochemistry Analyser). Finally the BMI was calculayed using the formula BMI = weight in kg/ height in m^2 The analysis of variance (ANOVA) of fasting serum insulin under the influence of vitamin D and BMI were examined followed by analysis of correlation coefficient.

Result and discussion
Individuals were grouped in to two groups, low and high vitamin D. In these two groups vitamin D concentration was 12.78±3.21 and 31.72±9.9 respectively. These two groups were further divided into low and high BMI groups, resulting in four groups. Lowest BMI was observed in low vitamin D low BMI group (BMI=18.64±1.24) and highest BMI was obtained in high vitamin D and high BMI (BMI=26.54±2.25). In the low vitamin D low BMI group fasting insulin was 4.84±1.49, in the high vitamin D high BMI fasting insulin was 10.44±5.29. These results showed that in the high vitamin D group BMI was higher and in high vitamin D high BMI group fasting insulin was higher. The mean fasting insulin is plotted in figure 1.
Analysis of variance of fasting insulin under the influence of BMI and vitamin D were analyzed. The F-ratio obtained was 6.48 and was higher than the table value. These results showed that the fasting insulin in the four groups were significantly different. The mean insulin value in the four groups were compared, this resulted in six combinations. The significant difference was obtained from Q-test and was found to be 3.88. There were two groups, X1(low vitamin D-low BMI) and X4(high vitamin D-high BMI); X3(high Vitamin D-low BMI) and X4(high vitamin D-high BMI) that had mean differences higher than the significant difference. Of these two significant different pairs X1 and X4 were further analyzed to understand the causes and influence of low and high vitamin D and BMI.
Another study showed that vitamin D and BMI significantly influences serum ferritin levels. Serum ferritin levels are also related to insulin resistance. Therefore we analyzed the X-Y scatter and correlation of ferritin and fasting insulin in the X1 and X4 groups. There was a positive and a significantly increased correlation of 0.512 was obtained, showing that there is a direct relationship of vitamin D and BMI with insulin and ferritin seen by Analysis of variance. And there is also a relationship between ferritin and insulin seen by correlation (fig.2).
Fasting insulin in the groups X1 and X4 were plotted as a scatter diagram (fig.3). The mean fasting insulin and standard deviation in these two groups were calculated. Mean fasting insulin in group X4 is more than two times than in group X1and the standard deviation is more than three times. Standard deviation of fasting insulin in group X4 is more than 50% of mean and this is seen in the scattering of fasting insulin in group X4 (fig.3).
Ferritin levels were analyzed in group X1 and X4. Mean ferritin was almost five times in group X4 when compared to group X1. The standard deviation in group X4 is more than five times that in group X1, and is almost equal to the mean value. This large variation of ferritin in group X4 is seen in fig.4. The results in table 7 and 8 showed that in individuals with increased BMI and vitamin D there is increase in fasting insulin level and there is increase in ferritin. Increased vitamin D and BMI may have a cumulative effect on increasing ferritin at the iron stores.
The correlation between fasting insulin and ferritin was also examined in group X4 (fig.5). There was a positive and significant correlation between fasting insulin and ferritin in group X4. The correlation was 0.345 and this was much less than the correlation in group X1 and X4.
The X-Y scatter of the correlation between fasting insulin and ferritin in all the four groups (total sample) was evaluated (fig.6). There was a significant and a high positive correlation coefficient of 0.669. These results showed that there is a relationship between fasting insulin and ferritin even without grouping by vitamin D, BMI. The relationship may be secondary to increase in BMI and increase in vitamin D, both of which are known to increase fasting insulin and ferritin.
As the group studied were low vitamin D-low BMI (X1) and high vitamin D-high BMI (X4), it may be expected that fasting insulin may correlate with the level of viatmin D. Vitamin D was also reported to increase insulin secretion. In another study vitymin D

was found to correlate with increase in BMI which increase fasting insulin resistance. When X-Y scatter of the correlation between vitamin D and fasting insulin was done, there was a positive correlation and the correlation coefficient was 0.58 (fig7). The correlation was also found to be significant. These result showed that fasting insulin correlates with vitamin D and BMI.

In conclusion it may be stated that vitamin D and BMI increase fasting insulin and ferritin at the iron storage sites. It is not clear from these observations whether insulin or vitamin D plays a role in increase of ferritin at the iron stores.

Tables and figures

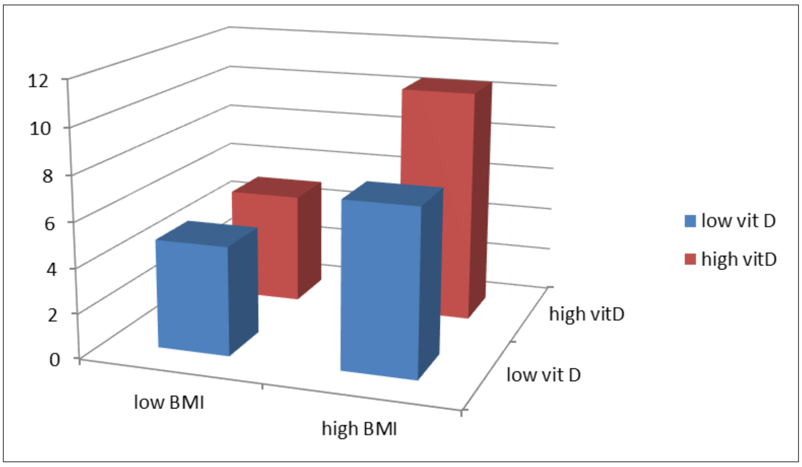

Fig 1: Mean fasting insulin in high and low vit D groups which were further divided into high and low BMI.

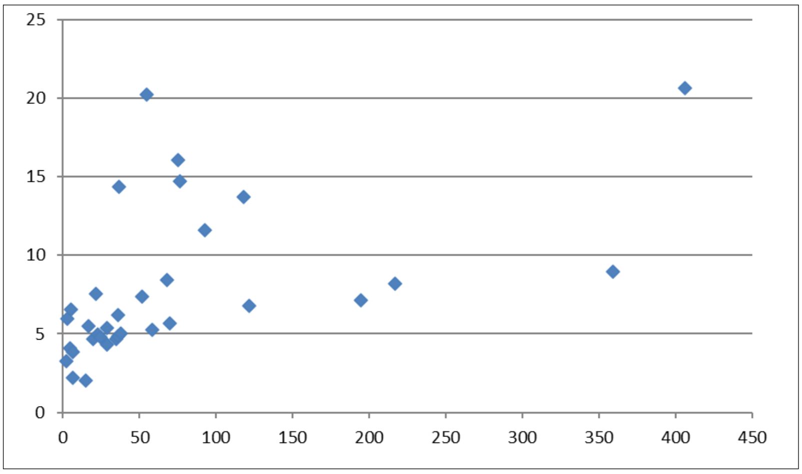

Fig 2: X-Y scatter of the correlation between ferritin and fasting insulin (X1 - X4 group)

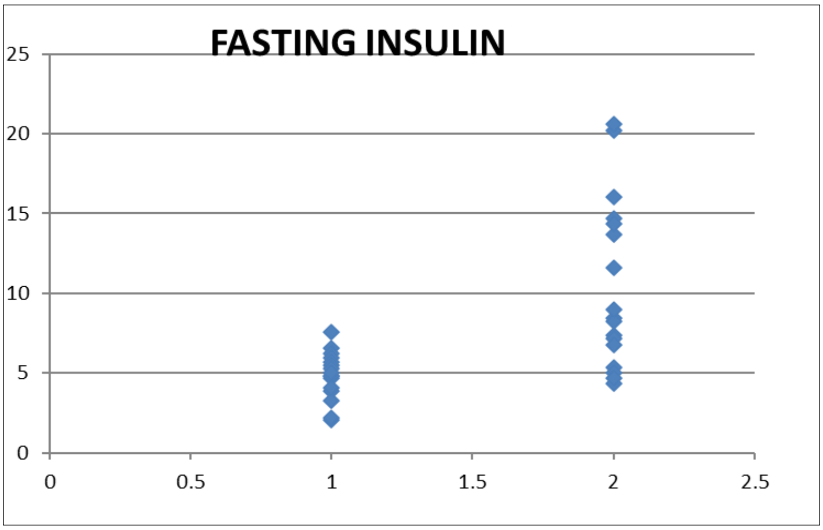

Fig 3: Fasting insulin levels in low vit D low BMI and high vit D high BMI groups

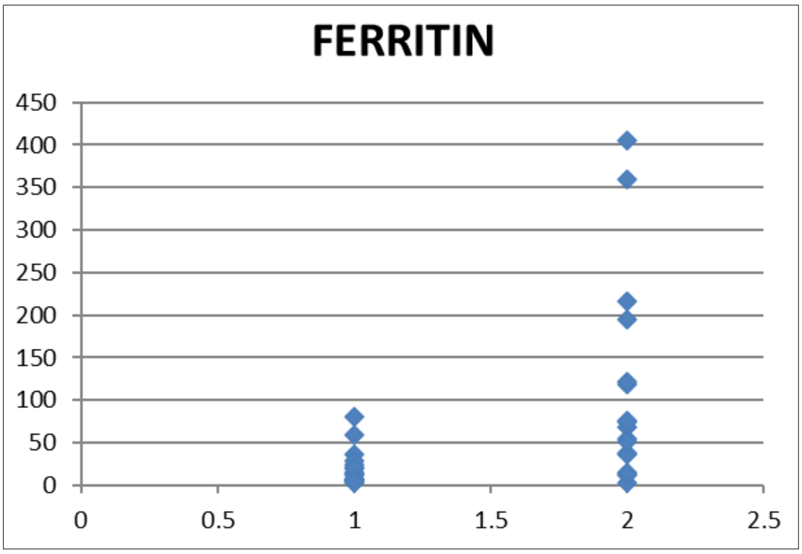

Fig 4: Ferritin levels in low vit D low BMI and high vitamin D high BMI groups (X1-X4).

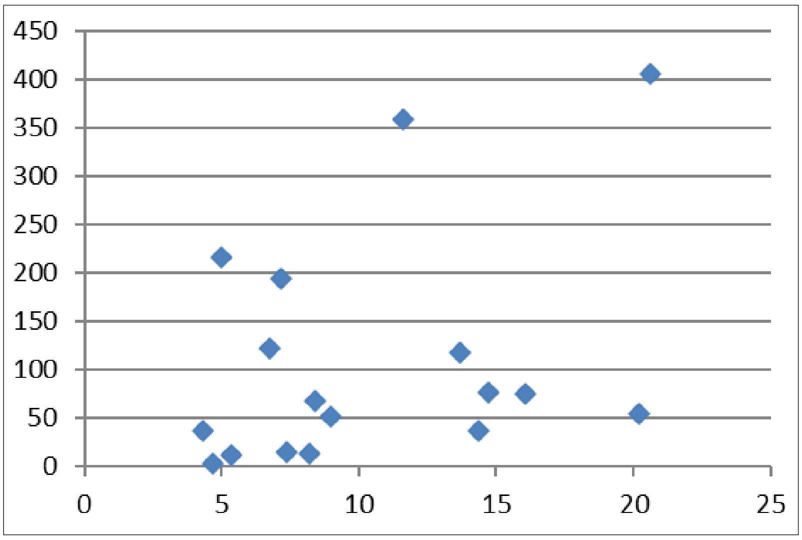

Fig 5: X-Y scatters of the correlation between Fasting insulin and ferritin (X4)

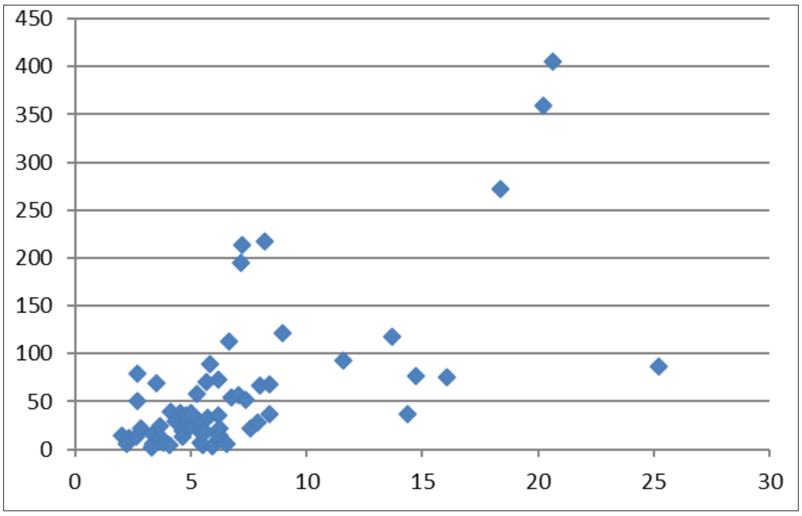

Fig 6: X-Y scatter of the correlation between insulin and ferritin in all the 4 groups**.**

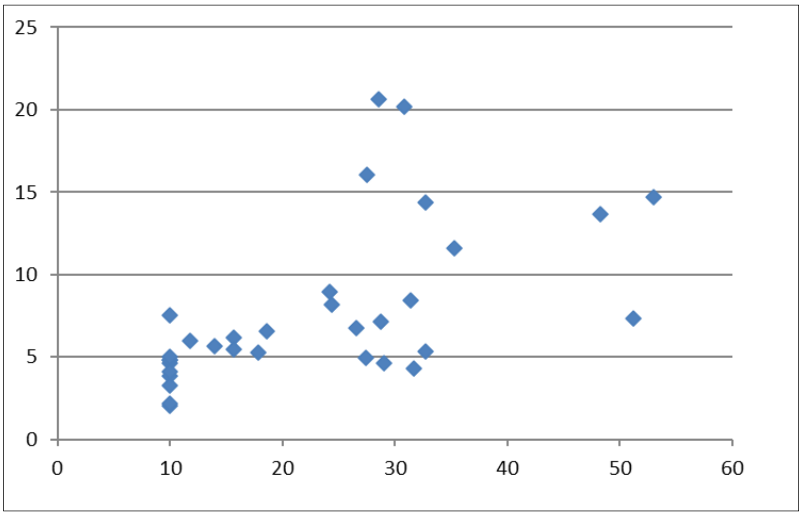

Fig 7: X-Y scatter of the correlation between Vitamin D and Fasting insulin in X1-X4 group.

Conclusion

Increase in BMI has been reported to increase ferritin at the stores and increase insulin resistance. Vitamin D has also been found to influence fasting insulin levels and ferritin at the iron stores. Analysis of variance of vitamin D and BMI on fasting insulin was done to understand their influence on insulin. In the high vitamin D-high BMI group (X4 group) there was marked increase in fasting insulin. These results showed that vitamin D and BMI increases fasting insulin and ferritin at iron stores. Thus Vitamin D which is a regulator of bone and mineral metabolism is also a potent immunomodulator which i linked to severalhuman diseases including diabetes and osteoporosis. The study showed that elevated vitamin D independeneltly elevate serum fasting insulin levels. Further there is a need for randomized trials to evaluate the significant effects of vitamin D supplementations in insulin resistance and also bone health.

References

1. Yamashita S, Nakamura T, Shimomura I, Nishida M, Yoshida S, Kotani K *et al*. Insulin resistance and body fat distribution. Diabetes Care,1996:19:287-291.
2. Rakel A, Sheehy O, Rahme E, LeLorier J. Osteoporosis among patients with type 1 and type 2 diabetes. Diabetes Metab,2008:34:19-205.
3. Ivers RQ, Cumming RG, Mitchell P, Peduto AJ. Blue Mountains Eye Study. Diabetes and risk of fracture: the Blue Mountains Eye Study. Diabetes Care,2001:24:1198-1203.
4. Vestergaard P. Discrepancies in bone mineral density and fracture risk in patients with type 1 and type 2 diabetes: a meta-analysis. Osteoporos Int,2007:18:427-444.
5. Lipscombe LL, Jamal SA, Booth GL, Hawker GA. The risk of hip fractures in older individuals with diabetes: a population-based study. Diabetes Care,2007:30:835-841.
6. Strotmeyer ES, Cauley JA, Schwartz AV, Nevitt MC, Resnick HE, Bauer DC *et al*. Nontraumatic fracture risk with diabetes mellitus and impaired fasting glucose in older white and black adults: the health, aging, and body composition study. Arch Intern Med,2005:165:1612-1617.
7. Bischoff-Farrari H, Dietrich T, Orav E. Higher 25-hydroxyvitamin D concentrations are associated with better lower extremity function in both active and inactive persons aged over 60 y. Am J Clin Nutr,2004:80:752-758.
8. Bischoff-Farrari H, Dietrich T, Orav EJ, Dawson-Hughes B. Positive association between 25-hydroxy vitamin D levels and bone mineral density; a population-based study of younger and older adults. Am J Med,2004:116:634-639.
9. Maestro B, Campi´on J, avila ND, Calle C. Stimulation by 1,25-dihydroxyvitamin D3 of insulin receptor expression and insulin responsiveness for glucose transport in human promonocytic cells. Endocrine Journal,2000:47: 4:383-391.
10. Williams PF, Caterson ID, Cooney GJ, Zilkens RR, Turtle JR. High affinity insulin binding and insulin receptor-effector coupling: modulation by Ca2+. Cell Calcium,1990:11(8):547-556.
11. Fernandez-Real JM, Ricast-Engel W, Arrovo E, Balanca R, Casamit jana-Abella *et al*. Serum ferritin as a component of insulin resistance syndrome. Diabetic care,1998:21(1):62-8.
12. Fernandez-Real JM, Ricast-Engel W, Arrovo E, Balanca R, Casamit jana-Abella, Cabreso R *et al*. Serum ferritin as a component of insulin resistance syndrome. Diabetic care,1998:21(1):62-8.