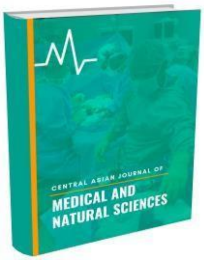

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Article

Diabetes and its Impact on Vitamin D Levels Review

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Abstract: Diabetes mellitus (DM), a prevalent metabolic disorder characterized by impaired insulin secretion or function, remains a significant global health challenge. Emerging evidence highlights the critical role of vitamin D in bone health, immune function, and inflammation regulation, with growing interest in its influence on pancreatic insulin secretion and sensitivity. Despite this, the interplay between DM and vitamin D deficiency is not fully understood, particularly regarding its impact on type 1 and type 2 diabetes. This review aims to synthesize current knowledge on the relationship between DM and vitamin D, exploring how DM affects vitamin D levels and how vitamin D deficiency may exacerbate diabetes progression. A comprehensive review of existing studies reveals that vitamin D deficiency impairs insulin secretion and sensitivity, contributing to worsened glycemic control in both types of DM. These findings underscore the potential of vitamin D as a therapeutic target for improving diabetes management and warrant further investigation to establish effective intervention strategies.

Keywords: Diabetes mellitus, Vitamin D, Vitamin D deficiency

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1. Introduction

Diabetes mellitus is considered one of the most prevalent endocrine disorders, maybe characterized by elevated of plasma glucose levels. Multiple types of diabetes with markedly diverse etiology exist. eventually, diabetes might result in Vision problems, renal failure, and neuropathy. Different forms of diabetes with very distinct pathogenesis exist [1]. According to WHO predictions, the number of individuals with diabetes will reach more than three hundred million by 2030, and this diabetes epidemic will continue [2]. The administration of diabetic mellitus is dictated by its causes and is primarily classified into type 1 and type 2 diabetes mellitus. Individuals with a genetic predisposition or concurrent corticosteroid medication exhibit an increased susceptibility to hyperglycemia [3].

Many studies considered vitamin D to be one of the most essential vitamins in the human body. Duo to its role in the human body. Some studies refer to vitamin D as "sunshine vitamin". There are many diseases that was connected with low vitamin D include heart diseases, diabetes, rheumatoid arthritis, cancer [4, 8]. Vitamin D insufficiency has been observed to reduce the synthesis of the insulin with reduced its secretion in humans or on the laboratory animal. Research indicates that a deficiency in vitamin D might elevate the likelihood of glucose intolerance [9]. Vitamin D has been revealed to be related with type 1 diabetes. through genetic and epidemiological research. Research indicates that individuals residing in areas with limited sunlight exposure a higher risk of type 1 of diabetes [10].

2. Materials and Methods

The article is a review that synthesizes information from multiple studies to explore the relationship between diabetes mellitus and vitamin D deficiency. The following methods were used to gather and analyze the data:

1. Literature Review:
   a. Peer-reviewed articles and studies were examined to collect data on the physiological roles of vitamin D, its sources, and metabolism.
   b. Data on the effects of type 1 and type 2 diabetes on vitamin D levels, as well as the mechanisms linking vitamin D deficiency to diabetes, were included.
2. Key Data Sources:
   a. Scientific databases and journals were referenced to ensure credibility.
   b. Relevant keywords like "diabetes mellitus," "vitamin D," and "vitamin D deficiency" guided the literature search.
3. Analysis Framework:
   a. Studies were categorized based on their focus (e.g., vitamin D's role in insulin regulation, its deficiency in diabetes, or supplementation effects).
   b. Insights were summarized to identify trends and mechanisms, such as the relationship between vitamin D deficiency and insulin resistance.

3. Results and Discussion

Vitamin D Source

Vitamin D is a "fat-soluble" vitamin that exit in two forms: the first one is vitamin D2 or refer to it as ergocalciferol and the second form of this vitamin is called vitamin D3 or cholecalciferol. The ergocalciferol is obtained from the diet, especially plants, Cholecalciferol can be sourced from dietary animal products, including deep-sea oily fish, the yolks of eggs, or liver. Other sources of obtaining vitamin D3 is through the skin which has the ability of converting cholesterol precursor "7-dehydrocholesterol" to vitamin D3 through being exposed to "ultraviolet B" radiation. Vitamin D production from sun exposure is effective only when the angle of sunlight exceeds 45°. Consequently, residents of the northern hemisphere may not obtain adequate vitamin D via skin synthesis during the winter months, and in certain northern regions, insufficient sun exposure may persist for up to six months annually.

Furthermore, a conventional Western diet is deficient in vitamin D [11]. To enhance vitamin D intake, certain nations have implemented policies to enrich milk products and margarine with vitamin D, while the utilization of light bulbs for artificial UVB exposure serves as an additional method to augment vitamin D synthesis [12]. Considering the challenge of acquiring adequate quantities of vitamin D from dietary sources, taking vitamin d from artificial sources in form of pills or injections containing different dose to cover the daily requirement. The Supplement of vitamin D like ergocalciferol or cholecalciferol may be used to for covering daily dose. Recent studies showed that the using of Vitamin d3 result in increasing level of the vitamin D active form 1,25(OH)2D compared with using vitamin D2 [13].

Vitamin D Metabolism

Vitamin D forms cholecalciferol and ergocalciferol Regardless of its source undergo the same metabolism, both forms of vitamin D are undergoing the addition of hydroxyl group that lead to formation of 25-hydroxyvitamin [25(OH)D] that take place in the liver, which is then release into the blood circulation and bound to Vitamin D binding-protein (DBP). 25(OH)D undergoes further hydroxylation, resulting in the formation of compound called 1,25-dihydroxyvitamin D [1,25(OH)2D], a method that ensues in the kidneys. The 1,25-dihydroxyvitamin D [1,25(OH)2D] is the known to be the functional form of vitamin D. Vitamin D 1,25(OH)2D functions predominantly in the duodenum by enhancing calcium absorption in osteoclasts, which subsequently mobilize calcium [14, 15]. This newfound interest arises from the finding that its active form, of vitamin D3, via its nuclear vitamin D receptor [VDR], modulates numerous genes throughout the body, including those responsible for proteins related to cell differentiation, cell proliferation, and calcium and phosphate homeostasis [16].

Calcium and phosphorus metabolism were regulating through Vitamin D in higher vertebrates and governs various biological activities associated with immune, circulatory systems, skin and muscle function, cellular development regulation, and many other processes in the human body [17, 18]. Studies shown that vitamin D act as Vitamin D is acting as hormone rather than vitamin D. The reason for this perspective is that vitamin D significantly influences neurobiological pathways and communication cascades associated with mental health, as shown by its reaction to specific components and the fact that the presences of vitamin D receptors (VDRs) in the brain. Evidence suggests that vitamin D is involved in various pathway of the endocrine system, indicating that a shortage of vitamin D may constitute a hormonal insufficiency [19, 20].

Vitamin D Deficiency

Vitamin D insufficiency is currently acknowledged as a pandemic. The low exposure to the sun is considering the main cause of low vitamin D level in the human body. Vitamin D insufficiency may result in osteomalacia, and rickets in children. Patients with cardiac disease found to be having a vitamin D deficiency due to the fact that those patient exposure inadequate sun-induced vitamin D synthesis in the skin and insufficient dietary intake of vitamin D [21, 22]. The insufficiency of vitamin D could interfere with pancreatic β-cell functionality, hence impairing the secretion of insulin. Moreover, vitamin D deficiency may aggravate inflammation, apoptosis in the pancreas, oxidative stress and several organs, resulting in insulin resistance [23, 25].

The Effect of Type 1 Diabetes on the Level of Vitamin D

Type 1 diabetes is classified as a chronic autoimmune disorder marked by insulin insufficiency, and resulted in hyperglycemia. Information about type 1 diabetes has elevated rapidly in the last twenty-five years, leading to in depth understanding of various aspects of the disease [26]. Studies showed that a supplement of vitamin D might link to lower the risk of type 1 diabetes. Providing sufficient vitamin D supplementation for babies could reduce the growing risk of type 1 diabetes. Supplementation of vitamin D throughout early childhood may provide a protective effect against the onset of type 1 diabetes [27, 28]. Lower level of vitamin D3 are often found in patients with type 1 diabetes compared with healthy controls. Supplementation of vitamin D in childhood correlates with a reduced risk of type 1 diabetes [29].

The Effect of Type 2 Diabetes on Vitamin D Levels in Patients

Type 2 diabetes mellitus (T2DM) is an expanding international health concern, strongly tied to the global obesity crisis. Members with type 2 diabetes mellitus (T2DM) are at elevated risk for microvascular consequences, including nephropathy, retinopathy, and neuropathy, along with macrovascular illness, such as cardiovascular coexisting conditions, due to hyperglycemia and components of insulin resistance syndrome [30].

Over four hundred million individuals globally are living with diabetes, with a predicted 193 million remaining undiagnosed. Type 2 diabetes makes up over ninety percentage of diabetes cases and lead to complication of both microvascular and macrovascular resulting in considerable psychological and physical distress for both patients and caregivers, while placing tremendous pressure on healthcare systems [31]. Deficiencies in vitamin D and calcium may negatively impact glycemia, however simultaneous treatment of both minerals may improve glucose metabolism [32].

The mechanism that diabetes cause vitamin D deficiency

Vitamin D insufficiency lowers insulin secretion in both laboratory animals and humans, leading to glucose intolerance; however, vitamin D replacement improves the abnormalities [33]. Epidemiological investigations have shown a correlation between vitamin D insufficiency, obesity, and an increased risk of type 2 diabetes [34]. Vitamin D and with its metabolites is likely to have substantial impacts on insulin production, secretion, and function, as well as inflammatory components, and all of these might have an impact on the etiology of the second type of diabetes [35].

Symptoms of painful diabetic neuropathy had reduced after the administration of an injection of 60000 IU of vitamin D [36]. Vitamin D influences metabolism of glucose. In gestational diabetes mellitus the level of vitamin D was linked inversely with glycosylated hemoglobin levels. Moreover, vitamin D seems to prevent the evolution of gestational diabetes mellitus [37]. Hereditary gene polymorphisms were suggested to be a possible causes of vitamin D deficiency by inducing insulin resistance in cases of the vitamin D-binding protein, vitamin D receptor, and vitamin D 1alpha-hydroxylase genes [38].

A controlled experiment shown that daily consumption of 1100 IU of colecalciferol (vitamin D) over four years significantly decreased the risk of non-skin malignancies, underscoring the profound medical, societal, and economic ramifications of addressing vitamin D insufficiency [39]. Studies has been shown that vitamin D might affect the pancreatic beta cell (β-cells) that responsible for the secretion of insulin. Insulin resistance consider the begins of the diabetes. Increasing the secretion of insulin by β-cells could reduce this resistance, so minimizing hyperglycemia [40].

An administration of vitamin D (VTD)—approximately 2000 IU per day—during early childhood has demonstrated a significant reduction in the chance of acquiring type 1 diabetes, with a projected decrease of up to 80% over the next 30 years [41]. The important role of vitamin D in relation to osteoporosis and fractures has been understood for over 40 years. Vitamin D deficiency is identified by assessing 25-hydroxyvitamin D (25-OHD) levels, which should exceed 50 nmol/l year around. Recent research indicates that several serious diseases may be averted by elevating 25-OHD levels to 80 nmol/l [42, 43].

4. Conclusion

In conclusion, this review underscores the significant interplay between diabetes and vitamin D, highlighting its critical role in insulin secretion, glucose metabolism, and overall glycemic control. Key findings reveal the high prevalence of vitamin D deficiency in individuals with type 1 diabetes and the potential benefits of early supplementation in reducing disease risk, as well as the role of vitamin D deficiency in exacerbating insulin resistance and hyperglycemia in type 2 diabetes. Mechanistic insights suggest that vitamin D enhances pancreatic β-cell functionality, reduces inflammation, and mitigates oxidative stress, with genetic factors potentially influencing these processes. These findings emphasize the importance of integrating vitamin D status assessment and supplementation into diabetes management strategies to improve health outcomes. However, further research is required to elucidate optimal supplementation protocols, long-term effects, and the underlying genetic and molecular mechanisms linking vitamin D to diabetes pathophysiology.

REFERENCES

[1] T. Takiishi, C. Gysemans, R. Bouillon, and C. Mathieu, "Vitamin D and Diabetes," Endocrinology and Metabolism Clinics of North America, vol. 39, no. 2, pp. 419–446, 2010.

[2] T. Martin and R. K. Campbell, "Vitamin D and Diabetes," Diabetes Spectrum, vol. 24, no. 2, pp. 113–118, 2011.

[3] U. Alam, O. Asghar, S. Azmi, and R. A. Malik, "General Aspects of Diabetes Mellitus," Handbook of Clinical Neurology, vol. 126, pp. 211–222, 2014.

[4] D. Challoumas, A. Stavrou, A. Pericleous, and G. Dimitrakakis, "Effects of Combined Vitamin D–Calcium Supplements on the Cardiovascular System: Should We Be Cautious?," Atherosclerosis, vol. 238, pp. 388–398, 2015.

[5] W. Yuan, W. Pan, J. Kong, W. Zheng, F. L. Szeto, K. E. Wong, et al., "1,25-Dihydroxyvitamin D3 Suppresses Renin Gene Transcription by Blocking the Activity of the Cyclic AMP Response Element in the Renin Gene Promoter," Journal of Biological Chemistry, vol. 282, pp. 29821–29830, 2007.

[6] T. Akiishi, C. Gysemans, R. Bouillon, and C. Mathieu, "Vitamin D and Diabetes," Endocrinology and Metabolism Clinics of North America, vol. 39, pp. 419–446, 2010.

[7] L. A. Merlino, J. Curtis, T. R. Mikuls, J. R. Cerhan, L. A. Criswell, and K. G. Saag, "Vitamin D Intake is Inversely Associated with Rheumatoid Arthritis," Arthritis & Rheumatism, vol. 50, pp. 72–77, 2004.

[8] C. F. Arland, G. W. Comstock, F. C. Garland, K. J. Helsing, E. K. Shaw, and E. D. Gorham, "Serum 25-Hydroxyvitamin D and Colon Cancer: Eight-Year Prospective Study," Lancet, vol. 2, pp. 1176–1178, 1989.

[9] X. Palomer, J. M. González-Clemente, F. Blanco-Vaca, and D. Mauricio, "Role of Vitamin D in the Pathogenesis of Type 2 Diabetes Mellitus," Diabetes, Obesity and Metabolism, vol. 10, no. 3, pp. 185–197, 2008.

[10] K. Rose, M. Penna-Martinez, E. Klahold, D. Kärger, F. Shoghi, H. Kahles, et al., "Influence of the Vitamin D Plasma Level and Vitamin D-Related Genetic Polymorphisms on the Immune Status of Patients with Type 1 Diabetes: A Pilot Study," Clinical & Experimental Immunology, vol. 171, no. 2, pp. 171–185, 2013.

[11] E. Hoseinzadeh, P. Taha, C. Wei, H. Godini, G. M. Ashraf, M. Taghavi, et al., "The Impact of Air Pollutants, UV Exposure, and Geographic Location on Vitamin D Deficiency," Food and Chemical Toxicology, vol. 113, pp. 241–254, 2018.

[12] I. M. Grønborg, I. Tetens, T. Christensen, E. W. Andersen, J. Jakobsen, M. Kiely, et al., "Vitamin D-Fortified Foods Improve Wintertime Vitamin D Status in Women of Danish and Pakistani Origin Living in Denmark: A Randomized Controlled Trial," European Journal of Nutrition, vol. 59, pp. 741–753, 2020.

[13] E. G. van den Heuvel, P. Lips, L. J. Schoonmade, S. A. Lanham-New, and N. M. van Schoor, "Comparison of the Effect of Daily Vitamin D2 and Vitamin D3 Supplementation on Serum 25-Hydroxyvitamin D Concentration: A Systematic Review and Meta-Analysis," Advances in Nutrition, vol. 15, no. 1, p. 100133, 2024.

[14] G. Jones, "100 Years of Vitamin D: Historical Aspects of Vitamin D," Endocrine Connections, vol. 11, no. 4, 2022.

[15] L. A. Plum and H. F. DeLuca, "The Functional Metabolism and Molecular Biology of Vitamin D Action," in Vitamin D: Physiology, Molecular Biology, and Clinical Applications, pp. 61–97, 2010.

[16] G. Jones, "Metabolism and Biomarkers of Vitamin D," Scandinavian Journal of Clinical and Laboratory Investigation, vol. 72, sup. 243, pp. 7–13, 2012.

[17] J. W. Pike and S. Christakos, "Biology and Mechanisms of Action of the Vitamin D Hormone," Endocrinology and Metabolism Clinics of North America, vol. 46, no. 4, pp. 815–843, 2017.

[18] A. Verstuyf, G. Carmeliet, R. Bouillon, and C. Mathieu, "Vitamin D: A Pleiotropic Hormone," Kidney International, vol. 78, no. 2, pp. 140–145, 2010.

[19] D. L. Ellison and H. R. Moran, "Vitamin D: Vitamin or Hormone?," The Nursing Clinics of North America, vol. 56, no. 1, pp. 47–57, 2021.

[20] M. Föcker, J. Antel, S. Ring, et al., "Vitamin D and Mental Health in Children and Adolescents," European Child & Adolescent Psychiatry, vol. 26, pp. 1043–1066, 2017.

[21] M. F. Holick and T. C. Chen, "Vitamin D Deficiency: A Worldwide Problem with Health Consequences," The American Journal of Clinical Nutrition, vol. 87, no. 4, pp. 1080S–1086S, 2008.

[22] M. F. Holick, "Vitamin D Deficiency," New England Journal of Medicine, vol. 357, no. 3, pp. 266–281, 2007.

[23] O. Sizar, S. Khare, A. Goyal, and A. Givler, "Vitamin D Deficiency," StatPearls, Treasure Island, FL: StatPearls Publishing, 2018.

[24] S. Pilz, A. Tomaschitz, C. Drechsler, J. M. Dekker, and W. März, "Vitamin D Deficiency and Myocardial Diseases," Molecular Nutrition & Food Research, vol. 54, no. 8, pp. 1103–1113, 2010.

[25] N. Mohd Ghozali, N. Giribabu, and N. Salleh, "Mechanisms Linking Vitamin D Deficiency to Impaired Metabolism: An Overview," International Journal of Endocrinology, vol. 2022, Article ID 6453882, 2022.

[26] L. A. DiMeglio, C. Evans-Molina, and R. A. Oram, "Type 1 Diabetes," The Lancet, vol. 391, no. 10138, pp. 2449–2462, 2018.

[27] E. Hyppönen, E. Läärä, A. Reunanen, M. R. Järvelin, and S. M. Virtanen, "Intake of Vitamin D and Risk of Type 1 Diabetes: A Birth-Cohort Study," The Lancet, vol. 358, no. 9292, pp. 1500–1503, 2001.

[28] C. S. Zipitis and A. K. Akobeng, "Vitamin D Supplementation in Early Childhood and Risk of Type 1 Diabetes: A Systematic Review and Meta-Analysis," Archives of Disease in Childhood, vol. 93, no. 6, pp. 512–517, 2008.

[29] X. Guillot, L. Semerano, N. Saidenberg-Kermanac'h, G. Falgarone, and M. C. Boissier, "Vitamin D and Inflammation," Joint Bone Spine, vol. 77, no. 6, pp. 552–557, 2010.

[30] R. A. DeFronzo, E. Ferrannini, L. Groop, R. R. Henry, W. H. Herman, J. J. Holst, F. B. Hu, C. R. Kahn, I. Raz, G. I. Shulman, and D. C. Simonson, "Type 2 Diabetes Mellitus," Nature Reviews Disease Primers, vol. 1, Article 15019, 2015.

[31] S. Chatterjee, K. Khunti, and M. J. Davies, "Type 2 Diabetes," The Lancet, vol. 389, no. 10085, pp. 2239–2251, 2017.

[32] A. G. Pittas, J. Lau, F. B. Hu, and B. Dawson-Hughes, "The Role of Vitamin D and Calcium in Type 2 Diabetes: A Systematic Review and Meta-Analysis," The Journal of Clinical Endocrinology & Metabolism, vol. 92, no. 6, pp. 2017–2029, 2007.

[33] B. L. Nyomba, R. Bouillon, and P. De Moor, "Influence of Vitamin D Status on Insulin Secretion and Glucose Tolerance in the Rabbit," Endocrinology, vol. 115, pp. 191–197, 1984.

[34] B. J. Boucher, "Vitamin D Insufficiency and Diabetes Risks," Current Drug Targets, vol. 12, no. 1, pp. 61–87, 2011.

[35] Z. Ozfirat, Z. Ozfirat, and T. A. Chowdhury, "Vitamin D Deficiency and Type 2 Diabetes," Postgraduate Medical Journal, vol. 86, no. 1011, pp. 18–25, 2010.

[36] C. C. Sung, M. T. Liao, K. C. Lu, and C. C. Wu, "Role of Vitamin D in Insulin Resistance," BioMed Research International, vol. 2012, Article ID 634195, 2012.

[37] J. J. Cannell, B. W. Hollis, M. Zasloff, and R. P. Heaney, "Diagnosis and Treatment of Vitamin D Deficiency," Expert Opinion on Pharmacotherapy, vol. 9, no. 1, pp. 107–118, 2008.

[38] M. Penna-Martinez and K. Badenhoop, "Inherited Variation in Vitamin D Genes and Type 1 Diabetes Predisposition," Genes, vol. 8, no. 2, Article 125, 2017.

[39] M. J. Berridge, "Vitamin D Deficiency and Diabetes," Biochemical Journal, vol. 474, no. 8, pp. 1321–1332, 2017.

[40] A. Basit, K. A. Basit, A. Fawwad, F. Shaheen, N. Fatima, I. N. Petropoulos, U. Alam, and R. A. Malik, "Vitamin D for the Treatment of Painful Diabetic Neuropathy," BMJ Open Diabetes Research & Care, vol. 4, no. 1, Article e000148, 2016.

[41] I. Kostoglou-Athanassiou, P. Athanassiou, A. Gkountouvas, and P. Kaldrymides, "Vitamin D and Glycemic Control in Diabetes Mellitus Type 2," Therapeutic Advances in Endocrinology and Metabolism, vol. 4, no. 4, pp. 122–128, 2013.

[42] G. Schwalfenberg, "Vitamin D and Diabetes: Improvement of Glycemic Control with Vitamin D3 Repletion," Canadian Family Physician, vol. 54, no. 6, pp. 864–866, 2008.

[43] H. Hey, A. Schmedes, P. Horn, and I. Brandslund, "Vitamin D Deficiency," Ugeskrift for Laeger, vol. 171, no. 26, pp. 2179–2184, 2009.