

The Effect of β -glucan on Reducing HbA1c Levels in Patients with Diabetes Mellitus: A Meta-Analysis Study

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ABSTRACT

Diabetes mellitus is a non-communicable disease with a continuously increasing global prevalence and is characterized by elevated glycated hemoglobin (HbA1c), which reflects poor glycemic control and increases the risk of chronic complications. Nutritional management, particularly the intake of water-soluble dietary fiber such as β -glucan, has been proposed as an adjunct therapy for glycemic control. This study aimed to analyze the effect of β -glucan on reducing HbA1c levels in patients with diabetes mellitus through a meta-analysis. Literature was retrieved from PubMed and ScienceDirect, and article selection followed the PRISMA flowchart, resulting in four eligible studies. Statistical analysis was performed by calculating the mean difference and 95% confidence interval using both common and random effects models, while heterogeneity was assessed using the I^2 statistic. The results showed that β -glucan intervention significantly reduced HbA1c levels, with greater reductions observed at doses ≥ 5 g/day and intervention durations ≥ 12 weeks. The common effect model demonstrated a mean difference of -0.57 (95% CI: -0.80 to -0.34 ; $p < 0.0001$), while the random effect model showed a mean difference of -0.50 (95% CI: -0.88 to -0.12 ; $p = 0.0094$). In conclusion, β -glucan effectively reduces HbA1c levels in patients with diabetes mellitus, with effectiveness influenced by dosage, duration, type of β -glucan, and participant characteristics, indicating its potential role in nutritional strategies for glycemic management.

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Introduction

Diabetes mellitus is a non-communicable disease and a leading cause of global mortality, particularly in low- and middle-income countries (Ogle et al., 2025). According to the International Diabetes Federation (IDF), in 2024 there were approximately 588.7 million adults aged 20–79 years living with diabetes mellitus worldwide, and this number is projected to increase by 45% to 852.5 million by 2050. In Southeast Asia, diabetes cases are estimated to reach 106.9 million in 2024 and are expected to rise by 73% to 184.5 million by 2050. Indonesia alone is estimated to have around 20.4 million diabetes cases in 2024, placing it fifth globally (IDF, 2025). This rapid increase highlights diabetes mellitus as a major public health challenge requiring effective management strategies. Diabetes mellitus is a metabolic disorder characterised by chronic hyperglycemia resulting from impaired insulin secretion, insulin action, or both (Kristelina et al., 2023). The condition is influenced by genetic predisposition, unhealthy lifestyles such as poor dietary patterns and physical inactivity, and obesity (Susanti et al., 2024; Wahidin et al., 2024). Diabetes mellitus is classified into two main types: type 1 diabetes mellitus, caused by autoimmune destruction of pancreatic β -cells leading to absolute insulin deficiency (Kartini, 2025), and type 2 diabetes mellitus, which

is associated with insulin resistance and relative insulin deficiency due to genetic and environmental factors (Lestari & Zulkarnain, 2021; Naki et al., 2025).

Insulin resistance occurs when target tissues, such as skeletal muscle and the liver, fail to respond adequately to insulin, leading to reduced glucose uptake and persistent hyperglycemia (Saputri et al., 2025). When pancreatic β -cells are unable to compensate for this resistance by increasing insulin secretion, blood glucose levels rise progressively, leading to diabetes mellitus (Lestari & Zulkarnain, 2021). Common clinical symptoms include polyuria, polydipsia, and polyphagia, often accompanied by unintentional weight loss due to increased fat and protein catabolism as alternative energy sources (Arania et al., 2021; Lembang et al., 2025; Untari et al., 2025).

Glycated haemoglobin (HbA1c) is widely used as a clinical indicator for diagnosing and monitoring diabetes mellitus. According to the Indonesian Endocrinology Association, an HbA1c level $\geq 6.5\%$ indicates diabetes mellitus (PERKENI, 2021). Persistently elevated HbA1c reflects poor glycemic control and is associated with an increased risk of chronic complications, including coronary heart disease, hypertension, kidney failure, retinopathy, and cardiovascular disease (Fauzi, 2023; Suryanti & Pudjianti, 2025; Zahrani et al., 2025). Therefore, interventions that effectively reduce HbA1c are

essential to prevent long-term complications of diabetes mellitus.

Nutritional therapy is one of the four pillars of diabetes mellitus management and plays a crucial role in improving glycemic control, including HbA1c levels (Dwitanti & Muharramah, 2025). Dietary fiber intake, particularly soluble fiber, has been shown to support metabolic regulation by enhancing satiety, slowing glucose absorption, and improving insulin sensitivity (Zakiyah et al., 2023). β -Glucan, a type of water-soluble dietary fibre, has attracted attention for its potential benefits in diabetes management. However, findings from individual studies on the effect of β -glucan on HbA1c reduction remain inconsistent, and the magnitude of its effect varies with dosage, duration, and study design.

Therefore, this study aimed to analyse the effect of β -glucan on reducing HbA1c levels in patients with diabetes mellitus through a meta-analysis study. This study addresses the lack of consolidated quantitative evidence by synthesising results from eligible studies and evaluating the influence of β -glucan dosage and intervention duration on glycemic outcomes. The findings of this meta-analysis are expected to provide stronger scientific evidence to support the use of β -glucan as a nutritional strategy for glycemic management in patients with diabetes mellitus.

Method

This study was quantitative and used a meta-analytic approach. Literature searches were conducted in two major databases, PubMed and ScienceDirect, using combinations of the keywords “ β -glucan,” “diabetes,” “diabetes mellitus,” “glycated haemoglobin,” and “HbA1c.” The inclusion criteria consisted of human intervention studies that evaluated the effect of β -glucan administration on HbA1c levels in patients with diabetes mellitus. Studies were excluded if they did not involve β -glucan intervention, did not report HbA1c outcomes, or were not relevant to the research objectives.

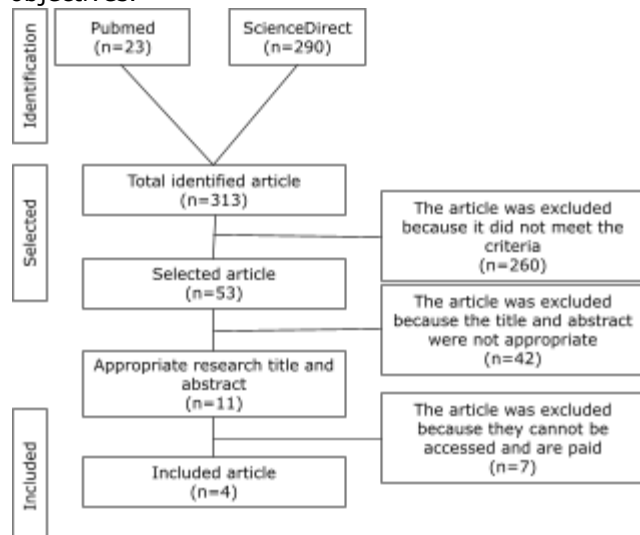


Figure 1. PRISMA Flow Chart Diagram

Statistical analysis was performed in RStudio using

the meta package. The extracted data included the mean and standard deviation of HbA1c values from both intervention and control groups. The pooled effect size was calculated as the mean difference (MD) with a 95% confidence interval. Heterogeneity among studies was assessed using the I^2 statistic and p-value. A common effect model was applied when the data were homogeneous ($p > 0.05$ and $I^2 < 50\%$). Conversely, a random effects model was used when heterogeneity was present ($p \leq 0.05$ and $I^2 \geq 50\%$) to account for between-study variability.

Results

The selection of articles for this meta-analysis was conducted using the PRISMA flowchart, as shown in Figure 1. During the initial identification stage, a total of 313 articles were collected, comprising 23 articles from PubMed and 290 articles from ScienceDirect. These articles were then screened based on predefined inclusion and exclusion criteria. After this process, 260 articles were excluded for failing to meet the basic eligibility criteria, leaving 53 articles. Further screening was conducted through title and abstract evaluation, which resulted in 11 articles that met the criteria, while the remaining 42 articles were deemed irrelevant. A full-text assessment was subsequently performed to ensure that all articles met the eligibility requirements. Following this step, four articles met all criteria and were included in the final meta-analysis, whereas the other seven were excluded because their full texts could not be accessed.

The characteristics of the articles

Table 1. Research Design and Sample Characteristics

Author, Year	Research Design	Sample
Barthow et al., 2022	Randomized controlled trial, parallel-groups, placebo-controlled, single-blinded	129 adults with pre-diabetes
Cugnet-Anceau et al., 2010	Blind randomized trial, placebo-controlled	53 people with type 2 diabetes (T2DM)
Pino et al., 2021	Randomized, double blind, and controlled trial	37 people with type 2 diabetes (T2DM)
Tessari & Lante, 2017	Controlled trial	22 people with type 2 diabetes (T2DM)

Table 1. shows differences in study design and sample size among the included studies. Barthow et al. (2022) conducted a single-blinded randomized controlled trial with 129 adults with pre-diabetes. Cugnet-Anceau et al. (2010) performed a blinded randomized controlled trial with 53 participants with T2DM. Pino et al. (2021) used a double-blind controlled trial with 37 T2DM patients, while Tessari and Lante (2017) conducted a controlled trial with 22 T2DM participants. These variations in study design and sample characteristics may influence the observed effects of β -glucan on HbA1c levels.

Table 2. Characteristics of Interventions and Control Groups

Author, Year	Intervention		Control	Duration
	Type	Dose		
Barthow et al., 2022	Cereal with β -glucan	4 g	Cereal without β -glucan	6 months
Cugnet-Anceau et al., 2010	Soup with β -glucan	3,5 g/day	Soup without β -glucan	8 weeks
Pino et al., 2021	Oat β -glucan	5 g/day	Microcrystalline cellulose	12 weeks
Tessari & Lante, 2017	Bread β -glucan	~2,3 g/100g bread	Regular white bread without β -glucan	6-7 months

According to Table 2., several studies have investigated the effects of β -glucan through various food forms and intervention durations. Barthow et al. (2022) used cereal containing 4 g of β -glucan as the intervention, compared with cereal without β -glucan, over six months. Cugnet-Anceau et al. (2010) evaluated a soup containing 3,5 g/day of β -glucan compared with a soup without β -glucan over eight weeks. Pino et al. (2021) examined oat β -glucan at 5 g/day versus microcrystalline cellulose over 12 weeks. Meanwhile, Tessari & Lante (2017) used bread containing approximately 2,3 g of β -glucan per 100 g, compared with regular white bread without β -glucan, over six to seven months. All of these studies administered β -glucan through food-based interventions with varying doses and durations to assess their effects compared with control groups without β -glucan.

Table 3. Characteristics of Research Results

Author, Year	Results
Barthow et al., 2022	The study found that HbA1c in the β -glucan cereal group was $46,5 \pm 4,0$ (n=67) at 6 months, showing no significant decrease compared with control cereal ($46,0 \pm 4,6$, n=62).
Cugnet-Anceau et al., 2010	The study found that HbA1c in the β -glucan soup group was $7,31 \pm 0,92$ (n=29) at 8 weeks, showing no significant decrease compared with control soup ($7,47 \pm 1,29$, n=24).
Pino et al., 2021	The study found that HbA1c at the beginning of the intervention was $8,91 \pm 1,57$ in the β -glucan group and $8,78 \pm 1,73$ in the control group. After 12 weeks, HbA1c decreased by $-0,68 \pm 1,89$ in the β -glucan group, compared with $0,36 \pm 1,28$ in the control group, showing a significant reduction in the β -glucan group.
Tessari & Lante, 2017	The study found that HbA1c at the beginning of the intervention was $7,97 \pm 0,36$ in the β -glucan group and $8,03 \pm 0,34$ in the control group. After 12 weeks, HbA1c decreased by $7,45 \pm 0,31$ in the β -glucan group, compared with $8,10 \pm 0,31$ in the control group, showing a significant reduction in the β -glucan group.

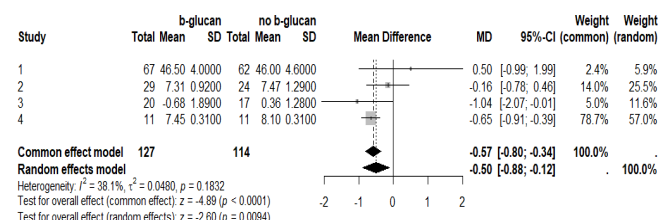
Table 3. shows the effects of β -glucan interventions on HbA1c levels across different studies. While Barthow et al. (2022) and Cugnet-Anceau et al. (2010) reported no significant changes in HbA1c after consuming β -glucan in cereal or soup, Pino et al. (2021) and Tessari & Lante (2017) observed significant reductions in HbA1c following β -glucan intake through oats or bread. These findings suggest that the impact of β -glucan on glycemic control may depend on the food matrix, dosage, and duration of the intervention.

Effect of β -Glucan on HbA1c Levels in Intervention and Control Groups

Table 4. Mean and Standard Deviation of HbA1c Data in the Intervention and Control Groups

Author, Year	Intervention			Control		
	n	Mean HbA1c	SD	n	Mean HbA1c	SD
Barthow et al. (2022)	67	46,5	4	62	46	4,6
Cugnet-Anceau et al. (2010)	29	7,31	0,92	24	7,47	1,29
Pino et al. (2021)	20	-0,68	1,89	17	0,36	1,28
Tessari & Lante (2017)	11	7,45	0,31	11	8,10	0,31

In the study by Barthow et al. (2022), the mean HbA1c in the intervention was 46,5 with a SD of 4, while in the control it was 46 with a standard deviation of 4,6. This difference indicates that HbA1c did not change significantly. Meanwhile, the study by Cugnet-Anceau et al. (2010) showed almost identical HbA1c values between the intervention group ($7,31 \pm 0,92$) and the control group ($7,47 \pm 1,29$), indicating no significant effect of β -glucan intervention on HbA1c. Pino et al. (2021) showed different results, with a significant decrease in HbA1c in the intervention ($-0,68 \pm 1,89$) compared to an increase in the control ($0,36 \pm 1,28$). These results indicate that administering 5 g/day β -glucan for 12 weeks can effectively lower HbA1c levels. This is also supported in a study by Tessari & Lante (2017), which showed that the intervention group had lower HbA1c values ($7,45 \pm 0,31$) than the control group ($8,10 \pm 0,31$).

**Figure 2.** Forest Plot Results

The results indicated that β -glucan significantly lowers HbA1c levels. This is evidenced by the results of the common effect model (Mean Difference = $-0,57$; 95% CI: $-0,80$ to $-0,34$; $p < 0,0001$) and the random effect model (Mean Difference = $-0,50$; 95% CI: $-0,88$ to $-0,12$; $p = 0,0094$), both of which show statistically significant results because the p-value is $<0,05$. The

negative mean difference indicates that the group receiving β -glucan had lower HbA1c levels than the control group. In addition, the heterogeneity value ($I^2 = 38,1\%$) indicates moderate heterogeneity between studies, but the results are acceptable. Of the four studies analysed, three showed a consistent negative effect on the mean difference. The fourth study had the greatest influence, with a weight of 78,7% in the common effect model and 57,0% in the random effect model, thereby greatly affecting the study's final results. Therefore, β -glucan significantly reduces HbA1c in patients with diabetes mellitus.

Discussion

β -Glucan is a water-soluble fibre found in wheat, barley, and certain mushrooms (Pino et al., 2021), known for its various health benefits, including antidiabetic activity. Several studies have reported that β -glucan can reduce HbA1c levels in individuals with diabetes mellitus. The fermentation of β -glucan by the gut microbiome is thought to produce short-chain fatty acids (SCFAs), such as propionate and butyrate, which stimulate the release of the hormones peptide YY (PYY) and glucagon-like peptide-1 (GLP-1). These hormones contribute to appetite suppression and improved insulin sensitivity, supporting better weight management and glycemic control (Pino et al., 2021; Tessari & Lante, 2017). The modulation of gut microbiota by β -glucan may differ depending on the intervention form, for example, solid foods such as bread and cereal can maintain higher viscosity in the gastrointestinal tract, enhancing SCFA production and hormone release, compared to liquid foods such as soups (Cugnet-Anceau et al., 2010; Barthow et al., 2022).

Physiologically, β -glucan reduces blood glucose by increasing the viscosity of gastrointestinal contents, which slows gastric emptying and carbohydrate absorption in the small intestine. This mechanism decreases postprandial glucose response and, consequently, lowers HbA1c levels. HbA1c, or glycated haemoglobin, is formed through non-enzymatic glycation between glucose and haemoglobin (Harahap et al., 2024). In this process, glucose binds to the valine residue at the N-terminal end of the haemoglobin β chain. Higher blood glucose levels increase glucose binding to haemoglobin, thereby elevating HbA1c. HbA1c reflects the average blood glucose level over approximately three months, corresponding to the lifespan of red blood cells (Destiani et al., 2023). These physiological effects suggest that the timing of intervention and baseline glucose control are critical. Studies have shown that participants with higher baseline HbA1c tend to experience greater reductions, whereas those with near-normal baseline values show smaller changes (Barthow et al., 2022).

The effectiveness of β -glucan in lowering HbA1c depends on several factors, including the type, dose, and duration of the intervention. Characteristics such as solubility, molecular weight, and purity influence its viscosity in the gastrointestinal tract, which in turn affects glucose absorption. β -Glucan with higher molecular weight and purity generally exerts a stronger glycemic effect compared to degraded forms

produced during processing (Pino et al., 2021; Cugnet-Anceau et al., 2010; Tessari & Lante, 2017). Dose is also a critical factor: moderate intakes of 3–4 grams per day are often insufficient to significantly reduce HbA1c, particularly over short intervention periods (Cugnet-Anceau et al., 2010; Barthow et al., 2022). In contrast, higher doses, such as 5 grams per day, have been shown to effectively lower HbA1c (Pino et al., 2021; Tessari & Lante, 2017).

Intervention duration significantly affects the effectiveness of β -glucan in lowering HbA1c. This is because HbA1c reflects the average blood glucose over approximately 2–3 months, and short-term interventions often fail to show significant reductions. Studies with brief intervention periods, such as 8 weeks, have reported nonsignificant changes in HbA1c, even when the β -glucan dose was adequate (Cugnet-Anceau et al., 2010; Barthow et al., 2022). This is due to the mechanisms of β -glucan such as slowing gastric emptying, reducing carbohydrate absorption, and modulating gut hormones like GLP-1 and PYY, which require sustained consumption for their effects to become apparent. Additionally, the fermentation of β -glucan by gut microbiota and the production of short-chain fatty acids, which enhance insulin sensitivity and promote satiety, develop gradually. Short-term interventions do not provide sufficient time for these processes to occur, resulting in minimal reductions in HbA1c.

Barthow et al. (2022) also indicated that baseline HbA1c levels and concurrent medications, such as statins or antihypertensives, may attenuate the effect of β -glucan, especially in short-term interventions. Patients with relatively well-controlled baseline HbA1c generally experience smaller reductions, which can make the effects of brief interventions appear negligible. In contrast, longer interventions of six months or more have shown larger decreases in HbA1c, particularly in studies using cereals or bread enriched with β -glucan (Tessari & Lante, 2017; Pino et al., 2021). Over time, cumulative physiological effects and microbiota-mediated changes can occur, resulting in significant reductions in HbA1c.

Conclusion

β -glucan has been shown to significantly lower HbA1c levels in patients with diabetes mellitus. The meta-analysis of four studies indicates that β -glucan consistently reduces HbA1c levels, particularly in interventions with a dose of ≥ 5 grams per day and a duration of ≥ 12 weeks. This effect is supported by results from both fixed-effects and random-effects statistical models, which show a statistically significant reduction in HbA1c. The effectiveness of β -glucan in reducing HbA1c levels is influenced by multiple factors, including type, dose, duration of intervention, and participant characteristics. Therefore, β -glucan has the potential to be used as part of a nutritional intervention and therapeutic strategy in the management of diabetes mellitus.

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