ORIGINAL ARTICLE

Association between Obesity and Low Serum Vitamin D Concentrations in Healthy Adult Females: A Public Health Perspective

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ABSTRACT:
Objective: To find out the association between obesity and low serum vitamin D concentrations among females.
Materials and Methods: This cross sectional study was conducted in females aged 20-45 years reporting to dietitian and family OPD of PNS Shifa Hospital from September 2014 to January 2015. Three forty seven females underwent physical examination for anthropometric data. Weight was measured using weight scale. Height was recorded using wall mounted stadiometer in erect position without shoes. BMI was calculated by weight in kilogram (kg) divided by height in square meter (m^2). Waist was recorded by placing measuring tape at midpoint of upper border of iliac crest and lower margin of last palpable rib (WHO STEPS protocol). Serum Vitamin D level was measured by electro-chemiluminiscence immunoassay.
Results: Mean serum vitamin D level was significantly lower among over weight (≥18.5-24.9 kg/m^2) and obese females(≥30 kg/m^2) as compared to normal weight (≥18.5-24.9kg/m^2) and underweight category (≤ 18.49 kg/m^2). Univariate regression analysis for BMI and age showed every 1 kg/m^2 increase in BMI associated with 0.61 nmol/l decrease in serum vitamin D levels. It also showed that every one year increase in age decreased 0.22 nmol/l of serum vitamin D level. Multivariate regression analysis was performed to control the effect of age and demonstrated only significant association with BMI. Pearson correlation showed that serum vitamin D level was inversely related to both BMI and waist circumference
Conclusion: Vitamin D level was low among overweight and obese females and showed an inverse association with BMI and waist circumference.
Keywords: Association, Females, Obesity, BMI, Waist circumference, Low serum vitamin D

INTRODUCTION:

Obesity is an emerging public health issue; there is continuous increase in burden of obesity all over the world. According to Global Burden of Disease Study 2013, worldwide 3.9%of years of life lost, 3.4 million deaths and 3.8% of disability-adjusted life-years(DALYs)are attributable to obesity.[1]InWHO International classification, obesity is measured by simple mathematical calculation using BMI.[2]Obesity is significantly contributing towards double burden of disease in developing country like Pakistan. It is adding to existing burden of under nutrition and infectious diseases which are already prevalent in developing and low income countries and there is rapid surge in obesity related health issues.[3]

According to data of National Health survey of Pakistan prevalence of obesity is reported to be higher in females, 14 % in rural area as compared to 37 % in urban area while in males it is 9 % versus 22% in rural and urban area respectively.[4]

In past few years several evidences have supported a possible association between obesity with low vitamin D levels.[5]Obesity is associated with increased risk for vitamin D deficiency.[6]Despite significant association between obesity and vitamin D[7] levels there is dearth of literature in this regard in our part of world. Several studies conducted in Western population[8, 9] and Pakistani immigrants[10] residing there have showed inverse relationship between obesity and low vitamin D levels. However, limited data is available in this regard in indigenous Pakistani population. Moreover owing to ethnic differences in nutritional status and vitamin D metabolism these results cannot be generalized to indigenous Pakistani population. Present study aims to find out the association between obesity and low vitamin D levels in healthy females.

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MATERIALS AND METHODS:

This cross sectional study was conducted on females of age 20-45 years reporting to dietitian and family OPD of PNS Shifa Hospital. Study duration was from September 2014 to January 2015. Inclusion criteria for study participants included disease free healthy females with no underlying co-morbid condition or inherited chronic disease that could affect vitamin D metabolism. Exclusion criteria included females with syndromal

obesity, pharmacotherapy for obesity, taking vitamin D or other supplements. A sample size of 368 was calculated, using 5% level of significance,margin of error as 5% and expected prevalence of 60%. Total three sixty eight females fulfilled the eligibility criteria and out of these twenty one females were not willing to participate and were therefore excluded while rest of three forty seven females were subjected to physical examination in order to obtain anthropometric data. Weight was measured using weight scale. Height was recorded using wall mounted stadiometer in erect position without shoes. BMI was calculated by equation taking weight in kilogram(kg) divided by height in square meter (m^2). Under weight is graded as BMI ≤18.49kg/m^2, BMI ≥ 18.5 – 24.9 kg/m^2 is considered as normal weight, Overweightis categorized as BMI 25 –29.9kg/m^2 and BMI ≥ 30 kg/m^2 is taken for obese. Waist circumference as per Asian cut off for females <80cm and hip circumference < 90 cm is taken as normal Waist was recorded by placing measuring tape at midpoint of upper border of iliac crest and lower margin of last palpable rib as per standardized WHO STEPS protocol.Serum Vitamin D levels were measured by using electro-chemilumniscence immunoassay methodology. Vitamin D level is considered as sufficient if it was >75 nmol/l, between 50 -75 nmol/l is taken as desirable and < 50 nmol/l is graded as deficient.[11]

Statistical analysis: Data was analyzed using statistical package for social sciences (SPSS) version 20.0.Descriptive statistics were used to calculate mean and standard deviation for weight, height, BMI, waist and hip circumference. ANOVA was applied to find mean difference of vitamin D level across different BMI categories.Pearson correlation was used to find the correlation of anthropometric variables with vitamin D levels. Univariate regression analysis was done taking vitamin D level as dependent variable. Multivariate regression analysis was performed to control for confounding effect of age. P value less than 0.05 was taken as significant.

RESULTS:

Socio demographic characteristics of study participants are shown (Table 1). Mean age of study participants was 45.31 ± 6.43.Mean BMI level of study participants were 27.14 ± 4.16. Comparison of mean serum Vitamin D level across four BMI categories showed that mean serum vitamin D level was significantly lower among overweight(≥ 18.5-24.9 kg/m^2) and obese females(> 25 kg/m^2) than the normal weight (18.5-24.9 kg/m^2) and underweight category(≤ 18 kg/m^2) (Table 2). Univariate regression analysis for BMI and age showed that every 1 kg/m^2 increase in BMI was associated with 0.61 nmol/l decrease in serum vitamin D level. This also showed that every one year increase in age decreased serum 0.22 nmol/l vitamin D level (Table 3a). Multivariate regression analysis was performed to control the effect of age which demonstrated only significant association with BMI and age showed no significant association in this model (Table 3b).Pearson correlation was calculated and it was found that serum vitamin D level was inversely related to both BMI and waist circumference however association was stronger with waist circumference as compared to BMI(Table 4, Figure 1)

Table: 1
Baseline characteristics of the study population
N=347

Variable	Mean	Standard deviation
Age (years)	45.31	6.43
Height (cm)	159.13	5.45
Weight (kg)	69.76	6.75
BMI (kg/m^2)	27.14	4.16
Vitamin D level (nmol /l)	41.34	7.13

Table: 2
Mean vitamin D levels in BMI categories (Normal)
N=347

BMI(kg/m^2)	Mean ± SD Vitamin D levels	95% CI	ANOVA p value
≤18.49	32.5 ± 8.6	24.8-38.2	13.4
18.5-24.9	56.3 ± 7.5	29.3-45.5	0.001
25-29.9	29.2± 5.5	15.6-26.3	
≥30	12.6 ± 4.3	10.1-16.3	

Table: 3a
Univariate regression analysis of vitamin D level (as dependent variable) with BMI and age
N=347

Variable	B coefficient	Standard error	95% CI	P-value
BMI	-0.61	0.08	-0.76-0.55	0.001
Age	-0.22	0.06	0.02-0.21	0.04

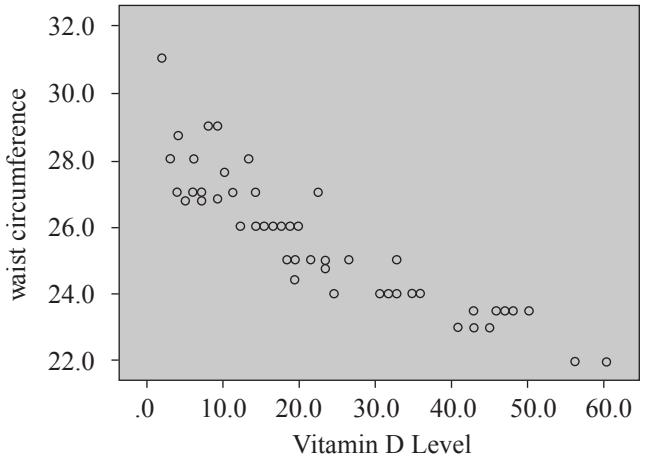
Table: 3b
Multivariate regression analysis of vitamin D level (as dependent variable) with BMI and age
N=347

Anthropometric levels	Vitamin D Levels	
	Pearson coefficient(r)	P value
BMI	-0.113	0.03
Waist circumference	-0.892	0.001

Table: 4
Correlation between anthropometric measures and vitamin D levels
N= 347

Variable	B coefficient	Standard error	95% CI	P-value
BMI	-0.63	0.06	-0.43-0.21	0.001
Age	-0.09	0.07	0.01-0.19	0.09

Figure: 1
Negative correlation between vitamin D levels and waist circumference



DISCUSSION:

Globally many regions are in the phase of rapid nutritional and epidemiological transition which accounts for increase burden of obesity related diseases.This nutritional transition is characterized by change in trends of traditional staple diet to higher calorie energy dense food which is predisposing towards increase in prevalence of obesity.[10]

According to report of World Health Organization (WHO) on Global burden of obesity, overall obesity prevalence is almost doubled up between 1980 and 2013, however prevalence in male has increased from 28.8 to 36.9%, while in females increase from 29.8% to 38% is observed.[11]However, it is predicted that by 2025 number of deaths can be reduced to 20% by targeting underlying major risk factors[12,13].This situation definitely warrants the in depth research to indentify all underlying modifiable risk factors to halt this global epidemic and to make effective strategies for future prevention find out modifiable.

We examine the relationship between vitamin D levels and obesity. Vitamin D deficiency is a critical public health issue and considered as unrecognized epidemic all over the world.[14,15,16]National Nutrition Survey of Pakistan reported prevalence of vitamin D deficiency around 46% among the urban dwellers.[17]

Results of our study have demonstrated low vitamin D concentration in overweight and obese individuals as compared to normal weight healthy disease free individuals. Several epidemiological studies have demonstrated negative association of obesity and vitamin D levels.[18,19]Report of recent meta- analysis on association between anthropometric state with vitamin D deficiency has reported that prevalence of vitamin D deficiency was more among overweight and obese individuals as compared to normal weight individuals.[20] The precise mechanism of vitamin D deficiency in obese individual is not known.However,it is hypothesized that vitamin D is sequestered in higher concentration in fat cells of obese individual resulting in decrease bioavailability of vitamin D and increase oxidative reactions within adipose tissues.[21]High fat content is responsiblefor sequestration of vitamin D in fat cells which act as reservoir for fat soluble vitamin resulting in decrease release of vitamin D from fat.[22]

On finding the correlation between obesity indices and vitamin D level it was found that waist hip ratio showed more strong inverse relationship as compare to BMI .Possible explanation can be that BMI assess obesity in term of body weight and height of an individual. It is an index for calculation of excessive body weight but it fails to demonstrate that whether this excessive weight is due to increase muscle mass or increased body fat. It does not provide accurate measurement of body fat.[22, 23]On the contrary waist circumference provide direct estimation of obesity in comparison to BMI.Results of recent randomized control trial conducted in Saudi females showed that effect of vitamin D supplementation on vitamin D deficient obese women had greater reduction in waist circumference as compared to other anthropometric variables.[24]

Similar results are supported by randomized trial on Chinese females which studied the effect of vitamin D supplementation on different anthropometric indices and have demonstrated that vitamin D supplementation in obese females had greater reduction in waist circumferenceas compared to BMI .[25]

Our results also demonstrated negative association between age and vitamin D level on univariate analysis .This is in accordance with results of previous studies.[26,27,28]In order to control the confounding effect of age on BMI, multivariate analysis was performed which showed no significant association and only vitamin D level is found to be significantly associated with BMI.

There are few limitations of our study.Although our study results demonstrated that vitamin D levels were low among overweight and obese individuals as compared to normal individual, however, it is not possible to conclude that vitamin D deficiency causes obesity because reverse causation bias is possible as vitamin D is fat soluble vitamin and can be sequestered in adipose tissue.[29]

Longitudinal studies or randomized control trial should be conducted to find out more accurate association and to overcome possible effect of reverse causation bias as well as evaluation of effect of vitamin D supplementation in obesity. Asymptomatic vitamin D deficiency can be prevented by education of the population on change in dietary habits, educating parents to expose their children regularly to sunshine, prophylaxis through periodic dosing, vitamin D fortification of foods especially milk, butter, oil and attention of government towards food fortification policies is the need of the day to combat hidden hunger and lessen the double burden of disease in Pakistan.

Limited number of anthropometric parameters was assessed due to cost and logistic constrains. Future research with measurement of anthropometric variables other than BMI and waist circumference should be conducted to find out association of these variables with

obesity. High body fat content, increased incidence abdominal obesity and increase risk of cardio metabolic risk factors at lower BMI cut offs and in Asian population should not be overlooked.

CONCLUSION:

Significant vitamin D deficiency was seen in overweight and obese females. It was found that vitamin D deficiency is associated with obesity, but its causal role has not been established. Future prospective studies should be conducted to further elaborate this association. This will provide an opportunity to health care providers to screen out the high risk individuals and need for vitamin D supplementation. This can be an effective strategy for early diagnosis and prevention. These measures can effectively reduce the burden on healthcare system

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