Vitamin D deficiency and metabolic syndrome are two major global health concerns in all age-groups, especially in elderly women. Postmenopausal women are the most susceptible group for vitamin D deficiency and greater risk for having metabolic syndrome due to decreased estrogen levels. In this regard, many workers have reported their noteworthy contributions as:

- **Chiu et al., (2004)** found a positive correlation of 25(OH) D concentrations with insulin sensitivity and a negative effect of hypovitaminosis D on β cell function. Subjects with hypovitaminosis D were at higher risk of insulin resistance and MS.

- **Ford et al., (2005)** reported an inverse association between concentrations of Vit-D and insulin resistance that provide a possible explanation for the prevalence of the MS. Vit-D deficiency might be a risk factor for the MS, a highly prevalent condition among US adults.

- **Liu et al., (2005)** suggested that dietary Vit-D was inversely associated with the prevalence of MS but was not independent of total calcium intake. Similar strong relations between intakes of dairy products and MS were also observed.

- **Peterlik and Cross, (2005)** reported that calcium and Vit-D deficiency increase the risk of malignancies, chronic inflammatory, autoimmune diseases and metabolic disorders such as hypertension and MS.

- **Botella-Carretero et al., (2007)** reported that the increased prevalence of Vit-D deficiency among morbidly obese patients. They showed that 61% of morbidly...
obese patients presenting a metabolic syndrome suffered from Vit-D deficiency compared to 33% of those who did not achieve the criteria for MS.

- **Pittas et al., (2007)** reported that Vit-D and calcium insufficiency negatively influence glycemia whereas combined supplementation with both nutrients might be beneficial in optimizing glucose metabolism.

- **Reis et al., (2007)** found that the low level of circulating Vit-D concentrations might be associated with an increased prevalence of MS and there was a link between an increased risk of MS and elevated parathormone levels in older age.

- **Forouhi et al., (2008)** showed that 25(OH)D level was inversely associated with 10-year risk of hyperglycemia, insulin resistance and with MS. These associations were independent of risk factors and potential confounders and were potentially important in understanding the etiology of metabolic disturbances associated with T2DM.

- **Hypponen et al., (2008)** reported that serum 25(OH) D was inversely associated with MS and suggested that when 25(OH) D level was high than the prevalence of MS was lower in British subjects.

- **McGill et al., (2008)** reported that low levels of circulating serum Vit-D were inversely related to weight, BMI and markers of T2DM (large WC, raised glycosylated hemoglobin) but not to adipose mass and MS.

- **Penckofer et al., (2008)** stated that the role of Vit-D for the prevention of diabetes and some of the complications associated with diabetes (CVD, renal insufficiency, and peripheral neuropathies). They also demonstrated that normal levels of Vit-D
might help to reduce the risk of MS and its components, particularly as it relates to beta cell function.

- **Reis et al., (2008)** reported an inverse association of 25(OH) D with MS, independent of potential confounding factors, calcium intake, and PTH. They also found that there was no evidence of a positive association of PTH with MS among older women, unlike older men.

- **Rueda et al., (2008)** showed that the 25(OH) D were less likely to present the MS, hyperglycemia, high TG, low HDL-C and high BP. They did not find any association between the PTH quartiles and the MS or its individual components.

- **Bonakdaran and Varasteh, (2009)** reported a strong link between Vit-D deficiency and high BMI, MS, and increased hs-CRP among type 2 diabetic patients of Iran.

- **Gannage-Yared et al., (2009)** reported that 25(OH) D was significantly inversely correlated with BMI, systolic blood pressure, WC, fasting plasma glucose, insulin levels and positively correlated with HDL-C. They observed new relationships between 25(OH) D and several metabolic risk factors and adiponectin in nonobese young subjects.

- **Hjelmesaeth et al., (2009)** stated that the PTH level, but not the Vit-D level, was an independent predictor of MS in treatment seeking morbidly obese Caucasian women and men. Randomized controlled clinical trials, including different therapeutic strategies to lower PTH, e.g. calcium/vitamin D supplementation and weight reduction, are necessary to explore any cause and effect relationship.
- **Lu et al., (2009)** showed that the low plasma Vit-D levels were significantly associated with increased risk of having MS and insulin resistance among middle-aged and elderly Chinese individuals.

- **Perez-Lopez, (2009)** found that hypovitaminosis D was associated with disturbed glucose metabolism, pancreatic β-cell dysfunction, lipoprotein alterations, hypertension, overweight, and obesity. And highlighted the importance of improving Vit-D status in the general population for the prevention of adverse long-term health risks.

- **Alvarez et al., (2010)** reported that the circulating 25(OH) D and PTH concentrations were independently associated with whole-body insulin sensitivity and may be more closely related to peripheral rather than hepatic insulin sensitivity. Although Vit-D and PTH are closely connected in the regulation of skeletal health, they likely influence metabolic health through independent mechanisms.

- **Kim et al., (2010)** reported a strong inverse association of serum Vit-D levels with both MS and hypertension in middle-aged Korean subjects.

- **Parker et al., (2010)** found that the high levels of Vit-D among middle-aged and elderly populations were strongly associated with significant decreases in CVD, type 2 diabetes, and MS.

- **Pinelli et al., (2010)** showed that Vit-D insufficiency and hypovitaminosis D was extremely common among Arab Americans women with or without MS and were also associated with insulin resistance, components of the metabolic syndrome and glucose intolerance. In women, lower 25(OH) D was associated with lower HDL-C levels.
• **Richart et al., (2011)** found that there was a positive association between Vit-D (as well as parathormone) disruption and carotid intima-media thickness (as well as MS prevalence) but carotid intima-media thickness was not associated with MS.

• **Chacko et al., (2011)** reported that the higher serum 25(OH) D concentrations were inversely associated with adiposity, TG, and TG: HDL-C ratio and MS but were not associated with LDL-C and HDL-C, insulin, glucose, HOMA-IR, or HOMA-β in postmenopausal women.

• **Moy and Bulgiba, (2011)** reported that the high prevalence of Vit-D insufficiency was also associated with Metabolic Syndrome among Malay adults especially females in Kuala Lumpur. Vit-D insufficiency was independently associated with younger age, female sex, and greater abdominal obesity.

• **Salekzamani et al., (2011)** suggested that 25(OH) D was the main predictor of both hs-CRP and plasma glucose. Vit-D status might be a determining factor of systemic inflammation and the related metabolic derangements of metabolic syndrome.

• **Durga-Prasad et al., (2012)** reported an inverse association were present for Vit-D with central obesity, hyperglycemia, hypertriglyceridemia, and hypertension and revealed that Vit-D deficiency may have an important role in metabolic syndrome and its components

• **Kilic et al., (2012)** showed that the increased frequency of metabolic syndrome was associated with Vit-D deficiency independent of hyperparathyroidism. Moreover, the Vit-D level was negatively correlated with waist circumference, BMI, triglycerides and fasting plasma glucose and positively correlated with HDL.
- **Maki et al., (2012)** reported that serum 25(OH) D level was inversely associated with the prevalence of MS, abdominal obesity, and low HDL-C concentration. Dietary intake of Vit-D was inversely associated with MS prevalence; however, total Vit-D intake, which included supplemental Vit-D, was not associated with odds for MS or its components.

- **Marjani and Moghasemi, (2012)** found that there were significant differences of 25(OH) D levels of postmenopausal women with and without Vit-D deficiency who had MS. They also reported that low HDL-C and high WC were the most usual factors of metabolic abnormality, thus postmenopausal status might be a predictor of MS.

- **Minambres et al., (2012)** suggested the association between Vit-D and MS was independent of the degree of obesity. They found that the patient with MS had lower levels of 25(OH) D than patients without and the odds ratio for hypovitaminosis D was 2.7 for patients with MS versus patients without MS.

- **Makariou et al., (2012)** reported that subjects with MS exhibit lower 25(OH) D serum levels compared with subjects without MS. Low 25(OH) D was associated with higher small dense LDL-C levels possibly with elevated triglycerides. No association was found between 25(OH) D and Lp-PLA2 or hs-CRP.

- **Yin et al., (2012)** reported that Vit-D deficiency is common in the young and middle-aged, urban Chinese population, with high prevalence in overweight/obese individuals and patients with metabolic syndrome. Low Vit-D concentration was associated with indices of adiposity and cardiometabolic risk factors.
• **Joshi et al., (2013)** reported that Vit-D deficiency was linked to obesity and CVD as Vit-D levels decrease with increase in BMI and TG. Thus concluded that Vit-D deficiency was an alarming issue among postmenopausal women in India.

• **Barchetta et al., (2013)** found a powerful association exists between hypovitaminosis D and metabolic syndrome in obese patients independently from body fat mass and its clinical correlates. This study indicates that the association between low 25(OH) D$_3$ levels and MS was not merely induced by Vit-D deposition in fat tissue and reinforces the hypothesis that hypovitaminosis D represent a crucial independent determinant of metabolic syndrome.

• **Dutta et al., (2013)** showed that the vitamin-D deficiency/insufficiency may have some role in the development/worsening of insulin resistance in individuals with prediabetes in India who have a high cardiovascular risk.

• **García-Bailo et al., (2013)** found an inverse association between plasma 25 (OH) D and metabolic syndrome risk and obesity and concluded that the Vit-D may modulate various metabolic processes and may influence cardio-metabolic disease risk in Canadians.

• **Li-Hua et al., (2013)** found that the subjects with Vit-D sufficiency had a lower risk of metabolic syndrome than those with Vit-D deficiency. The Vit-D level is inversely associated with MS, independent of several confounders and PTH level.

• **Song and Park, (2013)** found that a low serum 25(OH) D level was significantly associated with the presence of MS and some metabolic components, especially the high TG level and BP in Korean postmenopausal women.
- **Vanlint, (2013)** reported that the association between reduced 25(OH) D concentrations and obesity is well established. Correction of low 25(OH) D concentrations in obese individuals require higher doses than those often advocated for the general population.

- **Agarwal et al., (2014)** showed that there was a significant negative linear correlation between 25-OHD and HOMA-IR confounded by BMI. There was no correlation between serum 25-OH D and any other parameters of insulin resistance studied.

- **Alissa et al., (2014)** reported that hypovitaminosis D was associated with the risk of developing MS. Interrelations between insulin resistance, MS and hypovitaminosis D were of particular interest to Saudi postmenopausal women, given the high prevalence of these conditions in this region because of limited exposure to sunlight and lower dietary intake.

- **Chon et al., (2014)** found that the serum levels of 25(OH) D were not significantly correlated with the prevalence of metabolic syndrome in Korean postmenopausal women; however, elevated blood pressure, elevated TG and reduced HDL-C levels were found to decrease significantly as the serum levels of 25 (OH) D increased.

- **Janghorbani and Amini, (2014)** showed that LDL-C level is not a robust predictor of metabolic syndrome, independent of age, gender or the pre-existing components of metabolic syndrome, in high-risk individuals in Iran.

- **Masoni et al., (2014)** reported that the high prevalence of Vit-D deficiency (42.3%) and insufficiency (86.5%) in healthy postmenopausal women. Significant associations were also observed with menopause extension and BMI.
- **Muley and Iyer, (2014)** reported that the Vit-D status of the Indian population was not significantly related to the risk of developing MS and its metabolic component except WC. The results of this study highlighted the high prevalence of Vit-D deficiency among the population and it was independently associated with greater abdominal obesity.

- **Mitri et al., (2014)** found that the higher plasma 25(OH) D concentration was associated with a lower prevalence of MS among persons at increased high risk of diabetes and a lower, but non-statistically significant, risk of incident MS.

- **Sadiya et al., (2014)** reported that serum concentrations of 25(OH) D were correlated negatively with BMI, fat mass, WC, PTH, alkaline phosphatase, TG, LDL-C apolipoprotein B and positively with age and calcium concentration in Emirati population with obesity and T2DM. They also suggested that an adequate Vit-D status might be able to prevent the development of cardiometabolic disease-related processes.

- **Tandon et al., (2014)** reported that the high prevalence of Vit-D deficiency exists among apparently healthy Indian postmenopausal women. The current study had failed to show any statistical correlation between raised blood glucose levels and Vit-D deficiency.

- **Vujosevic et al., (2014)** showed that the patients with postmenopausal osteoporosis and hypovitaminosis D, besides a high BMI, elevated TG levels and insulin resistance, had an increased risk of developing T2DM.

- **Mandarino et al., (2015)** reported that a strong association between Vit-D deficiency and hypertension, metabolic syndrome, diabetes mellitus and
atherosclerosis. They establish the role of Vit-D supplementation in the prevention and control of cardiovascular disease.

- **Azizieh et al., (2016)** reported the high prevalence of Vit-D deficiency in healthy Kuwaiti adult women and explained the possible role of Vit-D as a contributing factor in balancing cytokines toward an anti-inflammatory role in inflammatory situations.

- **Mitra et al., (2016)** reported that the Indian postmenopausal women had a high prevalence of Vit-D deficiency as well as obesity and the MS.

- **Ashok et al., (2017)** found that Vit-D deficiency was common in Indian women. Elevated WC, BP, and triglycerides were found to inversely associated with low serum levels of 25(OH) D. Improving Vit-D status would be useful in improving the health of middle-aged urban women.

- **Al-Dabhani et al., (2017)** found the positive association between the presence of MS and Vit-D deficiency. They observed that MS components, such as obesity and high TG, were inversely associated with circulating serum Vit-D levels.

- **Srimani et al., (2017)** reported the high prevalence of Vit-D insufficiency and deficiency, as well as MS, existed among postmenopausal women of Singur block, West Bengal, India. They also found that 25(OH) D level had a significant inverse relationship with blood glucose level and direct relationship with WC. Thus, Vit-D deficiency or insufficiency may be one of the potential risk factors for developing MS in the studied population or vice versa.

- **Patel et al., (2017)** observed a high prevalence of Vit-D deficiency in middle-aged premenopausal Indian women. They also found that the inverse correlation between
the serum 25(OH) D concentrations and atherogenic lipid profile that can lead to dyslipidemia, CVD, and MS.

- **Schmitt et al., (2018)** reported that the Vit-D deficiency in postmenopausal women was associated with a higher prevalence of MS. Women with Vit-D deficiency had a higher risk of MS, hypertriglyceridemia and low HDL than those with adequate levels. They also suggested that the maintenance of adequate serum levels of 25(OH) D in postmenopausal women may reduce the risk of developing MS and CVD.