STUDI LITERATUR: PENGARUH PERHITUNGAN KARBOHIDRAT TERHADAP HbA1C, BMI, DAN LDL PADA PASIEN DIABETES MELLITUS TIPE 1

Effect of Carbohydrate Counting on HbA1C, BMI, and LDL in Type 1 Diabetes Mellitus Patients: Literature Review

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ABSTRACT

Proper management of type 1 diabetes mellitus can maintain the optimal quality of life of patients. Carbohydrate counting is a method of nutritional intervention that is more flexible and has been widely used by patients with diabetes mellitus as glycemic control. This study aims to investigate the effect of the carbohydrate counting method on HbA1c, BMI, and LDL in patients with type 1 diabetes mellitus. Systemic Mapping Study (Scoping Study) was used in this study as a literature study. The included criteria were met in a total of 10 types of literature, most of which were cross-sectional studies, randomized control tests, and pilot studies with a large sample of more than 35 students. Nine out of ten studies showed a decrease in HbA1c with the method carbohydrate counting, while the remaining one study reported an increase in HbA1c with the method carbohydrate counting. Four of the seven studies showed a lower mean BMI with the method carbohydrate counting, two studies reported no significant difference in BMI between the intervention group and the control group, and one remaining study reported an increase in BMI with the method carbohydrate counting. Four of the five studies showed a lower mean LDL by method carbohydrate counting, and the remaining one study reported an increase in LDL by method carbohydrate counting. The results of the literature review show that the method carbohydrate counting can reduce the concentration of HbA1c, BMI, and LDL in patients with type 1 diabetes mellitus.

Keywords: HbA1c, BMI, LDL, carbohydrate counting, Type 1 Diabetes Mellitus

INTRODUCTION

Insulin-dependent diabetes (IDDM) is the older name for Type I Diabetes Mellitus (DM). This situation arises as a result of T cell-mediated autoimmune destruction of pancreatic cells, resulting in an inability to produce insulin (absolute deficiency) (Pakar Gizi Indonesia, 2019). Indonesia is on the 6th rank in the world, with 103 million adults suffering from diabetes mellitus (International Diabetes Federation, 2017). According to the findings of Riskesdas (2018), the prevalence of diabetes mellitus in Indonesia increases from 1.5 percent in 2013 to 2 percent in 2018 (Kemenkes RI, 2019).

CDC epidemiological research in 2011 shows that around 1 million individuals are living with type 1 diabetes mellitus in America. Type 1 diabetes mellitus has a lower incidence in Asia than in the United States. Indonesian data shows that 720 pediatric Type 1 DM cases occurs in 2011 (Pakar Gizi Indonesia, 2019).

Type 1 diabetes mellitus is incurable, but with proper glycemic control, it is possible to maximize the patient's quality of life. Glycated hemoglobin (HbA1c) is a marker of glycemic control in diabetics (Soebagijo Adi Soelistijo et al., 2015). HbA1c reflects the long-term average glycemia over the previous 2-3 months (American Diabetes Association, 2010). Controlling the body mass index (BMI) and lipid profile, as part of comprehensive patient management, can also help patients with type 1 diabetes mellitus achieve optimal quality of life (Soebagijo Adi Soelistijo et al., 2015).

Losing weight improves blood glucose control by increasing glucose uptake by cells (Octaviana Wulandari & Martini, 2012). According to Wulandari and Adelina (2020), blood glucose levels and HbA1c levels increased, but not significantly, in subjects with obese BMI and central obesity. Low-density lipoprotein (LDL) is the primary cholesterol carrier in the blood. According to Arifin et al. (2019), an increase in blood glucose levels is directly proportional to an increase in total cholesterol, LDL cholesterol, and triglyceride levels.

The management of type 1 diabetes mellitus includes the administration of insulin, diet, training, and education also home surveillance as support. It is vital to highlight that the composition of carbs in the needed energy must be proportional to that of insulin-use units in individuals with type 1 diabetes mellitus (Melfazen et al., 2012). This is because insulin injection does not go with adequate intake causes hypoglycemia problems, which are normally present in individuals with type 1 diabetes mellitus with insulin treatment, insulin (Pakar Gizi Indonesia, 2019). The carbohydrate counting technique is also an alternative option.

According to Fu et al. (2016)'s systematic review and meta-analysis, carbohydrate counting is reducing HbA1c levels significantly (P<0.05) in comparison to other diabetes diet approaches or regular diabetes diet teaching. According to Gokosmanoglu & Onmez (2018), a statistical analysis is revealing a substantial reduction in HbA1c levels and LDL cholesterol (P<0.05) between the intervention group (carbohydrate counting method) and the control group in the intervention group (carbohydrate counting method). According to Body Mass Index (BMI), despite consuming a flexible and tight glycemic control diet, the patient's weight does not increase significantly (P>0.05).

So according to the explanation above, the aim of this study is investigating the effect of the carbohydrate counting method on HbA1c, BMI, and LDL in patients with type 1 diabetes mellitus.

MATERIALS AND METHOD

Method

The systematic Mapping Study (Scoping Survey) approach was used as a literature study in this research, which investigates the influence of glycemic control (HbA1c), BMI, and LDL carbohydrate counts on patients with type 1 diabetes mellitus. During the investigation, scientists conducted a research publication, published online using the keywords "Carbohydrate Counting", "Diabetes Mellitus Type 1" with PubMed and the Scholars' search engines.

According to the keywords sorted by the parameters, an article or journal was found. Articles or journals published in English in the recent ten years, with a cross-sectional study design, randomized control trial, or pilot study, had been selected as inclusion criteria. The final findings of journals that might be studied according to preset criteria are seven, with three from Google Scholar and seven from Pubmed. The results of data searches utilizing the prism flow chart method were documented in the following section, as shown in Figure 1.
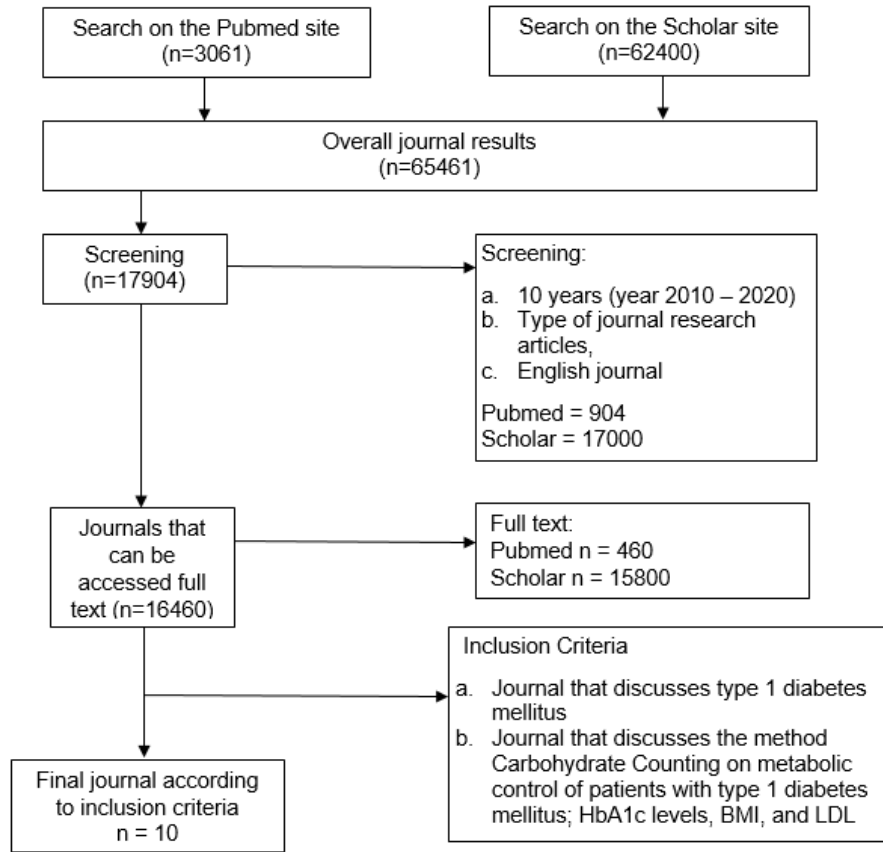
Figure 1. Prism Flow Chart Search Results in Literature Review

Full-text data (research publication) was utilized to evaluate a project's quality or viability (inclusion and exclusion criteria). The name of the author, year of publication, country, title, technique (study design, sample size, intervention, and analysis), a summary of results, and database were all included in the tabular presentation of the results of the literature review.

RESULTS AND DISCUSSION

Respondent Characteristics

The participants in this study were all individuals with type 1 diabetes mellitus who were on insulin therapy and lived in all parts of the country. The bulk of the study's participants were over 35 years old, with an average age of 10-41 years. The majority of respondents (56 percent) were female, and the average length of diabetes mellitus diagnosis was 2-22 years. Table 1 shows the detailed characteristics of respondents from eligible studies.

The Research's Characteristics

Between 2010 and 2020, ten studies with a total of 513 people were published. Children and adolescents were involved in four of the research, while adults were involved in the other six. There were 10 studies in total, one of which compared the adherent and non-adherent groups to the carbohydrate counting approach. The carbohydrate counting method was compared to various diabetic diet approaches in eight trials, and the carbohydrate counting applications were compared to the normal DM diet method without application in one study. All studies reported changes in HbA1c concentrations, seven studies reported changes in BMI and

five studies reported changes in LDL (Low-
Density Lipoprotein). The research duration

Table 1. Characteristics of Respondents

Gender Male/Female (n)	245/286
Age (years)	10-41
Duration of DM (years)	2-22

Table 2. Characteristics of Studies that Meet Inclusion Criteria

Author/Year	Country	Methods	Summary of Results
(Bayram, 2020)	Turkey	- Design: cross-sectional study - Sample: 53 children and adolescents with type 1 diabetes mellitus - Intervention: method training carbohydrate counting - Control: Non-adherent group with carbohydrate counting - Analysis: Shapiro-Wilk test and Mann-Whitney test	Mean levels The HbA1c of the adherent group was significantly (P<0.05) lower than the non-adherent group with the carbohydrate counting method. Adherence also affected the decrease in mean LDL cholesterol, and BMI but not significant (P>0.05)
(Alfonsi et al., 2020)	Canada	- Design: Pilot randomized control trial - Sample: 44 adolescents with type 1 diabetes mellitus - Intervention: application Carbohydrate counting using image recognition - Control: Method standard DM diet without application - Analysis: independent *t*-tests and the chi-squared test	The intervention of carbohydrate counting method with application of image identification resulted in significantly lower HbA1c values (P = 0.03) compared to the control group.
(Gokosmanoglu & Onmez, 2018)	Turkey	- Sample: 40 adults with type 1 diabetes mellitus - Intervention: Flexible insulin dosing using the method *carbohydrate counting* - Control: Standard dose insulin without the carbohydrate counting method - Analysis: Pearson correlation, independent paired t-test, and Wilcoxon test	Statistical analysis showed a decrease in hemoglobin levels A1c, and LDL cholesterol was significant (P<0.05) between the intervention group and the control group. While the BMI showed no significant difference between the intervention group and the control group (P> 0.05). However, patients generally did not gain weight despite flexible eating, and strict glycemic control
(Gökşen et al., 2014)	Turkey	- Sample: 84 children and adolescents with type 1 diabetes mellitus - Variable: method *Carbohydrate counting* on metabolic control of patients with type 1 diabetes mellitus - Analysis: Chi-square test, Mann-Whitney U- test, and ANOVA test	The mean HbA1c value at the end of the second year was significantly (P<0.05) lower in the group *carbohydrate counting*. The mean value of BMI and LDL cholesterol was lower in the method group *carbohydrate counting* but not significant (P>0.05).

Table 2. Characteristics of Studies that Meet Inclusion Criteria (Cont.)

Author/Year	Country	-	Methods	Summary of Results
(Son et al., 2014)	Turkey	-	Sample: 37 adults with type 1 diabetes mellitus - Intervention: Method *carbohydrate counting* - Control: standard DM diet - Analysis: chi-squared test and Mann-Whitney U test	In the group *carbohydrate counting*, there was an insignificant decrease in HbA1c levels at 6 months of treatment compared to the study baseline (P > 0.05). In the carbohydrate counting group, a statistically insignificant increase was detected in the LDL cholesterol ratio at the end of 6 months
(Hayes et al., 2012)	Australia	-	Design: Pilot study - Sample: 38 adolescents with type 1 diabetes mellitus - Intervention: *Carbohydrate counting* with insulin adjustment for flexible diet (1 unit/15g ratio) - Control: before receiving the intervention - Analysis: Mann-Whitney U test, Chi-squared test, and Paired t-test	After the intervention, there was a significant decrease in the mean BMI (P<0.05), but a significant increase in HbA1c concentration (P<0,05).
(Trento et al., 2011)	Italy	-	Design: Randomized control trial - Sample: 56 adults with type 1 diabetes mellitus - Intervention: Carbohydrate counting educational program - Control: standard DM diet education - Analysis: Independent t-tests and the chi-squared test	HbA1c concentrations in the intervention group were significant (P< 0.05) lower than the control group. The mean BMI had no significant difference (P>0.05) when compared to the control group. However, the comparison of BMI values in the carbohydrate counting group before and after the intervention showed a decrease but not significant.
(Laurenzi et al., 2011)	Italy	-	Design: Randomized control trial - Sample: 56 adults with type 1 diabetes mellitus - Intervention: Education program on carbohydrate counting method - Control: estimating pre-meal insulin dose in the usual empirical way - Analysis: x2 test, unpaired, two-tailed t-test, or Mann –Whitney two-sample statistic	HbA1c levels were significantly (P<0.05) lower in the intervention group than in the control group. There was a significant decrease in BMI (P<0.05) in the intervention group compared to control subjects

Table 2. Characteristics of Studies that Meet Inclusion Criteria (Cont.)

Author/Year	Country	-	Methods	Summary of Results
(Dias et al., 2010)	Brazil	-	Sample: 32 adults with type 1 diabetes mellitus - Intervention: dietary method with *carbohydrate counting* - Control: before receiving intervention - Analysis: Paired t-test	A significant decrease in HbA1c concentration (P<0.05) was observed from baseline to evaluation three months after the intervention. After the intervention there was an increase in BMI but not significant (P>0.05). A decrease in LDL was observed from baseline to evaluation three months after the intervention but was not significant (P>0.05).
(Scavone et al., 2010)	Italy	-	Design: a pilot study - Sample: 73 adults with type 1 diabetes mellitus - Intervention: education *Carbohydrate counting* - Control: usual care - Analysis: chi-square test or Fisher's exact test	After the intervention, there was a significant decrease in HbA1c concentration (P<0.05).

of the ten studies was a minimum of 3 months. Detailed characteristics of the eligible studies were presented in Table 2.

HbA1c levels in patients with Type 1 Diabetes Mellitus

Data on HbA1c concentrations were provided by all studies, which included a total of 513 participants. Nine out of ten studies found that the carbohydrate counting method resulted in lower HbA1c concentrations than the control group. Hayes et al. (2012) reported an increase in the concentration of HbA1c following the intervention of the carbohydrate counting method with insulin adjustment for a flexible diet (1 unit/15g ratio).

Insulin production or utilization had impaired DM sufferers. Carbohydrate intake was one of the main nutrients to be evaluated for insulin in DM (Lindawati et al., 2019). Carbohydrates in the body become glucose the fastest, reaching 100% within 1 hour (Pakar Gizi Indonesia, 2019). Excess carbohydrate intake can build glucose and produce hyperglycemia in the body (Lindawati et al., 2019). The composition of carbohydrates in energy required ought to be

proportional to the insulin utilized units in patients with type 1 and 2 diabetes mellitus who were getting intense insulin therapy (Multiple Daily Insulins = MDI) (Melfazen et al., 2012). The carbohydrate counting approach could be used as an alternative. The carbohydrate counting procedure highlights the number of carbs used compared with the carbohydrate type (Pakar Gizi Indonesia, 2019).

According to Fu et al. (2016), a systematic review and meta-analysis found that carbohydrate counting resulted in a substantial (P<0.05) reduction in HbA1c concentrations when compared to alternative diabetes diet approaches or regular diabetes diet teaching. According to Bishop et al. (2009), dinners with the right carbohydrate measurement utilizing the carbohydrate counting method had a significantly lower HbA1c concentration (P<0.05) than those with overestimated and underestimated carbohydrate estimates. Spiegel et al. (2012) found that the carbohydrate counting education group had a lower HbA1c concentration, although it was not statistically significant (P>0.05).

Patients with Type 1 Diabetes Mellitus and their Body Mass Index (BMI)

Seven out of ten studies with a total of 396 individuals provided information on changes in BMI in type 1 diabetic patients. Four of the seven investigations conducted by Laurenzi et al. (2011), Hayes et al. (2012), Gökşen et al. (2014), and Bayram, (2020) found that the carbohydrate counting method resulted in a lower average BMI than the control group. Trento et al. (2011) and Gokosmanoglu & Onmez (2018) found no significant difference in BMI between the intervention and control groups, but the average patient weight did not increase when the carbohydrate counting method was used. Dias et al. (2010) reported an increase in BMI in type 1 diabetes mellitus patients, but it was not statistically significant.

Obesity causes a reduced number of insulin receptors that can work in cells in skeletal muscle and fat tissue, this can lead to insulin resistance. Obesity causes the response of pancreatic beta cells to an increase in blood glucose to decrease, besides that insulin receptors on cells throughout the body, including muscles, are reduced in number and activity (less sensitive) (Junaidi dkk, 2021). Weight loss improved blood glucose control through increasing glucose absorption by cells (Octaviana Wulandari & Martini, 2012). According to Wulandari and Adelina's (2020) study, blood glucose levels and HbA1c levels increased in participants with obese BMI and central obesity, but not significantly. According to Spiegel et al. (2012), using the carbohydrate counting method on compliant patients helped reduce overeating by reducing frequent hypoglycemia, resulting in weight loss. According to Fu et al. (2016)'s comprehensive review and meta-analysis study, carbohydrate counting did not reduce mean BMI considerably (P>0.05) when compared to other diabetic diet approaches or regular diabetes diet teaching.

Low-Density Lipoprotein (LDL) in Type 1 Diabetes Mellitus Patients

The variations in Low-Density Lipoprotein (LDL) in individuals with type 1 diabetes mellitus were studied in five of the 10 studies, which included a total of 246 participants. Dias et al. (2010), Gökşen et al. (2014), Gokosmanoglu & Onmez (2018), and Bayram (2020) all found that the carbohydrate counting method reduced mean LDL relative to the control group in four of the five investigations. One other study Son et al. (2014) found that patients with type 1 diabetes mellitus had an increase in LDL, although it was not statistically significant.

Low-density lipoprotein (LDL) is often referred to as bad cholesterol because it can stick to blood vessels. If there is a lot of LDL in the blood, it causes the accumulation of fatty deposits (plaque) in the arteries, so that blood flow narrows. The higher the HbA1c level, the higher the LDL level. The worse the glycemic control in people with diabetes mellitus, the more severe the plaque buildup (Damara & Ariwibowo, 2021). The triglyceride and cholesterol level increases were strongly linked to a rise in the blood level, as stated in Daboul (2011). Blood glucose had shown its significance in boosting blood fat levels according to research by Arifin et al. (2019). Blood glucose increases were directly related to total cholesterol, LDL, and triglyceride levels increase. The incidence of dyslipidemia could therefore be suppressed by the management of the growth of glucose levels in the blood. The glycemic control (blood glucose levels and HbA1c) in patients with diabetes mellitus could be used for the dietary measurement of carbs.

CONCLUSION

Based on the results of the study of literature can be concluded that using the method of carbohydrate counting as nutritional interventions can reduce the concentration of HbA1c, BMI, and LDL patients with type 1 diabetes mellitus. The method is carbohydrate counting expected to be used as a nutritional intervention in patients with type 1 diabetes mellitus, to achieve optimal quality of life with control of glycemic control (HbA1c), BMI, and LDL (Low-Density Lipoprotein) remained within normal limits.

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