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Bibliometric Analysis: Research Trends in Vitamin D and Magnesium as A Diabetes Mellitus Therapy Model (2013-2024)

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ABSTRAK

Pendahuluan: Diabetes Melitus (DM) merupakan masalah kesehatan global yang serius. Penelitian ini bertujuan untuk mengetahu bagaimana kombinasi Vitamin D dan magnesium dapat memberikan manfaat sinergis yang digunakan sebagai terapi diabetes melitus.
Metode: Penelitian ini menggunakan database Scopus untuk mengumpulkan dan menganalisis artikel yang relevan. Sebanyak 410 artikel dimasukkan untuk analisis bibliometrik. Data dianalisis menggunakan software Vos Viewer versi 1.6.19, Microsoft Excel, dan Biblioshinny versi R 4.3.0
Hasil: Sebanyak 410 artikel dimasukkan untuk dianalisis. Temuan tersebut mengungkapkan tren peningkatan penelitian tentang vitamin D dan magnesium dalam beberapa tahun terakhir. Negara yang dominan dalam publikasi adalah Amerika Serikat. Artikel ilmiah mendominasi jenis publikasi dengan persentase sebesar 70,7%. Penulis paling produktif adalah Bener A dan Martinez Gonzalez M.A, masing-masing dengan 4 dokumen. Jurnal "Nutrisi" adalah sumber utama yang membahas topik ini secara ekstensif. Bidang studi yang paling dominan adalah bidang kedokteran dengan persentase 51,7%. Isu hangat dan potensial di masa depan divisualisasikan melalui VOSviewer dengan warna kuning, termasuk kontrol glikemik, mikronutrien, pola makan, asam lemak Omega-3, dan vitamin.
Kesimpulan: Analisis bibliometrik ini memberikan wawasan status penelitian terkini mengenai peran vitamin D dan magnesium pada Diabetes Mellitus. Temuan ini penting untuk memandu arah penelitian dan kolaborasi di masa depan, serta menawarkan perspektif dan strategi baru untuk pencegahan dan pengobatan Diabetes Mellitus.

Kata Kunci: Analisis Bibliometrik; Diabetes Mellitus; Magnesium; Vitamin D

ABSTRACT

Introduction*: Diabetes Mellitus (DM) is a serious global health problem. This research aims to find out how the combination of Vitamin D and magnesium can provide synergistic benefits for use as diabetes mellitus therapy.*
Method: *This research uses the Scopus database to collect and analyze relevant articles. A total of 410 articles were included for bibliometric analysis Data were analyzed using Vos Viewer software version 1.6.19, Microsoft Excel, and Biblioshinny version R 4.3.0*
Results*: A total of 410 articles were included for analysis. The findings revealed an increasing trend in research on vitamin D and magnesium in recent years. The dominant country in the publication is the United. Scientific articles dominate the type of publication with a percentage of 70.7%. The most prolific authors are Bener A and Martinez GonzalezM.A, each with 4 documents. The journal "Nutrients" is the main source that discusses this topic extensively. The most dominant subject area is the medical field with a percentage of 51.7%. Hot and potential issues in the future are visualized via VOSviewer in yellow, including glycemic control, micronutrients, dietary patterns, Omega-3 fatty acids, and vitamins.*
Conclusion: *This bibliometric analysis provides insight into the current status of research regarding the role of vitamin D and magnesium in Diabetes Mellitus. These findings are important for guiding the direction of future research and collaboration, as well as offering new perspectives and strategies for the prevention and treatment of Diabetes Mellitus.*

Keywords*:* **Bibliometric Analysis; Diabetes Mellitus; Magnesium; Vitamin D**

INTRODUCTION

Diabetes mellitus (DM) is a non-communicable disease with a combination of symptoms that appear in a person due to an increase in blood glucose levels above normal values (Hadi, 2020). Diabetes mellitus is often associated with food metabolic disorders which are relatively related to insulin secretion, insulin abnormalities, or both of them. The increase in blood glucose levels is controlled by insulin, which plays a very important role in the process of food metabolism, namely carbohydrates, fats and proteins that enter the body to be used as energy (Nuraini, 2016). There are 4 types of classification of diabetes mellitus according to (American Diabetes Association, 2018) including: type 1 diabetes mellitus, type 2 diabetes mellitus, other types of diabetes mellitus, and gestational diabetes.

Based on basic health research (Riskesdas, 2018), the prevalence of diabetes mellitus according to age classification is age 35-44 (1.1%), 45-54 (3.9%), 55-56 (6.3%) while age 65 -74 (6.0%) while the prevalence based on gender is more female patients (1.8%) compared to male patients (1.2%). According to the International Diabetes Federation (IDF) 2021, the number of people suffering from type 2 DM in Indonesia is 17.5 million people. Indonesia has diabetes alert status because it ranks 7th out of 10 countries with the highest number of diabetes patients. The prevalence of patients suffering from diabetes in Indonesia reached 6.2 percent, which means that there were more than 10.8 million people suffering from diabetes as of 2020 (IDF, 2021)

The two main pathophysiologies that genetically underlie cases of type 2 diabetes mellitus (T2DM) are insulin resistance and defects in pancreatic beta cell function (Decroli, E. 2019). Current T2DM treatment focuses on improving insulin sensitivity, controlling blood sugar levels, and minimizing complications. Pharmacological therapy may involve oral antidiabetic drugs, such as metformin, sulfonylureas, or glucosidase inhibitors, or even insulin (Sanchez, 2017). Additionally, lifestyle modifications, such as weight loss, a healthy diet, increased physical activity, and dietary changes, are also important components in managing this disease. There is a weakness of T2DM therapy against the side effects of several oral antidiabetic drugs and insulin, such as weight gain, hypoglycemia, and digestive disorders. Some patients may also not respond well to these medications, or over time, the efficacy of therapy may decrease (Patel, 2023).

Vitamin D may also affect insulin resistance indirectly via renin–angiotensin–aldosterone system (RAAS). RAAS is known for its inhibitory effects on insulin action in peripheral tissues, and regulation of cellular Ca2+ level in skeletal muscle cells. This regulation may promote transport of glucose via membrane as a result of GLUT4 recruitment (Szymczak & Śliwińska, 2019). GLUT4 is an insulin-regulated glucose transporter found primarily in adipose tissue and striated muscle. On the other hand, diabetes mellitus often experiences changes in magnesium distribution. Lack of magnesium levels in the body will reduce tyrosine kinase activity in the insulin receptor, this will have an impact on reducing insulin sensitivity (Faradhita et al., 2014). Based on this background, researchers have not found any metadata-based studies using bibliometric analysis. The existing literature has not yet comprehensively discussed combination therapy in diabetes mellitus therapy (Marchio, P., 2019).

In this study, we aimed to provide an overview of quantitative and visual information in the global literature regarding the relationship between vitamin D and reproductive health, identifying emerging trends and potential hot spots from various aspects through an integrative analysis of relevant information from published manuscripts. worldwide from 2012 to 2021. We present a brief discussion of vitamin D reproductive research and estimate possible trends in this field over the next few years, laying the foundation for future research directions and developments.

METHOD

Refinement of search result and compile preliminary data statistics

We conducted a systematic search of the literature in the SCOPUS database using the strategy described below: Literature studies with Title (Vitamin AND d AND magnesium AND diabetes AND mellitus) AND PUBYEAR > 2012 AND PUBYEAR < 2025 AND (LIMIT-TO (LANGUAGE , "English")). To avoid the impact of frequent database updates, all literature searches and data collection were carried out within 1 day on June 11, 2024. The search procedure is presented in Figure 1.

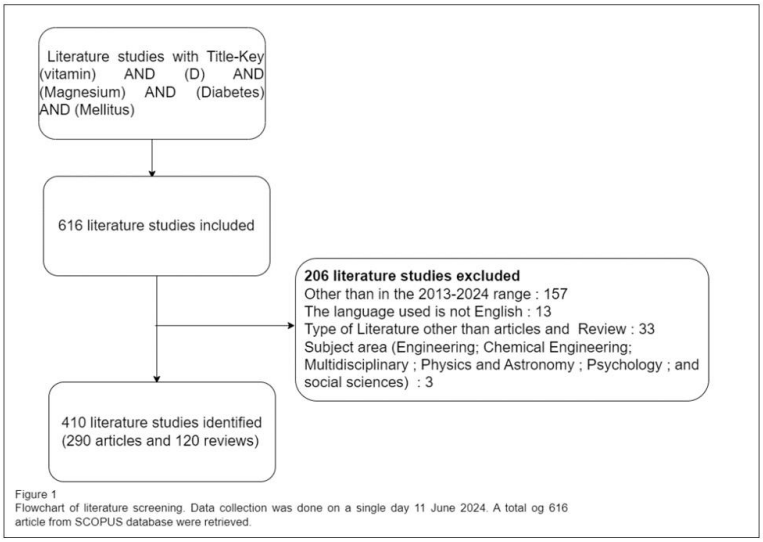

Figure 1. Search strategy for bibliometric analysis

Tools and materials

This research uses a research instrument in the form of bibliometric analysis. The data obtained comes from search results on the SCOPUS database which is saved in the form of CSV and ZIP files. The data processing can then be analyzed using Vos Viewer software version 1.6.19, Microsoft Excel, and Biblioshinny version R 4.3.0 which produces data in graphical form complete with bibliometric maps. A network diagram of keyword occurrences can be created by mapping the basic terms used to define the content of the paper (Zardari et al., 2022). Keywords, which come from the title and abstract, are represented as dots in the diagram, with edges connecting them to show words that appear together. When two nodes are connected, it indicates a correlation or relationship between the two terms. The distance between adjacent nodes shows a high correlation relationship, and vice versa. The node size describes the number of occurrences of the keyword.

RESULTS

Development of publications per year

The aim of this research was to explore scientific literature regarding the combination of Vitamin D and magnesium for diabetes mellitus published between 2013 and 2024. From this research, a total of 410 publications were found. Based on the graph, the number of publications from 2013 to 2018 was relatively stagnant. However, starting in 2019 the number of publications increased significantly to 39, and continued to increase to 67 publications in 2021. In 2024, the number of publications decreased because data was available only until June. The trend in publication development from 2013 to 2024 can be seen in Figure 2

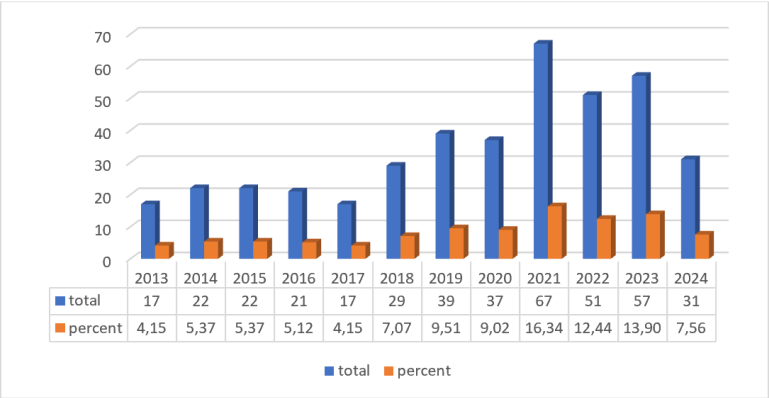

Figure 2. Development of publications for the period 2013 - 2024

Distribution of Journal

Based on the graph below, the distribution of journals that publish articles about the combination of vitamin D and magnesium in diabetes mellitus shows that the Nutrient journal has the highest number of publications with 30 articles (blue line). Followed by three journals with the same number of publications, each with 7 articles: Frontiers in Endocrinology, British Journal of Nutrition, and Obesity Surgery. Meanwhile, the journal with the lowest number of publications is Diabetes Metabolic Syndrome and Obesity, with only 5 articles.

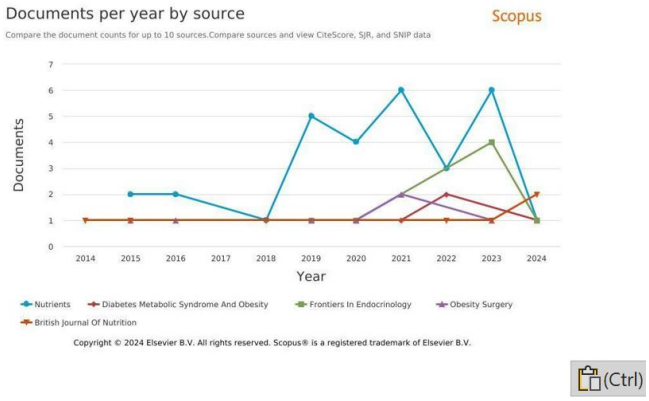

Figure 3. Journal sources used according to the topic

Distribution of Publication Document by Country

The combination of vitamin D with magnesium has attracted significant global attention, with publications originating from various countries around the world. Based on Figure 4, which analyzes the author's publication frequency by country, it is found that developed countries dominate the ten countries with the highest publication frequency. The United States leads with 95 publications, followed by the United Kingdom with 37 publications, while China and Iran each have 31 publications.

In addition, regarding the number of citations, the United States occupies the top position with 4,990 citations, followed by Australia with 683 citations and the United Kingdom with 624 citations. Figure 4B depicts this geographic distribution, demonstrating the broad and diverse interest in research regarding the combination of vitamin D and magnesium as a model for diabetes mellitus therapy.

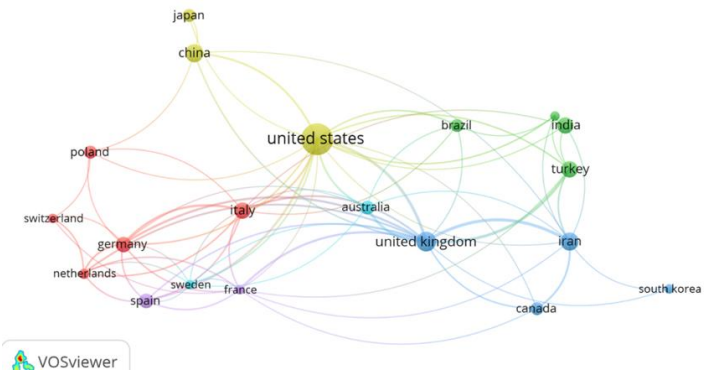

Figure 4.A Frequency of Author Publications by Country

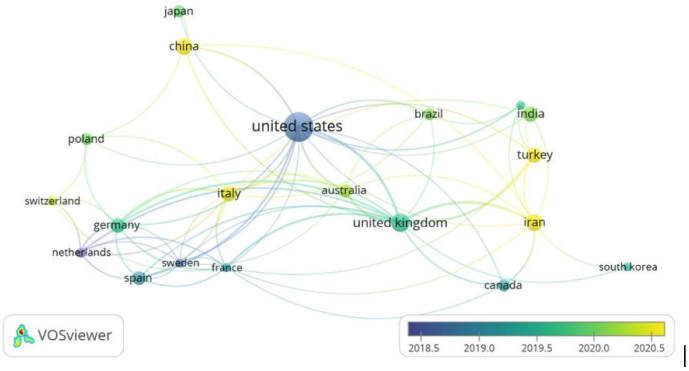

Figure 4.B State overvlay visualization

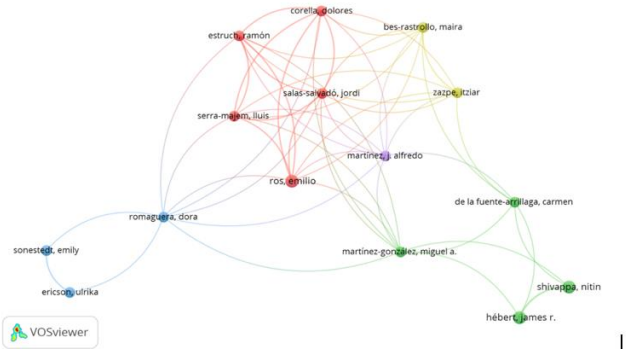

Figure 5. A Collaboration Network across authors

Distribution Author

From the results of the bibliometric analysis of Figure 5, it was found that Bener, A. and Martínez-González, M.A. are the two authors with the largest number of publications on this topic during that period, with each producing 4 publications. Apart from that, based on the analysis of the highest number of citations, three main authors were found, namely Mozaffarian, D. with 1470 citations, Yancy, W.S. with 747 citations, and De La Fuente-Arrillaga, C. with 167 citations. These authors have made significant contributions to increasing the visibility and impact of research on the combination of vitamin D and magnesium in the treatment of diabetes mellitus. Analysis using VOSviewer also shows connectivity between authors. Bes-Rastrollo, M. and Zazpe, I. are marked in yellow, which shows that although their number of publications is still small, namely 2 articles, the number of citations is also

relatively low with 127 citations. However, the articles of these two authors can be used as references because although they are few in number, they make important contributions to the research of this topic.

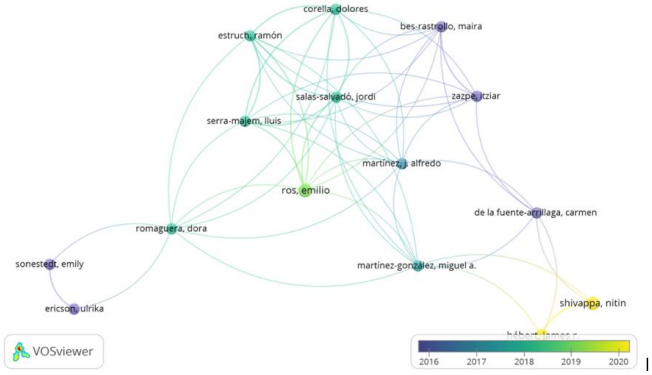

Figure 5.B Analysis of author co-authorship

The distribution of fields of science

Based on the results of bibliometric analysis, the top three scientific disciplines that published the most articles regarding the combination of vitamin D and magnesium in diabetes mellitus therapy were medicine (51.7%), nursing (15%), and biochemistry (13.6%). In addition, pharmacology is also a relevant field with a contribution of 7.3%.

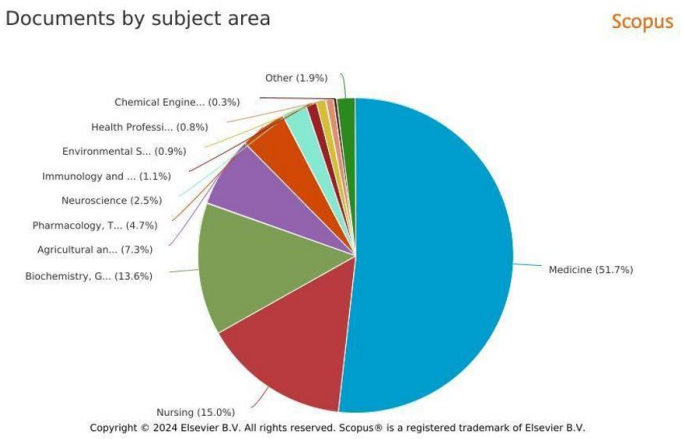

Figure 6. Article Related to the Combination of Vitamin D and Magnesium

Figure 7. Wordcloud

Diversity of keywords used (wordcloud)

The total number of keywords is 1141 words generated in research on the combination of vitamin D and magnesium on diabetes mellitus. Based on Figure 7, the wordcloud overview shows that the bigger the word, the more frequently the keyword appears, proven by analysis that the top 5 keywords are Vitamin D, which appears 45 times, followed by Diabetes 31 times, Magnesium 30 times, and Nutrition 26 times. . The word cloud resulting from this analysis provides an opportunity for future researchers to gain insight into the selected topic.

Co-occurrence (Network visualization)

In this study, VOS viewer was used to detect 1141 keywords, and 5 was chosen as the minimum number of keyword occurrences. As a result, there were 47 keywords that met the threshold. Figure 8. shows a keyword co-occurrence network showing the 50 selected keywords. These keywords are divided into 5 clusters: red, blue, green, purple, and yellow. Cluster analysis can be used to identify research trends. Each cluster is illustrated with a different color. The first cluster marked in red consists of 13 keywords, the second cluster marked in green consists of 10 keywords, the third cluster in blue has 10 keywords, the fourth cluster in yellow consists of 10 keywords, and the fifth cluster those marked in purple have 4 keywords.

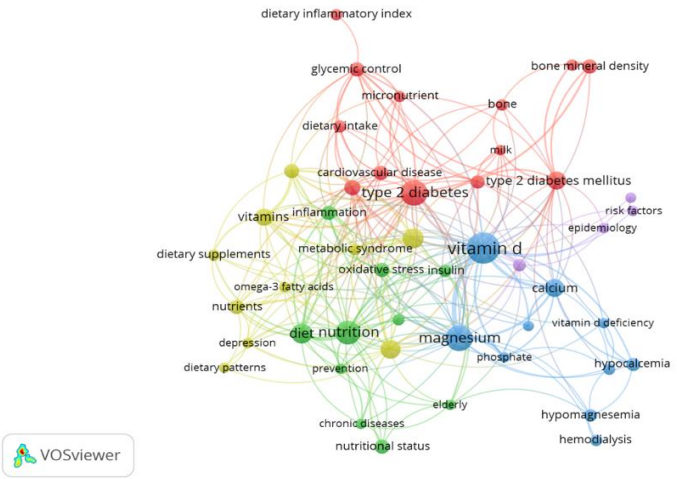

Figure 8.A Co-occurance Network Visualisation

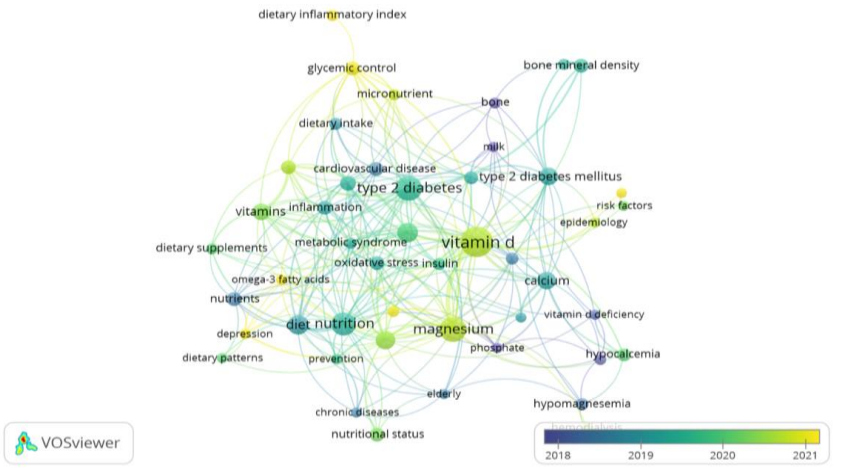

Figure 8.B. Co-Occurance Overvlay Visualization

Potential Opportunity on the Topic of th Influence on Nutrition on Diabetes

Some hot topics that require study and research in the future include glycemic control, micronutrients, dietary patterns, Omega-3 fatty acids, and vitamins. In 2020, many published articles discussed Vitamin D, magnesium, type 2 diabetes, and the influence of nutrition on diabetes. This visualization helps in identifying recent research trends and areas that require further exploration, thereby providing valuable insights for researchers interested in this topic.

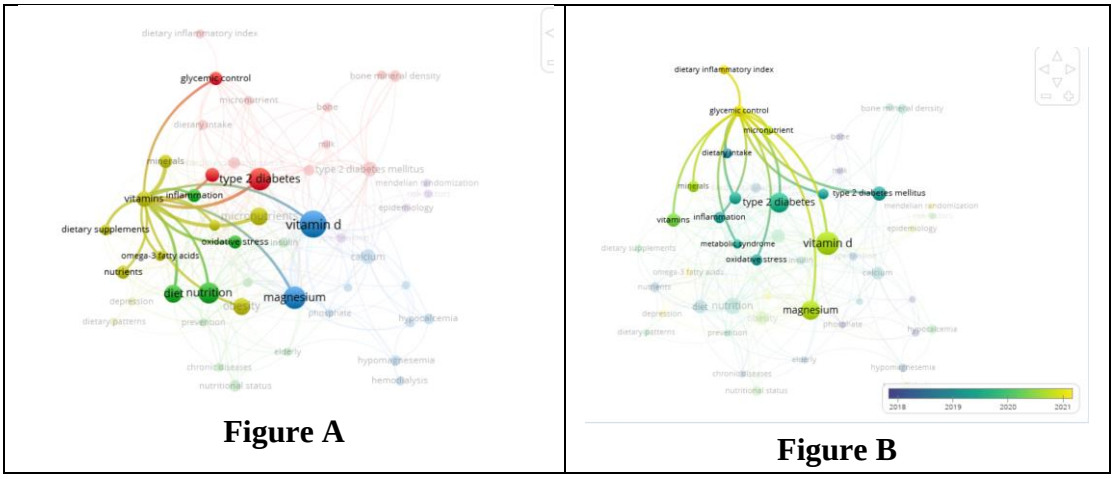

Figure 9. There are four columns that show potential topics including: (a) vitamins, dietary supplements, omega 3 fatty acids, and nutrients and (B) glycemic control.

DISCUSSION

Year

Research on the combination of Vitamin D and magnesium as a therapeutic model for diabetes mellitus has shown an interesting trend in recent years. Both have the potential to address this chronic condition in a more effective and holistic manner.

From 2013 to 2018, the number of publications on this topic remained relatively stagnant. This may be due to the lack of research focus on the specific interaction between Vitamin D and magnesium in the context of diabetes mellitus. However, a significant increase in the number of publications began to be seen in 2019, indicating increasing interest and awareness of the therapeutic potential of this combination.

Vitamin D is known to have an important role in calcium and phosphate metabolism and immune function. Research shows that Vitamin D deficiency can contribute to insulin resistance, which is one of the main causes of type 2 diabetes (Pittas et al., 2017). Additionally, Vitamin D supplementation has been found to improve pancreatic beta cell function and increase insulin sensitivity (Song et al., 2013).

Magnesium, on the other hand, is a mineral that is essential in various biochemical reactions in the body, including glucose and insulin metabolism. Several studies show that adequate magnesium intake can help reduce the risk of type 2 diabetes and improve glycemic control in diabetes patients (Veronese et al., 2016). Magnesium deficiency is often found in people with diabetes, which can worsen blood sugar control and increase the risk of diabetes complications (Barbagallo & Dominguez, 2010).

In the period 2019 to 2021, research began to focus more on how the combination of Vitamin D and magnesium can provide synergistic benefits in the management of diabetes mellitus. One study found that supplementation with both can improve blood sugar control and reduce the risk of diabetes-related complications (Dalgard et al., 2019). Other research shows that this combination can reduce

inflammation and oxidative stress, which are important factors in the development of diabetes and its complications (Zhang et al., 2020).

Research Year 2022-2024: In 2022, even though the number of publications is lower due to data tracking only up to June, research still shows a positive trend. The research focus this year is more on how to optimize the dose and method of administering a combination of Vitamin D and magnesium for maximum results in diabetes mellitus therapy (Jorde et al., 2022). Research is also starting to explore potential side effects and interactions with other medications frequently used by diabetes patients (Ljungberg et al., 2022).

Field of Study

The dominance of medical science (51.7%) in this study shows that the topic of the combination of vitamin D and magnesium in diabetes mellitus therapy is closely related to aspects of health and clinical treatment. Diabetes Mellitus is a type of disease that originates from food issues and therefore nutraceuticals are used to treat this disease because they have the ability to control the disease (Rejeki, 2019). Medical science plays a central role in the diagnosis, treatment and management of diabetes mellitus patients. Studies show that vitamin D can increase insulin sensitivity and regulate blood glucose levels (Sadiya et al., 2015). Magnesium also plays an important role in glucose metabolism and insulin function (García-Cruz et al., 2020). Nursing knowledge (15%) shows the important role of nurses in the management of diabetes patient care, including monitoring and educating patients regarding vitamin D and magnesium supplements. Studies show that education and intervention by nurses can improve glycemic control in diabetes patients (Housden et al., 2017).

The field of biochemistry (13.6%) shows that research on the combination of vitamin D and magnesium is closely related to understanding at the molecular level. Research has often focused on the biological mechanisms underlying the therapeutic effects of vitamin D and magnesium. Research by Dibaba (2019) shows that vitamin D supplementation can increase insulin sensitivity in individuals at risk of diabetes. Pharmacology (7.3%) focuses on the study of drugs and supplements, including vitamin D and magnesium, and their interactions with the human body. Research helps understand optimal dosage, side effects, and potential interactions between supplements and medications. Research by Kheder et al. (2016) emphasized the importance of vitamin D in the prevention and management of type 2 diabetes.

Wordcloud

Word Cloud is a graphic illustration of the words that appear most frequently in a text (DePaolo & Wilkinson, 2014). Figure. 6 shows a collection of the most commonly used keywords taken from the Scopus database, consisting of the top 50 results. The word cloud resulting from this analysis provides an opportunity for future researchers to gain insight into the selected topic. The data obtained shows that the larger the word in the word cloud, the higher the frequency of its occurrence in this topic, which is positively correlated with the number of occurrences of the keyword.

Potential opportunities on the topic of diabetes mellitus and therapy with vitamin D and magnesium

Good glycemic control is key in the management of diabetes mellitus to prevent long-term complications. Further research is needed to understand how nutritional interventions and supplementation may affect glycemic control in patients with type 2 diabetes (Ahluwalia et al., 2016; Ley et al., 2014). Micronutrients, such as vitamins and minerals, play important roles in various body functions and can influence the risk and management of diabetes. Further research is needed to explore the specific role of micronutrients in the pathophysiology of diabetes (Lamichhane et al., 2015 ; Ristic-Medic et al., 2013).

Diet has a significant impact on diabetes risk and management. Research evaluating the effects of various eating patterns, such as the Mediterranean diet, low-carbohydrate diets, and high-fiber diets, is essential for developing effective dietary recommendations for people with diabetes (Esposito et al., 2015; Hu, 2011). Omega- 3 fatty acids, have demonstrated anti-inflammatory and cardioprotective effects, which may be beneficial in the management of diabetes and related complications. Further research is needed to evaluate the optimal dose and long-term effects of omega-3 supplementation in people with diabetes (Hartweg et al., 2008; Salas-Salvado et al., 2011).

Certain vitamins, such as vitamin D and vitamin E, have been associated with improved insulin sensitivity and a reduced risk of diabetes complications. Further research is needed to determine the specific role of vitamins in diabetes management and prevention of complications (Pittas et al., 2007; Al-Daghri et al., 2014).

CONCLUSION

This research describes global trends in research on the combination of vitamin D and magnesium as a therapy for diabetes mellitus from 2013 to 2024. Publications have increased significantly since 2019, with a peak in 2021. The journal Nutrient has the highest number of publications. The United States leads in the number of publications and citations, indicating a major contribution. Prominent authors such as Bener, A. and Mozaffarian, D. had significant influence. Primary keywords included “Vitamin D,” “Diabetes,” and “Magnesium,” with five major research clusters identified. Potential future topics include glycemic control and micronutrients. The combination of vitamin D and magnesium shows great potential as a diabetes mellitus therapy, with the hope that further research will explore its mechanisms and effectiveness.

UCAPAN TERIMA KASIH

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