SUMMARY

Menopause is one of the critical phase of a woman’s life when she stops having her monthly period. It typically occurs between 45 to 55 years of age and triggers some profound changes in her body due to hormonal variation. Premenopause, perimenopause, menopause, and postmenopause are the stages of menopause. For every woman, the experience of each stage of menopause is different, based on how her body uniquely adapts to her towards the process of aging. Due to declining estrogen level and increasing age, postmenopausal conditions are at high risk of several diseases like osteoporosis, metabolic syndrome, CVD, and T2DM. Aging also affects multiple steps of vitamin D metabolism in elderly women, as the aging of skin led to reducing the efficiency to synthesize vitamin D upon exposure to the sun. Despite the plenty of sunshine being present throughout the year in India, vitamin D deficiency is one of the major health concern among all age-groups of women, especially in postmenopausal women. The vitamin D receptor expressed ubiquitously in almost all body cell and modulates the expression of several other genes that are responsible for the pathophysiology of risk factors of metabolic syndrome. Metabolic syndrome comprises a combination of metabolic abnormalities like abdominal obesity, hypertension, impaired fasting sugar, increased triglycerides and low HDL-C levels that predisposes to the development of CVD and T2DM. The transition from premenopausal to postmenopausal is associated with the emergence of many features of metabolic syndrome due to estrogen and vitamin D deficiency. Therefore, the study was aimed to know whether the vitamin D deficiency has a direct association with metabolic syndrome in menopausal women or not.
The study was carried out in 500 female subjects, out of which 100 healthy female subjects were considered as control, 200 were premenopausal women with age group of 30-45 years and had a regular menstrual cycle and 200 were postmenopausal women with age group >45 years onward and had amenorrhea for 12 consecutive months. The pre- and postmenopausal women were further categorized on the basis of sufficient and deficient vitamin D levels. Since the study was focused on pre- and postmenopausal women who had vitamin D deficiency and whether they are suffering from metabolic syndrome. The anthropometric, biochemical parameters and inflammatory markers were analyzed in various categories. The 5 mL blood sample from all the studied female subjects was drawn in fasting state for the analysis of serum vitamin D levels, fasting blood sugar (FBS), lipid profile, calcium (Ca) and hormonal parameters like estrogen (E2), parathyroid hormone (PTH), and inflammatory markers like interleukin-6 (IL-6), and high sensitivity C-reactive protein (hs-CRP). The data were analyzed by using Statistical Package for the Social Sciences, version 22.0 (IBM SPSS Statistics., 2015) and Excel (Microsoft Corp., Redmond, WA). The results were expressed as Mean ± Standard Deviation. Statistical analysis was made by independent student’s t-test and Chi-square test. Pearson correlation coefficient was done to determine the association between the vitamin D deficiency and all the biochemical parameters and components of metabolic syndrome in pre- and postmenopausal women. The outcomes of the study are as follows:

- Anthropometric parameters including BMI, WC, and blood pressure were found significantly increased (p<0.001) in both premenopausal and postmenopausal women as compared to control healthy women.
In premenopausal women with sufficient vitamin D levels (n=73), all the anthropometric, biochemical parameters, and inflammatory markers were found nonsignificant. Similarly, in postmenopausal women with sufficient vitamin D levels (n=59), the anthropometric, biochemical parameters, and inflammatory markers (IL-6 and hs-CRP) were nonsignificantly increased while serum E₂ and HDL-C levels were significantly decreased (p<0.001) as compared with control healthy women.

In premenopausal and postmenopausal women with deficient vitamin D levels, all anthropometric, biochemical parameters, and inflammatory markers were found significantly increased (p<0.001) while serum E₂ and HDL-C levels were significantly decreased (p<0.001) in postmenopausal women when compared with control subjects.

Nonsignificant changes were found between the components of metabolic syndrome and sufficient vitamin D levels of pre- and postmenopausal women as compared with control subjects.

Estrogen hormone was also found significantly decreased (p<0.001) in postmenopausal women with deficient vitamin D levels as compared with the control healthy female.

In vitamin D deficient premenopausal women (n=127), 55 women did not show any variations among the metabolic syndrome components while impaired fasting sugar, increased blood pressure and dyslipidemia was found in remaining 72 women who fulfill the criteria of having metabolic syndrome. Similarly in
postmenopausal women with deficient vitamin D levels (n=141), among the metabolic syndrome components, only HDL-C was significantly decreased in 45 women thus they were not suffering from metabolic syndrome while 96 postmenopausal women showed significant variations (p<0.001) in all the components of the metabolic syndrome when compared with control healthy females.

- The comparative status between the components of metabolic syndrome and vitamin D deficient group of pre- and postmenopausal women were found significantly increased (p<0.001) while HDL-C was significantly decreased (p<0.001) in postmenopausal women with vitamin D deficient levels.

- The comparative aspects of deficient vitamin D levels in pre- and postmenopausal women showed that low levels of serum vitamin D were significantly (p<0.001) associated with abdominal obesity, hypertension, increased fasting blood sugar and dyslipidemia.

- The correlative studies showed a significant negative correlation between vitamin D deficiency with anthropometric, biochemical parameters, and inflammatory markers while the positive correlation with HDL-C in both pre- and postmenopausal women. Thus, abdominal obesity, hyperglycemia, dyslipidemia, inflammation and decreased estrogen level induces metabolic syndrome components.

On the basis of above findings, it is concluded from the study that obesity, hypertension, hyperglycemia, dyslipidemia were associated with vitamin D deficiency for the onset of
metabolic syndrome in premenopausal women. While in postmenopausal women the onset of metabolic syndrome was due to the combined effect of vitamin D deficiency and estrogen deficiency. As the age advances both hormones act in concert resulting in the commencement of metabolic syndrome. Thus, the severity of vitamin D deficiency and prevalence of metabolic syndrome were more in postmenopausal women as compared to premenopausal women.

Limitations of the present study: In spite of major outcomes of association between vitamin D deficiency and risk of metabolic syndrome, this study had some limitations. We could not collect information regarding UVB exposure, sunscreen use, fortified dietary intake, daily workout, measures of adiposity and other risk factors that affect the levels of vitamin D. Regarding multivitamin use, we do not have any data on vitamin D content or adherence, which may confound the effects of multivitamin use. The further study requires the measures of all the risk factors that affect the serum vitamin-D levels.