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Evaluating Pharmacists' Knowledge Of The Relationship Between Vitamin B12 And Magnesium Deficiency In Diabetics.

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ABSTRACT

T2DM is a persistent, complicated, and diverse condition. It is one that exhibits a variety of pathophysiological abnormalities, as well as a variable propensity to complications and a variable clinical response to therapeutic intervention. The study aims to identify the experiences and awareness of pharmacists about the relationship between vitamin B12 and magnesium deficiency in diabetics and to determine the effect of using metformin for diabetics on vitamin B12. Data were distributed by Electronic questionnaires designed for pharmacists. The questionnaire was also published on various Facebook pages dedicated to pharmacists, and answers were collected from them within two weeks using the electronic questionnaire via Google Forms. Pharmacists' knowledge of nutritional supplements is average, as half of the pharmacists are above the minimum level, due to their knowledge of the relationship between vitamin B12 and magnesium deficiency in diabetic patients. And the 60% of pharmacists have obtained pharmaceutical training regarding vitamins and nutrients. With an 82% of pharmacists know vitamin B12 is the most important vitamin for diabetics. 56% of pharmacists recognize that metformin causes vitamin B12 deficiency 64% of pharmacists' answers know that magnesium deficiency occurs with diabetes.

Keywords: Magnesium, Deficiency, Vitamin B12, Food supplement, Food source, diabetes

1. Introduction

There are 415 million adult cases of diabetes worldwide, 91% of which are type 2 diabetes mellitus (T2DM) (ADA, 2012). T2DM is a persistent, complicated, and diverse condition. It is one that exhibits a variety of pathophysiological abnormalities, as well as a variable propensity to complications and a variable clinical response to therapeutic intervention. It necessitates continual medical monitoring, along with a significant amount of self-management to keep an eye on lipid profiles, blood pressure, and blood sugar levels. The danger of potential acute and long-term consequences, such as neuropathy, retinopathy, and nephropathy, as well as cardiovascular morbidities, which are elevated two- to thrice in these patients and are afterwards a major cause of death, and must also be minimized. This calls for multifactorial solutions (DeFronzo et al, 2015).

One of the most popular oral diabetes medications is metformin. With estimations that it is commonly approved and advised for persons with diabetes worldwide (Viollet et al, 2012), metformin is the basic medication for the treatment of type 2 diabetes mellitus (T2DM). In both US and European standards, metformin is recommended as a first-line treatment for T2DM. Despite its efficiency and safety, there have been reports of negative effects such vitamin B12 malabsorption (Liu KW,et al 2006 , Bell, 2010).

A subsequent drop in vitamin B12 plasma level, especially with high doses. Vitamin B12 insufficiency may result from metformin's interference with the calcium-dependent absorption of intrinsic factor and vitamin B12 (Fogelman, 2016). Some individuals may experience vitamin B12 insufficiency as a result of other diabetes treatments; vitamin B12 is crucial for healthy blood cells and the neurological system. When a person does not consume enough vitamin B12 through their food, they may experience a vitamin B12 deficiency (Louise Morales, 2023). Since numerous illnesses may eventually result in macrocytic anemia, neuropathy, cognitive dysfunction, and mental abnormalities, diagnosing vitamin B12 insufficiency is crucial from a therapeutic standpoint (Fogelman, 2016).

There is evidence to suggest that people with type 2 diabetes who take metformin may experience a vitamin B12 deficit. Higher metformin doses and longer treatment times also increase the risk of low vitamin B12 levels. Furthermore, mounting data point to a potential link between low vitamin B12 levels and an increased risk of developing diabetes. However, the 2020 report emphasizes the need for additional research to fully comprehend the potential contribution of vitamin B12 to the onset of diabetes (Louise Morales, 2023). Even if there is a discrepancy between findings and clinical symptoms, vitamin B12 insufficiency should still be treated to prevent neurological deterioration in patients (Hunt, et al, 2014).

The majority of research on vitamin B12 and diabetes up to this point has concentrated on vitamin B12 insufficiency in diabetic patients. There is conflicting data that links the use of metformin with low vitamin B12 levels (Yang et al., 2019).

Patients with type 2 diabetes typically experience a significant drop in serum vitamin B12 levels while taking metformin because ileal vitamin B12 absorption is a calcium-dependent process, and metformin is known to have an impact on calcium-dependent membrane function (Bauman et al., 2000). However, due to the conflicting findings of earlier studies, the hazards and advantages of vitamin B12 on the chance of developing diabetes in the future are unclear. Both the metabolism of glucose and other enzymatic reactions require the cofactor magnesium. Low magnesium levels are linked to diabetes, and hypomagnesemia is linked to insulin resistance, inflammation, and an increased risk of CVD (Peters KE, et al 2013).

Increased renal magnesium and glucose excretion brought on by hyperglycemia may result in hypomagnesemia (McNair, et al 1982). When low magnesium was added to conventional risk factors in diabetic individuals, Haglin et al. previously documented a substantial increase in all-cause death (Haglin, et al 2007). The beneficial cardiovascular benefits of metformin may be compromised by its association with potentially decreased plasma magnesium concentrations and renal magnesium excretion (Peters KE, et al 2013).

Depending on the dose given and whether the treatment is acute or chronic, there also seem to be changes in our knowledge of how the medicine operates at the molecular level. Metformin has been shown to limit mitochondrial respiration, possibly by inhibiting mitochondrial glycerophosphate dehydrogenase and/or by involving a lysosomal mechanism, as well as AMP-activated protein kinase (AMPK)-dependent and AMPK-independent actions (Rena, etal 2017, McCreight, et al 2016).

It is important to note that many adults in developed nations do not consume the advised daily intake of foods high in magnesium, such as whole grains, nuts, and green leafy vegetables, and that magnesium is rarely discussed in studies on the prevention of type 2 diabetes or stroke (Powers, 2018, Brignole, 2018).

As a result, we focused on type 2 diabetes, vitamin B12 deficiency, and magnesium shortage due to the significance of the pharmacist's role, which has gained more attention over the past few decades (Hijazi, et al 2019).

Community pharmacists are well-positioned to be a key player in the delivery of care (Kayyali, 2016). Due to their position at the point of service, community pharmacists are the most numerous and easily accessible health care providers. (Kayyali, 2016). The health care system depends heavily on pharmacists, who also have the biggest impact on the results of public health initiatives. Patients' education has always been greatly influenced by the local pharmacist (Alaqeel, 2015).

Additionally, a number of research have highlighted communication gaps between pharmacists and patients when it comes to health goods, dietary choices, and supplements, and some studies have recommended that pharmacists need effective training in order to support better health care outcomes (Hadi, et al 2016).

Lack of knowledge hinders pharmacists from providing informative advice about nutritional and vitamin choices to consumers. Lack of counseling skills has also been cited as one of the primary challenges that many pharmacists face while providing care (Al-Arifi MN 2014, Alotaibi , 2018)

1.1.1 Importance of vitamin B12

A crucial B vitamin is vitamin B12. It is essential for the health of the brain, the generation of red blood cells, and nerve tissue. Another name for vitamin B12 is cobalamin. The largest and most physically intricate vitamin is vitamin B12. The formation of red blood cells and the prevention of anemia, the ability to think, the prevention of congenital abnormalities, the protection of the eyes from macular degeneration, and the production of energy are just a few of the many bodily functions that require vitamin B12 (medical news today, 2022).

The creation of DNA and RNA, the body's genetic material, as well as maintaining healthy nerve cells are two of the vitamin B12's key functions. In order to aid in the formation of red blood cells and improve iron absorption in the body, vitamin B12 closely collaborates with vitamin B9, commonly known as folic acid or foliate. S-adenosylmethionine (SAMe), a substance implicated in immune function and mood, is created when folate and B12 combine. Together, vitamins B12, B6, and B9 regulate the amount of the amino acid homocysteine in the blood. Heart disease is linked to homocysteine levels that are high (mountsinai, 2022).

1.1.2 Vitamin B12 deficiency

A lack of healthy red blood cells brought on by low levels of vitamin B-12 and folate is known as vitamin deficiency anemia. This may occur if you do not consume enough foods rich in folate and vitamin B-12 or if your body has difficulties absorbing or processing these nutrients. Red blood cells that are produced by the body without these nutrients are overly big and do not function correctly. They are less able to transport oxygen as a result. Dizziness, weariness, and shortness of breath are other symptoms. Vitamin injections or pills used as supplements can make up for the inadequacies. Anemia caused by a vitamin deficiency typically takes months or years to develop. At first, signs and symptoms could be mild, but they typically get worse as the deficit gets worse. Weight loss, numbness or tingling in the hands and feet, muscle weakness, personality changes, shortness of breath, dizziness, pale or yellowish complexion, irregular heartbeats, fatigue, and unsteady movements are a few of these that may occur. Meat, eggs, milk, breakfast cereals, nutritional yeast products are all sources of nutrients (mayo clinic, 2022). The recommended daily intake (RDI) for vitamin B12 for adults over the age of 14 is 2.4 mcg (health line, 2022).

A rising number of different biological systems and organs benefit from vitamin B12. Lack of vitamin B12 is a typical issue. There is evidence that vitamin B12, deficiency occurs more frequently than anticipated. Early identification of vitamin B12, deficiency is crucial for prescribing appropriate treatment. Patients who are unable to absorb vitamin B12 and people with dietary habits that exclude animal products are at risk of developing vitamin B12 insufficiency. Pernicious anemia has been cited as a common cause of vitamin B12,

insufficiency. Vitamin B1, deficiency has several causes, including pernicious anemia. More detailed definitions and descriptions of new causes of vitamin B12 insufficiency, such as inadequate dietary intake (Narayanan et al, 1991). Food-vitamin B12 malabsorption syndrome, are included in recent studies on the condition (Andrès et al, 2004 - Termanini et al, 1998)

Hematological abnormalities are typically incomplete, as contrasted to historical descriptions, as evidenced by hereditary vitamin B12, metabolism illnesses such Imerslund-Grasbeck syndrome.

People with B12 insufficiency may be asymptomatic, but vitamin B12 deficiency should be considered in individuals who exhibit myelopathy, cognitive decline, neuropathy, mental problems, or certain hematological signs and symptoms (Gräsbeck, 2006).

1.1.3 Vitamin B12 Development

Many research studies emphasize the health complications of nutritional vitamin B12 deficiency and a necessity of clinical, biochemical, and metabolic monitoring in infants born to mothers with a vita- min B_1, deficiency. Dietary deficiencies of vitamin B, during pregnancy and lactation may result in health problems in exclusively breastfed infants. Physical examinations of these children often reveal psychomotor retardation, apathy, muscular hypotonia, irritability, anorexia, abnormal movements, and failure to thrive. Laboratory analyses show hematological abnormalities, such as a megaloblastic anemia, low levels of vitamin B12 high levels of homocysteine and methylmalonic acid, and methylmalonic aciduria (Smolka ,2001).

1.1.4 Relation between Metformin and Vitamin B12 deficiency

Metformin may cause vitamin B12 deficiency through one or more of the following mechanisms:

(1) Interference with the calcium-dependent binding of the intrinsic factor (IF)-vitamin B12 complex to the cubilin receptor on enterocytes at the ileum level and/or interaction with the cubilin endocytic receptor.

(2) Alteration in bile acid metabolism and reabsorption, resulting in impaired enterohepatic circulation of vitamin B12.

(3) Reduced IF secretion by gastric parietal cells

(4) Increased liver accumulation of vitamin B12, resulting in altered tissue distribution and metabolism of vitamin B12.

(5) Alteration in small intestine motility, resulting in small intestinal bacterial overgrowth and subsequent inhibition of IF-vitamin B12 complex absorption in the distal ileum. B12: Vitamin B12: BAS: Bile acids; IF:

Intrinsic factor. As shown in figure (1.1) (Infante, Marco ,et al 2021).

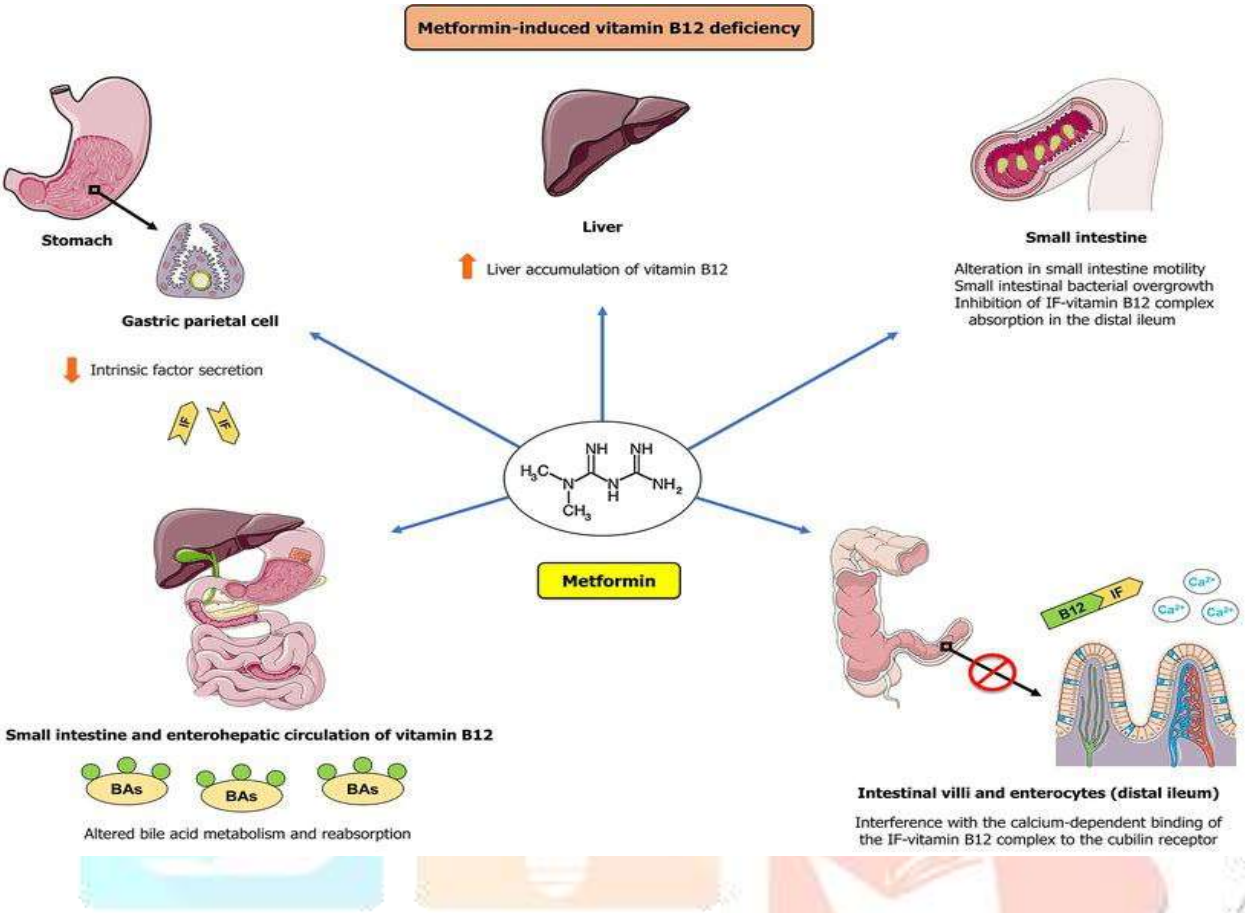

Figure (1.1): Postulated mechanisms accounting for metformin-induced vitamin B12 deficiency. (Infante, Marco et al, 2021).

1.1.5 Importance of Magnesium

In the human body, magnesium is involved in about 300 enzyme processes. It supports the immune system and assists with blood pressure control, muscle and neuron function, and other processes. A typical adult's body has about 25 grams (g) of magnesium, of which the skeletal system retains 50–60%. Magnesium is essential for numerous body processes, and the remainder can be found in muscle, soft tissues, and bodily fluids. Getting enough of this mineral can aid in the treatment or prevention of chronic illnesses like migraine, type 2 diabetes, Alzheimer's disease, and cardiovascular disease (Miho, 2023) and type 2 diabetes. High magnesium diets have been related in studies to a decreased risk of type 2 diabetes. This may be because magnesium is essential for insulin metabolism and glucose regulation to occur (Miho, 2023). Reviewing 2015 According to a reputable source in the World Journal of Diabetes, magnesium deficiency affects the majority of persons with diabetes, although not all of them (Barbagallo, 2015).

After calcium, sodium, and potassium, magnesium is the fourth most prevalent mineral in the human body and the second most prevalent intracellular cation (Elin, 2010). Due to its critical function in the manufacture of ATP (adenosine triphosphate) from ADP (adenosine diphosphate) and inorganic phosphate (Ko Y. H, 1999),

intracellular Mg reserves are concentrated in mitochondria (Kubota, 2005). Additionally, it is thought that 3571 human proteins may be able to bind to Mg+2 since Mg is coupled to ATP in order to produce the bioactive form of ATP (Mg-ATP) (Piovesan, 2012). According to Avioli (1966), magnesium has a half-life of around 1000 hours, or 42 days, in the body.

1.1.6 Magnesium and type 2 diabetes

An increased prevalence of Mg deficits have been found in DM2 patients, especially in those with poorly controlled glycemic profiles, with longer disease duration, and with the presence of micro- and macrovascular chronic complications (Del Gobbo, 2012). Type 2 diabetes mellitus (DM2) is frequently accompanied by alteration of Mg status. Hypomagnesemia is not a need for magnesium insufficiency. But when it occurs, hypomagnesemia typically signals a serious systemic Mg deficiency. Individuals with normal total serum Mg levels may exhibit a decrease in intracellular and/or ionized plasma Mg (Barbagallo, 2014). It is difficult to link Mg deficiency to diseases because the majority of research in the literature have examined total serum Mg rather than the free, ionized (bioactive), or intracellular Mg contents.

It has been recently confirmed that elderly diabetes patients are more likely to develop hypomagnesemia; this condition is directly associated to metabolic control as measured by glycated hemoglobin, even after relevant confounders have been taken into account. With merely a test of total Mg, it may be difficult to identify diabetic older persons with low blood Mg concentrations. (Barbagallo, 2014).

When compared to non-diabetic subjects, subjects with DM2 consistently have lower intracellular free Mg levels (Barbagallo, 2000. 2007_ Resnick, 1993).

The cause of the cellular Mg deficit seen in DM2 has not yet been fully determined, however it may be explained by changes to the mechanism(s) of Mg uptake in the cells and/or a lack of ATP. ATP concentration and intracellular Mg concentration have a complicated relationship. The decline in cellular Mg may be partially explained by the drop in ATP. If cellular ATP levels drop, Mg is less likely to bind to ATP and produce MgATP, which could result in an increase in intracellular Mg concentration (Barbagallo, 2007).

1.1.7 Deficiency of magnesium

There are two forms of nutritional deficiencies: subclinical deficiencies, which are characterized by a clinically silent decline in physiological, cellular, and/or biochemical capabilities, and frank deficiencies, such as scurvy from an ascorbic acid shortage or goiter from an iodine deficiency. The latter is particularly troubling because it is challenging to identify and predisposes to many chronic conditions. Even though both have harmful impacts on one's health, the former has evident symptoms (thus frank deficiency), and the latter may have less visible negative or changeable health effects (such vascular calcification). According to the evidence in the literature, subclinical magnesium deficiency is widespread, one of the major factors in the development of

chronic illnesses including cardiovascular disease and early mortality, and it should be prioritized as a public health concern (Elin, 2011_ Marier, 1986)

In clinical medicine, hypermagnesemia is a reasonably frequent condition. Since few doctors are aware of the several clinical situations in which deficiency, or excess, of this ion may arise, it is typically overlooked since magnesium levels are rarely checked (Henzel, 1967).

Older statistics predicted that 15%–20% of the population in wealthy nations had a marginal magnesium shortage (Durlach, 1989). This supports more recent studies showing that subclinical magnesium shortage affects 10%–30% of a population when serum magnesium levels are less than 0.80 mmol/L (Costello, 2016). Low serum magnesium concentrations were reported in 36.3% of Mexican adult females and 31% of Mexican adult males, respectively, according to the 2006 National Health and Nutrition Survey (Mejía, 2006).

Although serum magnesium levels may be normal, magnesium insufficiency might nevertheless exist (Abbot, 1993). The potassium and magnesium levels in the erythrocytes of 381 unselected old men and women, most of whom were in their 80s, were found to be low in about 20% of the population (Touitou, 1987)

1.1.8 Magnesium homeostasis

Although saturable magnesium buildup processes have been seen in the brush border cells of the ileum, the absorption of magnesium in the digestive tract is not entirely understood. The rest of the small intestine absorbs magnesium passively while the ileum uses an active transport pathway. Through a Na+/Mg2+ exchange, magnesium from the diet is taken up at the apical side of intestinal epithelial cells and released into the blood at the basolateral side (Long, 2022). Magnesium stored in the bones creates an interchangeable pool that is beneficial for absorbing fluctuations in serum magnesium levels. The erythrocytes in blood contain magnesium as well, and their magnesium content is regarded as a good predictor of the body's magnesium levels. Plasma ion concentration is significantly influenced by renal regulation of these ions, which is accomplished through tubular reabsorption and glomerular filtration. The tight junction proteins claudin-10 and claudin-16 have been found to play a key role in the paracellular reabsorption of magnesium along the ascending limb of the Henle's loop in recent years. Genetic studies in patients with primary hypomagnesaemia have shown “transient receptor potential melastatin 6” (TRPM6) as the principal component involved in epithelial magnesium reabsorption (Fanni, 2020).

The equilibrium of magnesium mostly depends on the kidney. Under typical conditions, 84 mmol of magnesium are filtered each day, and only 95%, or around 80 mmol, are reabsorbed. This causes an excretion of around 4 mmol/day in the urine. The kidneys are principally in charge of excreting magnesium. Magnesium excretion by the kidneys seems to have a diurnal cycle, peaking at night. The glomeruli filter about 2400 mg (99 mmols) of magnesium every day. Contrary to most other ions, where reabsorption often occurs in the proximal tubule, the majority of reabsorption occurs in the thick ascending limb of the loop of Henle. In the

proximal tubule, only 10–25% of magnesium is reabsorbable via passive paracellular transport (Ehrenpreis, 2022).

1.1.9 Relationship between type 2 diabetes and altered Magnesium balance

The human body has several physiological processes that depend on the ion magnesium (Mg2+), one of the most prevalent ions in the body. For instance, Mg2+ is a cofactor of numerous enzymes involved in cell signaling, protein metabolism, and cellular bioenergetics. Thus, Mg2+ deficiency in the development and persistence of T2DM. Although Mg2+ deficiency has been widely studied in T2DM, the molecular clinical and molecular mechanisms are poorly reviewed. This review examines the recent literature linking type 2 diabetes to altered Mg2+ homeostasis, from experimental observations and clinical trials to the molecular mechanisms by which Mg2+ influences glucose homeostasis in type 2 diabetes. (Feng,j. Et al 2020/ Silva Morais, et al 2017)

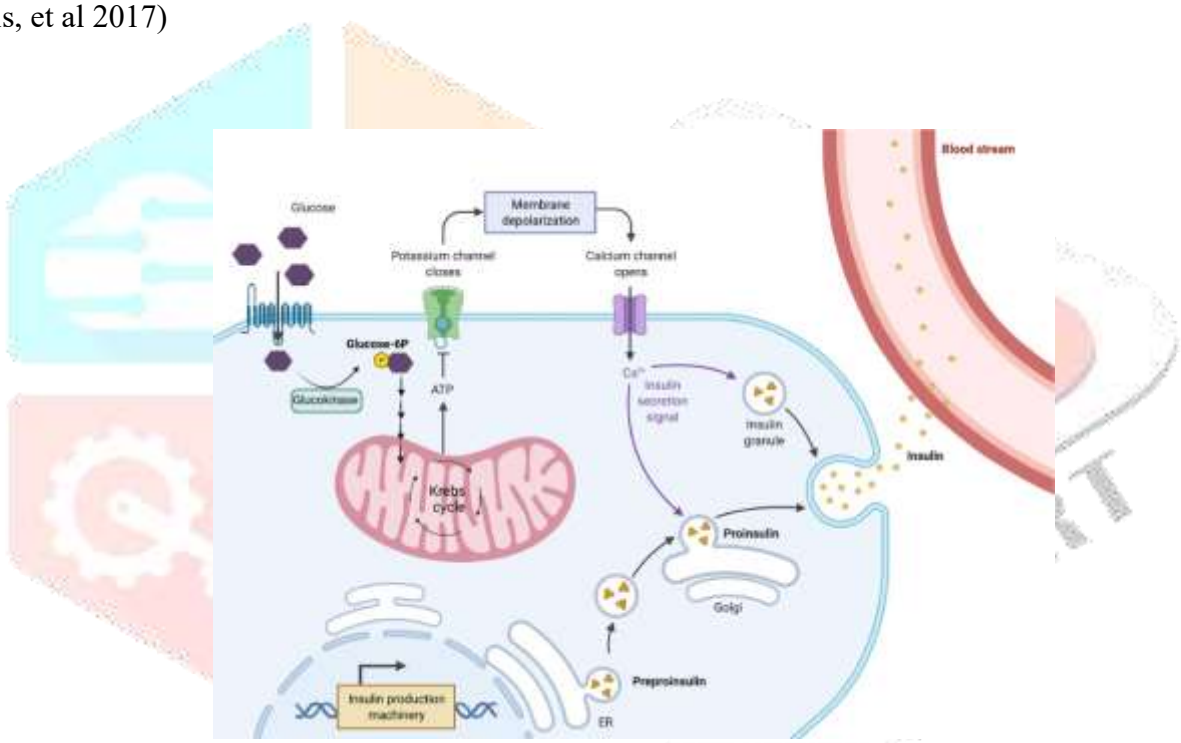

Fig. (1.2): Glucose-mediated insulin secretion.

As shown in Figure (1.2) Glucose enters beta cells (β-cells) by glucose transporter 2 (GLUT2) and is converted to glucose-6 phosphate (Glucose-6P) by glucokinase. Several steps lead to the glucose transformation into adenosine triphosphate (ATP) through glycolysis, the Krebs cycle, and oxidative phosphorylation (OXPHOS). ATP inhibits and closes the potassium channel, inducing membrane depolarization. The latter promotes calcium channel opening to release calcium (Ca2+) into the cytosol, causing insulin secretion signals to secret insulin into the bloodstream. (Soriano ,et al 2022).

1.2 Aims & Objectives of the study

The study aims to achieve the following objectives:

1. Identify the experiences and awareness of student pharmacists about the relationship between vitamin B12 and magnesium deficiency in diabetics.

2. To know the effect of using metformin for diabetics on vitamin B12?

3. Identify the possibility of errors and misunderstanding by diabetic patients about the importance of vitamin B12 during treatment.

4. Identify the potential for errors and misunderstanding by diabetic patients about the importance of magnesium during treatment.

1.3 Limitations of the study

• The number of patients included in this study was small and we recommend conducting multiple studies with a larger number of pharmacists for better evaluation.

• This study can be considered as a pilot study for future studies that will include pharmacists from all regions. Therefore, despite those existing limitations, our study will serve as a baseline for future studies and will send signals to health policy makers regarding health aspects in patients with diabetes and the need for nutritional supplements.

2. METHODOLOGY

2.1 Introduction

This chapter provides an overview of the research methodology and describes the procedures used in the study, including the research design, selection and description of participants, and the tools used for data collection and data analysis.

2.2 Research design

This research aims to identify the experiences and awareness of student pharmacists about the relationship between vitamin B12 and magnesium deficiency in diabetics. To achieve this goal, a quantitative research design was adopted to analyze the data collected through the Google Form questionnaire.

2.3 Participants

The participants in this study were pharmacists. Participants were randomly selected. They volunteered to participate in this study by answering the electronic questionnaire that was published on the various Facebook pages of the Pharmacy Department. The total number of participants was 50 and all participants were between 18 and 65 years old.

2.4 Tool

The research instrument used in this study is a questionnaire designed to obtain data from pharmacists about the experiences and awareness of pharmacists about the relationship between vitamin B12 and magnesium deficiency in patients with diabetes. To find out the effect of using metformin for diabetics on vitamin B12, the questionnaire consists of three parts: the first part is personal information, and the second part: pharmacists' awareness of the relationship between vitamin B12 and magnesium deficiency in diabetics. The third part: The pharmacist's awareness of patients about vitamin B12 and magnesium deficiency. It consists of (31) questions. In order to obtain a more accurate picture, this closed questionnaire was designed using Google Forms to collect data from participants and all questions were multiple-choice.

2.5 Data collection

Electronic questionnaires designed for pharmacists were distributed. The questionnaire was also published on various Facebook pages dedicated to pharmacists, and answers were collected from them within two weeks using the electronic questionnaire via Google Forms. The researchers expressed their willingness to assist all participants if there was any unclear or indirect item used in the questionnaire.

2.6 Data analysis

Data collected from pharmacists' answers will be quantitatively analyzed using Microsoft Office Excel sheets and Google Forms statistical analysis and will be illustrated in pie charts, tables and graphs.

3. Results

3.1 Introduction

Pharmacists had an important role in taking actions to addressing including drug information for healthcare professionals, patient counseling, and suggestion for change in therapy, monitoring results reports, drug supply management, safety measures, and application of tools to evaluate a disease (Visacri. et al, 2021). This study was carried out as a survey presented to 50 pharmacists at private pharmacies in Libya to collect information on the experiences and awareness of student pharmacists about the relationship between vitamin B12 and magnesium deficiency in diabetics.

3.2 part one: Description demographic characteristics of study participants

The Demographic characteristics of the participants are summarized in Tables and figures (3.1 to 3.4) A total of 50 pharmacists in this study were recruited for the study, the age ranges was between (18-55 years), the mean age was 41.5 , included 26 males and 24 females.

Table (3.1) Distribution of Age

	N	*Minimum*	*Maximum*	*Mean*
age	*50*	*18*	*55*	*41.5*

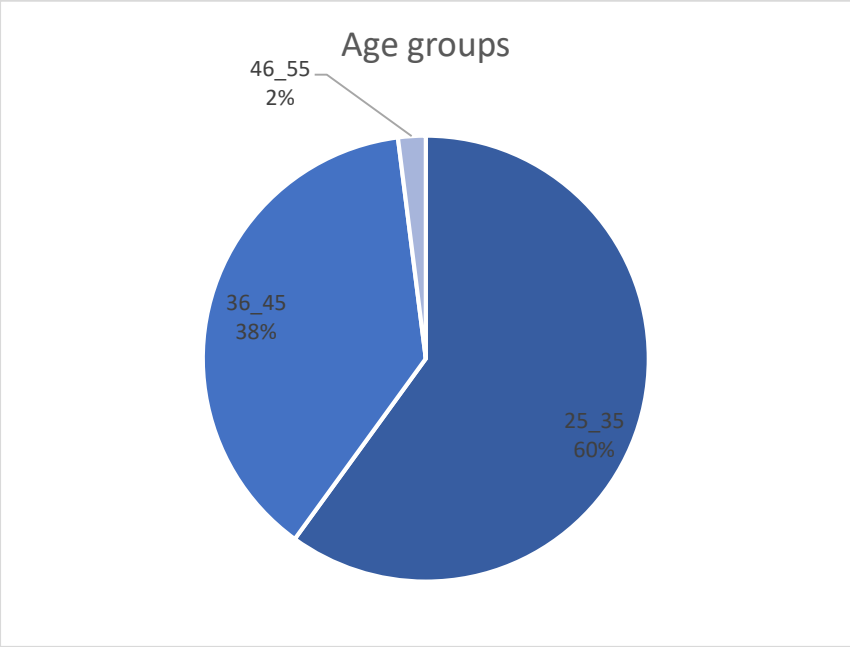

Figure (3.1) Distribution of Age

As shown in Figure 3.1, the highest percentage was 60% among young pharmacists between the ages of 25 and 35 years. And about 2% among pharmacists aged 46-55 years.

Table (3.2) Distribution of Gender

	Frequency	*Percent*
male	*26*	52%
female	*24*	48%
	50	

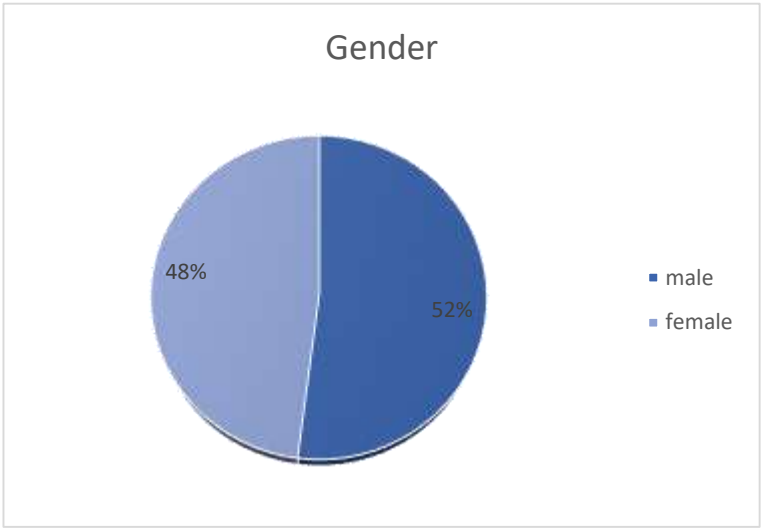

Figure (3.2) Distribution of Gender

As shown above in Figure 3.2, it was concluded that 52%, meaning that more than half of the pharmacists were male, and 48% of the pharmacists were female.

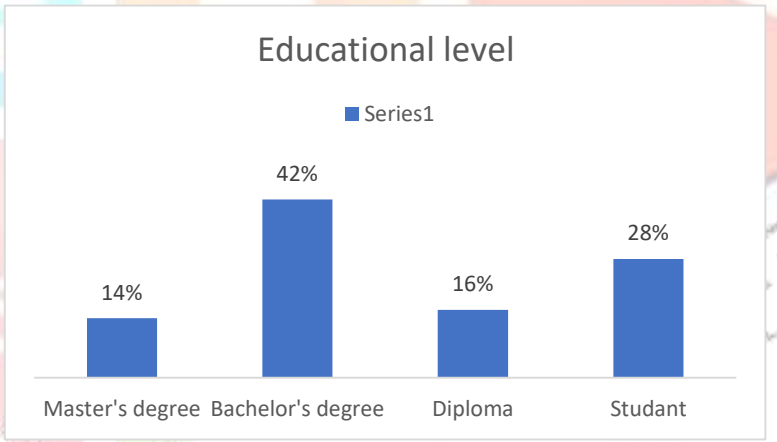

Figure (3.3) Education level of participants

Regarding the participant's educational level, approximately 42% whereas bachelor's degree, and 28% were student and 16% of diploma holders as demonstrated in figure (3.3)

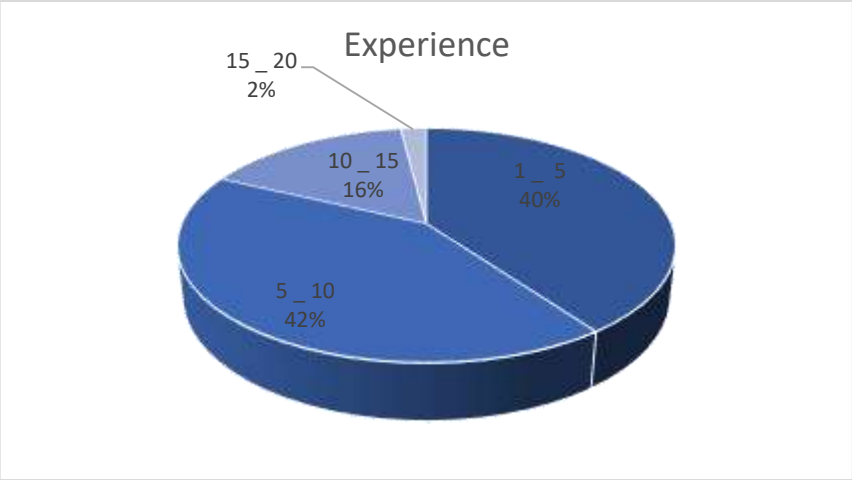

Figure (3.4) experience of participants

Figure (3.4) showed that the highest percentage of participants had experience from 5 to 10 years, at 42%, while 40% had experience from one to 5 years.

3.3 part two: pharmacists' awareness of the relationship between vitamin B12 and magnesium deficiency in diabetics.

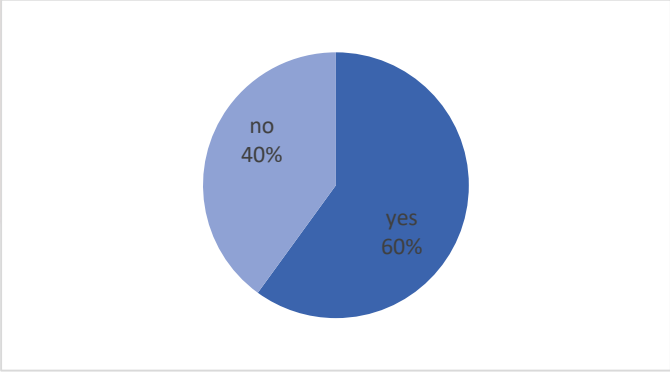

Figure (3.5) pharmaceutical ***training regarding vitamins and nutrients***

In the figure (3.5) the pharmacist was asked whether he obtained pharmaceutical training regarding vitamins and nutrients. More than half of the pharmacists' answers said that they obtained training, at a rate of 60%.

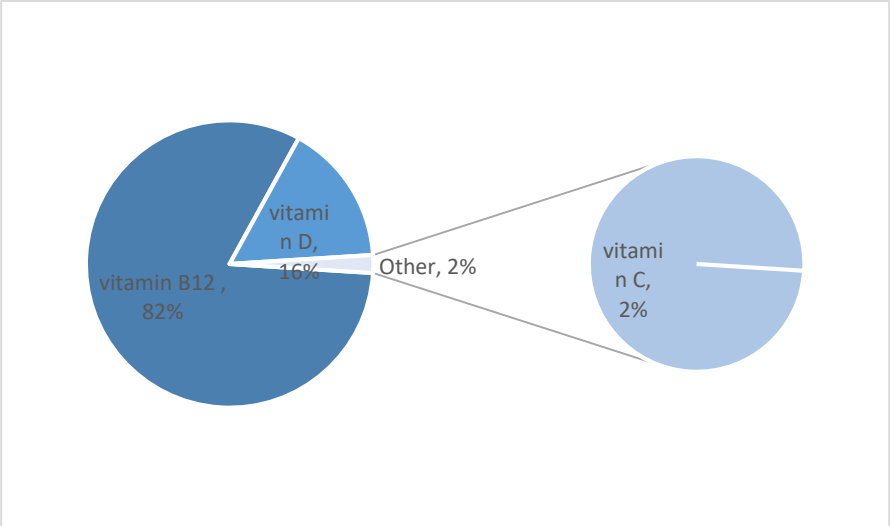

Figure (3.6) most important vitamin for diabetics

It is shown in the figure above (3.6) with a percentage of 82% that vitamin B12 is the most important vitamin for diabetics. This indicates that pharmacists know that the most important treatment necessary for a diabetic patient is taking vitamin B12. Then comes Vitamin D at 16%.

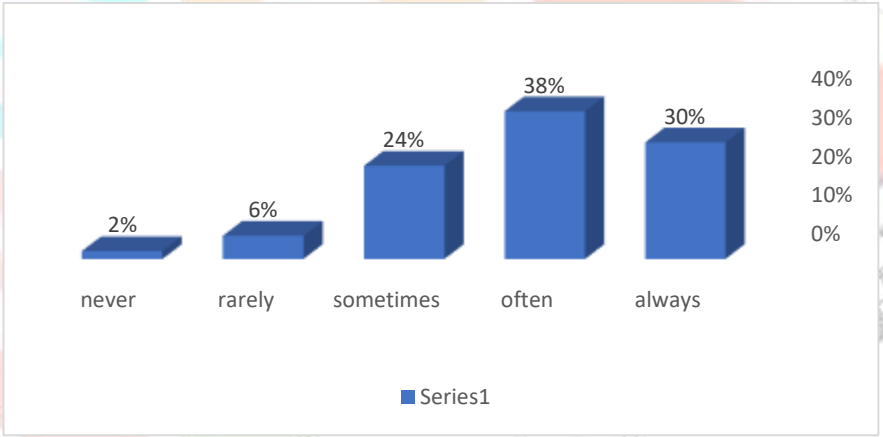

Figure (3.7) provide advice to patients and consumers

It was found that 38% of pharmacists often provide advice to patients and consumers about the side effects of taking vitamins and nutritional supplements, and 30% of pharmacists always provide advice as in the figure (3.7)

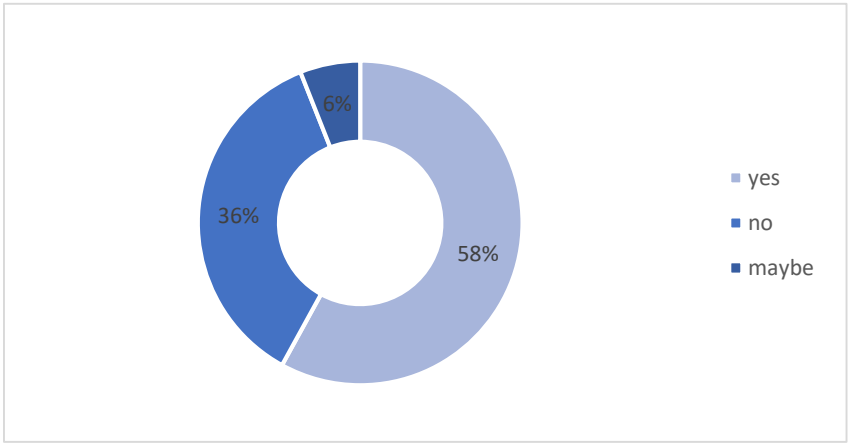

Figure (3.8) cause of nausea, vomiting, and diarrhea in diabetics

As shown above in the figure (3.8) it was found that more than half of the pharmacists, at a rate of 58%, said that vitamin B12 deficiency is one of the problems of nausea, vomiting, and diarrhea in diabetics.

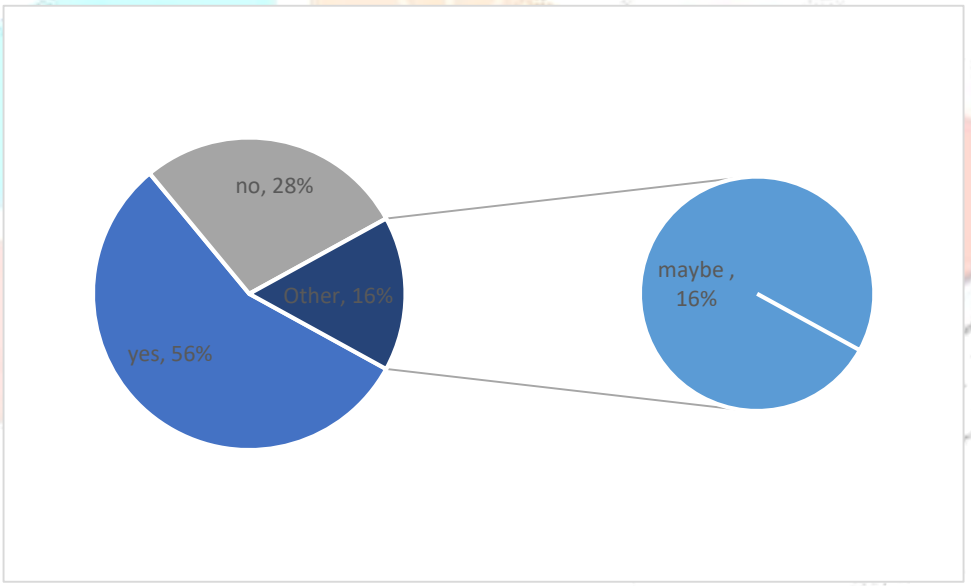

Figure (3.9) reason behind depression and mood changes

In the figure (3.9), 56% showed that the reason behind depression and mood changes in diabetics is a deficiency of vitamin B12 and magnesium.

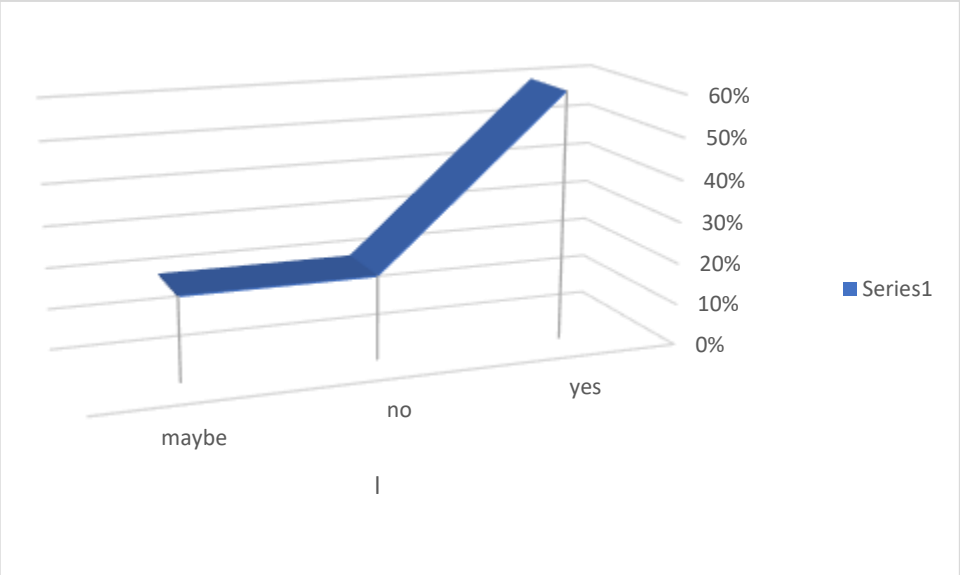

Figure (3.10) cause of neurological diseases in diabetics.

It is shown in the figure (3.10) above that more than half of the pharmacists (60%) know that vitamin B12 deficiency is the cause of neurological diseases in diabetics.

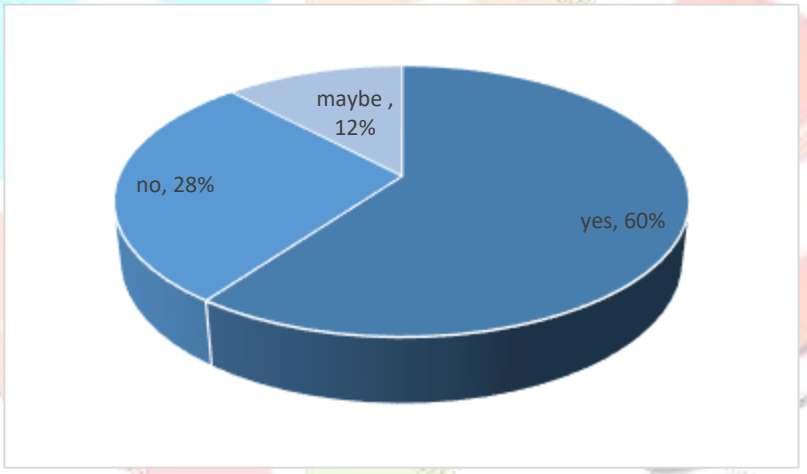

Figure (3.11) cause of vitamin B12 deficiency in diabetics

As shown above in the figure (3.11) After the census, it was concluded that 60% of pharmacists know the cause of vitamin B12 deficiency in diabetics, and 28% of them do not know the reason, while 12% of pharmacists answered that they may know the cause of vitamin B12 deficiency.

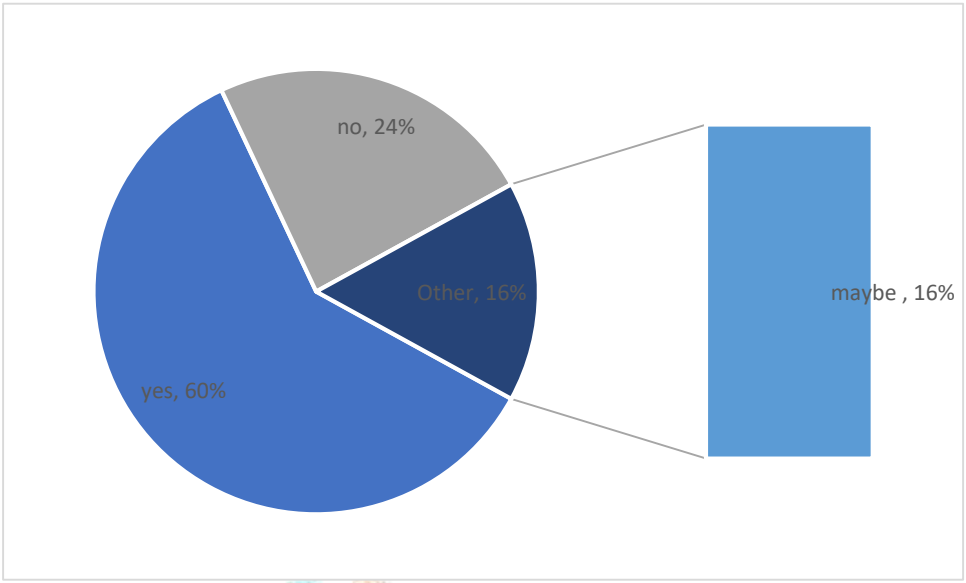

Figure (3.12) advise diabetics to take treatment for vitamin B12 deficiency

It is shown in the figure (3.12) that more than half of pharmacists (60%) advice diabetics to take treatment for vitamin B12 deficiency, and this indicates the importance of the role of community pharmacists in caring for diabetics.

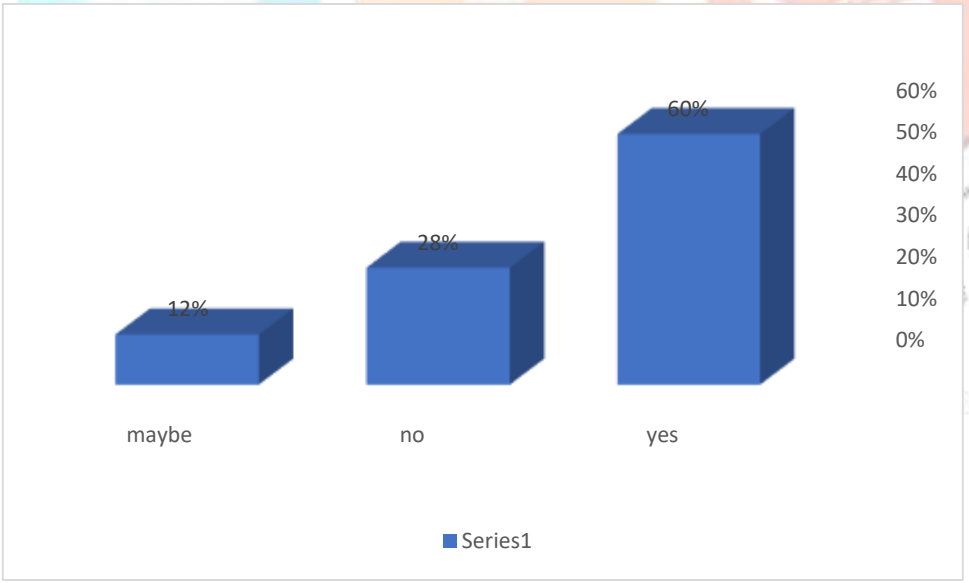

Figure (3.13) know the dosage when taking treatment for vitamin B12 deficiency

It is also shown in the figure (3.13) that more than half of the pharmacists, or 60%, know the dosage when taking treatment for vitamin B12 deficiency. This indicates that pharmacists have a role in spreading awareness and attention to diabetes patients.

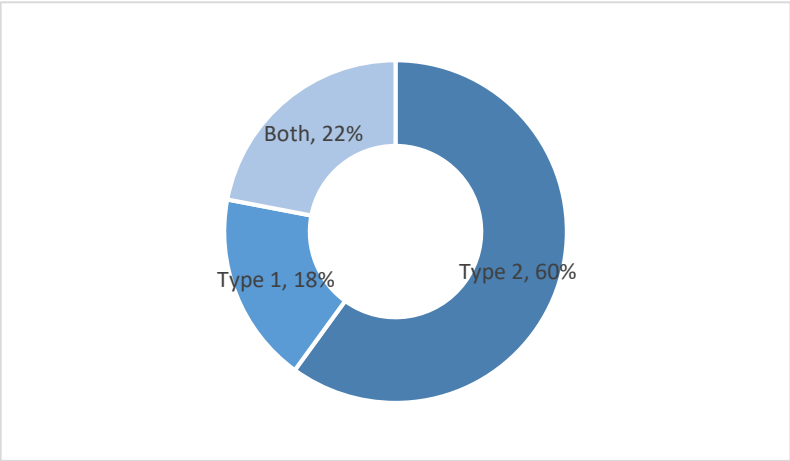

Figure (3.14) Know that vitamin B12 deficiency occurs with any type of diabetes.

As shown above in the figure (3.14) after the statistics, it was concluded that 60%, or more than half of the pharmacists, know that vitamin B12 deficiency occurs with type 2 diabetes.

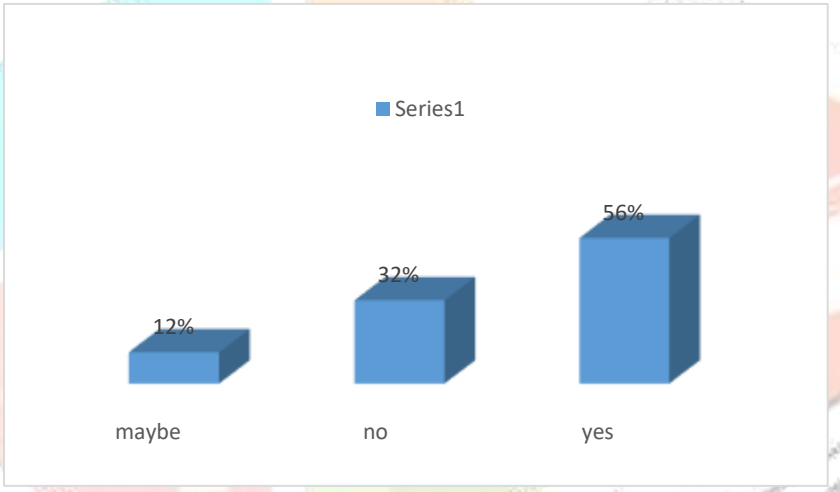

Figure (3.15) know that metformin causes vitamin B12 deficiency in diabetic patients

It was found that 56% of pharmacists know that metformin causes vitamin B12 deficiency in diabetic patients by obstructing the absorption of vitamin B12. As shown in Figure (3.15)

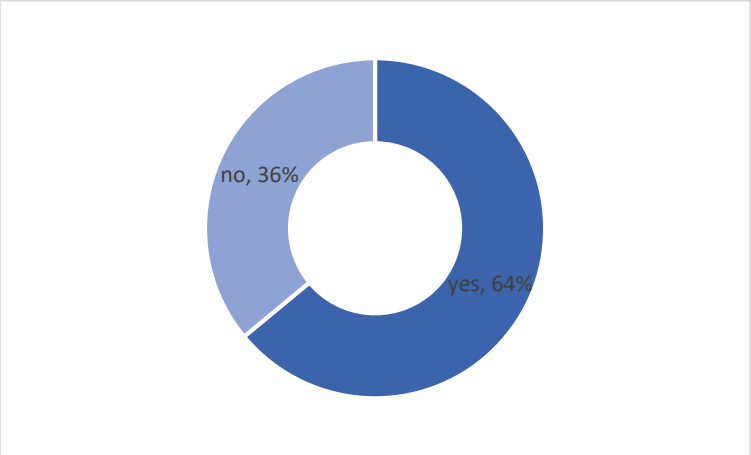

Figure (3.16) know that magnesium is a helpful factor in glucose metabolism.

As shown above in the figure (3.16) 64% showed that the majority of pharmacists' answers know that magnesium is a helpful factor in glucose metabolism.

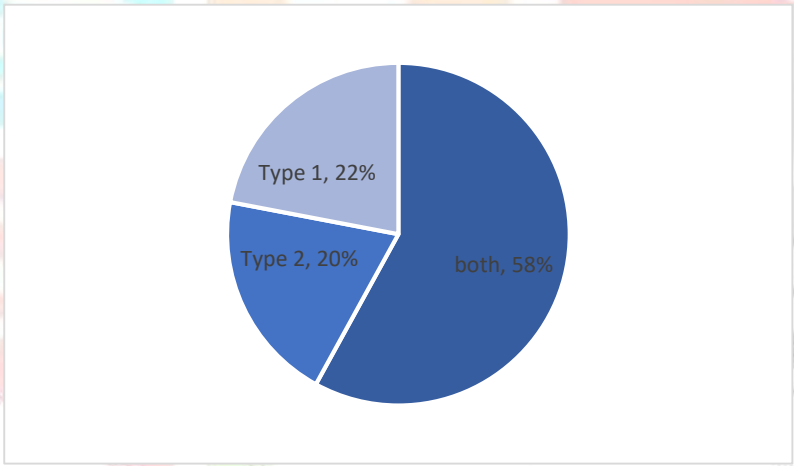

Figure (3.17) know that magnesium deficiency occurs with any type

As shown in the figure (3.17) it was concluded that 58%, or more than half of pharmacists know that magnesium deficiency occurs with type 1 and type 2 diabetes.

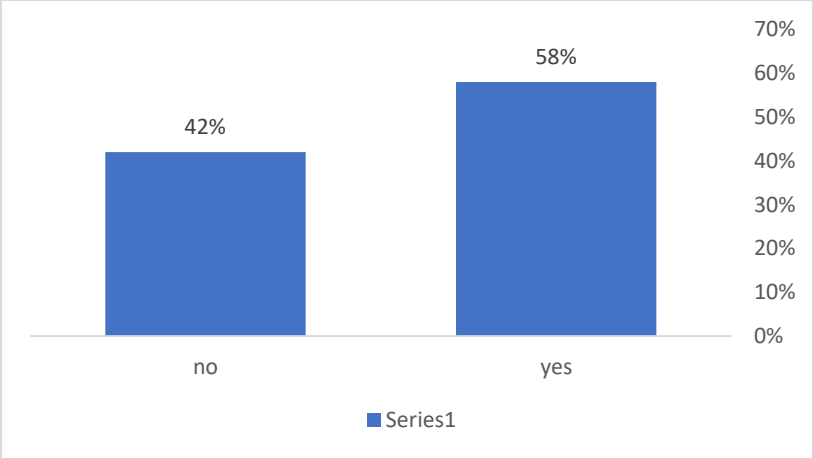

Figure (3.18) know the dosage to taking treatment for magnesium deficiency

In the figure (3.18) it appears that 58% of pharmacists know the dosage according to age groups in the case of taking treatment for magnesium deficiency, and this indicates the extent of their awareness of everything related to diabetics.

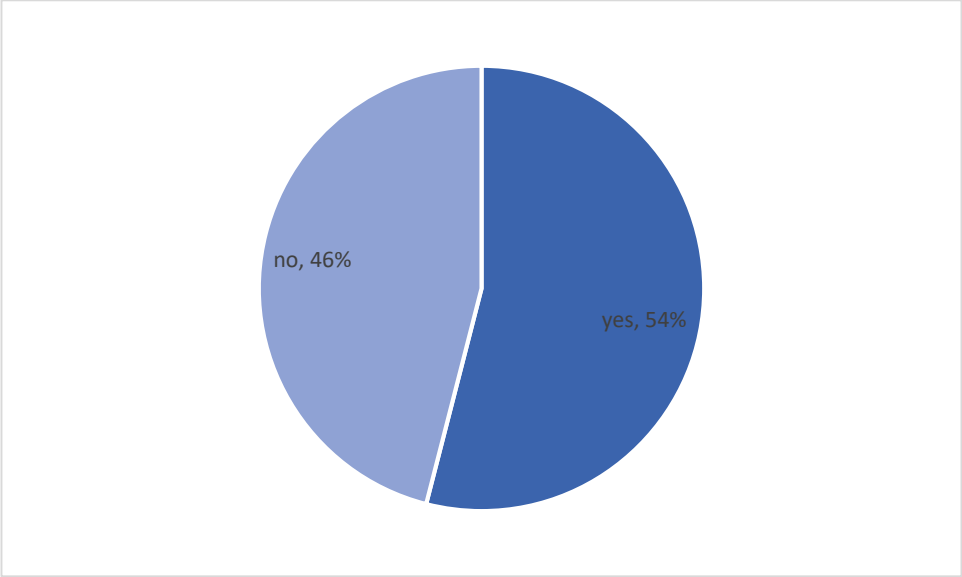

Figure (3.19) advise diabetics to take treatment for magnesium deficiency.

In the figure above (3.19), it is shown that 54% of pharmacists advise diabetics to take treatment for magnesium deficiency.

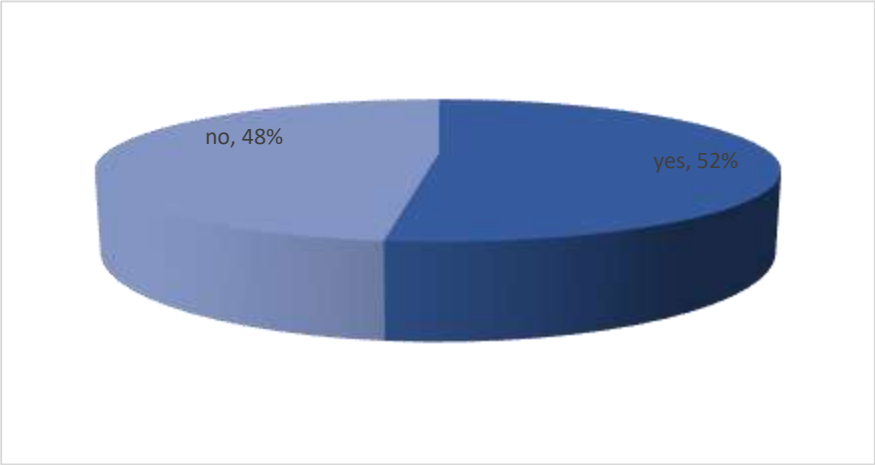

Figure (3.20) pharmacist required to treat vitamin B12 and magnesium deficiency

It turns out that the majority of answers to the pharmacist are that the patient requests treatment for vitamin B12 and magnesium deficiency from the pharmacist, at a rate of 52%, as in the figure (3.20) This indicates that the citizen is aware of this deficiency.

Part Three (pharmacist awareness of patients about vitamin B12 and magnesium deficiency)

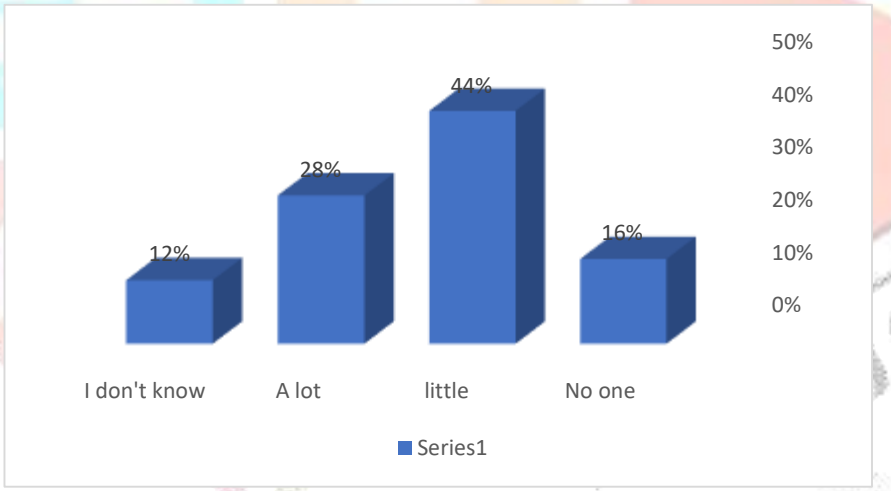

Figure (3.21) patients ***hesitate to visit the pharmacy***

It is clear from the figure (3.21) 44% responded that a little diabetic patients hesitate to visit the pharmacy, and a lot of them hesitate (28%).

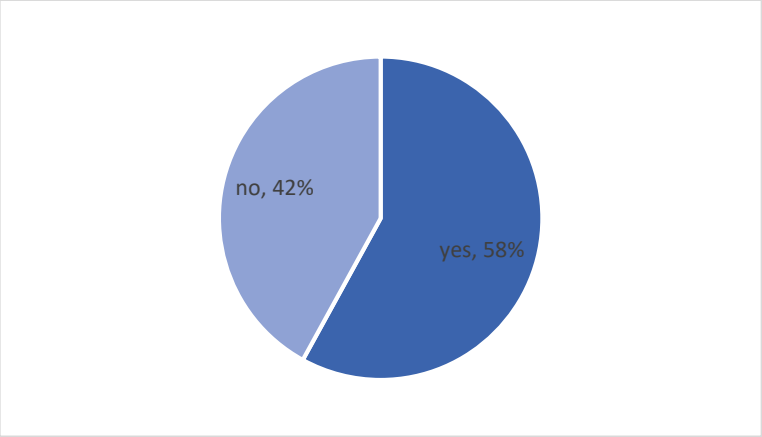

Figure (3.22) awareness of the vitamins and minerals given to diabetics.

As shown above in the figure (3.22) after the statistics, it was concluded that 58% responded that there is citizen awareness of the vitamins and minerals given to diabetics.

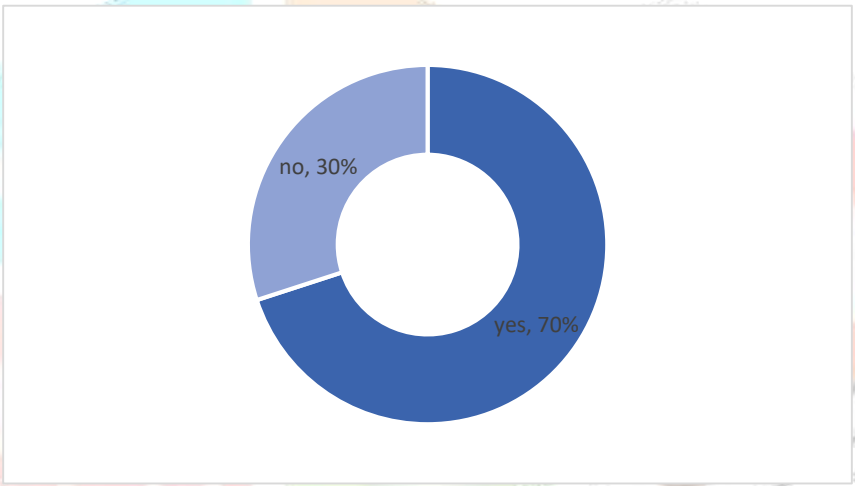

Figure (3.22) metformin is the drug that is widely accepted by patients

It was found that 70% of pharmacists answered that metformin is the drug that is widely accepted by patients and is known to treat diabetes.

4. Discussion

4.1 Discussion

The study aims to identify the experiences and awareness of student pharmacists about the relationship between vitamin B12 and magnesium deficiency in diabetics and to determine the effect of using metformin for diabetics on vitamin B12. To our knowledge, this is the first study that examines the knowledge, attitudes, and practices of pharmacists in Libya. This information is valuable since pharmacists are front-line healthcare professionals and may be asked to advise patients about these products and nutritional supplements. This study showed that more than half of pharmacists are male and have 5 to 10 years of work experience, in contrast to the study (Brunelli, 2022), which can be explained by the fact that Libya has a large work community consisting mainly of men.

It has been concluded from the results of this study that pharmacists' knowledge of nutritional supplements is average, as half of the pharmacists are above the minimum level, due to their knowledge of the relationship between vitamin B12 and magnesium deficiency in diabetic patients. These results seem to confirm what was already found in a review on this topic, where the average knowledge score was 64% in a study (Waddington et al, 2015), but contradict the high level of knowledge recently reported (Bukic et al, 2021).

The results show that pharmacists have obtained pharmaceutical training regarding vitamins and nutrients. Similar to their study (Al-Jamei, 2019) where pharmacists took courses on pharmacy in their pharmacy degree programs. In addition, the role played by an important factor in influencing the decision to recommend nutritional supplements was subjective and personal experience with nutritional supplements.

The need for stronger collaboration between all parties interested in ensuring optimal use of nutritional supplements has been recognized (Ung, 2019_Harnett, 2020). Interprofessional collaboration, especially between pharmacists and physicians, was seen as important in improving patient treatment outcomes and safety (Rakvaag, 2020_ Seselja, 2019). To contribute to this collaboration, pharmacists will need further education on the principles and applications of evidence-based pharmacy, with a particular focus on vitamins, nutritional supplements, and chronic diseases.

Although nutritional supplements are an important complementary source of essential nutrients, pharmacists were fully aware that vitamin deficiencies may be related to chronic drug therapy and a healthy lifestyle. Pharmacists know that the most important supplement necessary for a diabetic patient is taking vitamin B12. And also the side effects of taking vitamins and nutritional supplements. This belief seems to be confirmed in their attitudes and practices, and with regard to counseling patients about natural sources of vitamin intake and healthy lifestyles, including those with diabetes. Especially its importance in maintaining health and wellness and preventing diseases. This is also similar to (Epicentro, 2022, FederSalus, 2018) and that pharmacists provide advice to patients and consumers about the importance of vitamins and nutritional supplements and

the side effects of taking vitamins and nutritional supplements, and this is similar to the study (Marupuru, 2019) that they recommend many nutritional supplements to patients. This finding is similar to that of a 2001 survey of 420 pharmacists' patterns of dietary supplement use (Nutritional Products International). Pharmacists in this study advise diabetics to take treatment for vitamin B12 deficiency. This indicates the importance of the role of community pharmacists in caring for patients with diabetes and other chronic diseases and vitamin deficiencies, which is consistent with the results of other studies (Eisenberg, 1998_wootton, 2001).

It is difficult to diagnose the neurological manifestations of vitamin B12 and magnesium deficiency in diabetic patients, including myelopathy, neuropathy, and dementia (Hemmer, 1998_ Maamar, 2006), but the pharmacists in this study know that vitamin B12 deficiency is the cause of neurological diseases in diabetics. Also, the reason behind depression and mood changes in diabetics is a deficiency of vitamin B12 and magnesium. As reported by Ikapi et al (Ekabe, 2017). Therefore, the severity of neurological complications can only be reversed by early treatment after their onset, so timely diagnosis is important. Although vitamin B12 levels are rapidly corrected by prompt treatment and early clinical improvement is restored, nerve conduction neuropathy may be slow to develop. More attention should also be paid to the issue of whether pharmacists should be specifically trained to provide advice to patients with chronic diseases, most notably diabetes, regarding the use of nutritional supplements, because to date, this expertise is likely to have grown primarily in hospice settings. acute, and are therefore provided by hospital pharmacists, who were excluded from this study. But in general, pharmacists seem to be fulfilling their responsibilities in counseling patients, believing that their role is essential and that the pharmacy is the safest place to sell these products. The results of our study could support previous reports that pharmacists are using these nutritional supplements and provide new evidence suggesting that the use of these products has increased. If this trend is also achieved in the general population, this finding has important implications for ensuring that pharmacists are able to identify any drug interactions and advise patients on the appropriate use of nutritional supplements in patients with diabetes.

4.2 Conclusion

It is necessary for pharmacists to provide advice to patients and consumers about the importance of vitamins and nutritional supplements and the side effects of taking vitamins and nutritional supplements and to recommend many nutritional supplements to patients. This indicates the importance of the role of community pharmacists in caring for patients with diabetes and other chronic diseases and vitamin deficiencies, as vitamin B12 and magnesium are important elements for the blood cells and nervous systems of patients, and it is possible for any person who may suffer from a deficiency of vitamin B12 and magnesium when he does not get enough of it. From his diet. Vitamin B12 deficiency can occur in individuals with type 2 diabetes who take metformin. The risk of low vitamin B12 levels also increases with higher metformin doses and longer duration of treatment. In addition, there is a possible relationship between low levels of vitamin B12 and a

higher risk of diabetes. However, more research is needed to understand the potential role of vitamin B12 in the development of diabetes. There also appear to be differences in understanding how the drug works at a molecular level, depending on the dose given and whether the treatment is of an acute or chronic nature. Diabetes is also associated with low magnesium, and hypomagnesemia is associated with insulin resistance, inflammation, and increased risk of cardiovascular disease. Hypomagnesemia is likely a result of increased excretion of magnesium and renal glucose due to high blood sugar. The drug metformin has been associated with low concentrations of magnesium in plasma. And renal magnesium excretion.

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