Jurnal Kedokteran Methodist, Vol. 17 No.2 Tahun 2024
https://doi.org/10.46880/jkm.v17i1

RESEARCH ARTICLE

The Impact of a High-Fat Diet on Blood Glucose Levels

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ABSTRACT

Background: *Diabetes mellitus (DM) sufferers in the world and even in Indonesia are expected to continue to increase, especially type 2 DM (DMT2). DMT2 often occurs in people who are obese, the cause of obesity is often consuming foods that contain a lot of fat. Hyperlipidemia plays a role in the pathogenesis of pancreatic β-cell dysfunction.*
Research method: *This study is an experimental laboratory study with a pretest-posttest only controlled group design, using male white rats (Rattus norvegicus) with a sample size of 30 divided into 6 groups, namely the normal group, the negative control group, the positive control group, the group given a high fatty diet (HFD). The independent variable is HFD, while the dependent variable is blood sugar levels. Data were analyzed using the Anova test.*
Results: *Giving HFD of 4 ml/day for 4 weeks has not been able to increase KGD to hyperglycemic, this is thought to be because the HFD was not given for long enough so that insulin resistance had not occurred in the test animals.*
Conclusion: *Based on the results of the study, it was concluded that giving HFD for 4 weeks still could not increase KGD in male white mice to become hyperglycemic.*

Keywords: : Diabetes Mellitus, Blood Sugar Levels, High Fatty Diet

INTRODUCTION

Non-communicable diseases, especially diabetes mellitus (DM), can occur in all countries. Diabetes is known as a heterogeneous chronic disease caused by impaired insulin secretion, insulin action, or both, which causes increased blood sugar levels..1 Based on the Atlas of the International Diabetes Federation (IDF), it is estimated that DM sufferers aged 20-79 years will reach 537 million people in 2021 and will continue to increase in 2024 to 783 million.2 In Indonesia itself, the number of DM sufferers is estimated to increase from 8.4 million in 2000 to around 21.3 million in 2030, according to the World Health Organization (WHO)..3 Based on the IDF, the number of DM sufferers in Indonesia is estimated to increase from 19.5 million in

2021 to 28.6 million in 2045. 2 . According to the Health Office in 2022, the prevalence of diabetes mellitus (DM) in North Sumatra was 225,587, of which 68,182 had received health care.

In T2DM, the body experiences increased metabolic levels, one of which is uric acid. In people with insulin resistance, uric acid levels increase. This is because insulin resistance causes hyperinsulinemia and hyperglycemia, which decrease uric acid excretion in the renal tubules, resulting in increased uric acid levels in the blood. Metformin is the first-line medication for DM management; however, it has side effects. T2DM often occurs in obese individuals, a cause of obesity being the frequent consumption of foods high in fat. 5 Among the many factors influencing the pathogenesis of pancreatic β-cell dysfunction, hyperlipidemia plays a crucial role. 6

RESEARCH MATERIALS AND METHODS

The tools used in the research process included an Autocheck device with glucose test strips, a mouse cage, a mouse drinking bowl, tissues, a measuring cup, an oral probe, writing instruments, a 3 ml syringe, and a beaker.
Materials used for the study included 30 male white rats, rat husks and feed (commercial pellets), HFD food, tap water (drinking), label paper, 0.9% NaCl solution, distilled water, permanent marker, and labels.

Research Design
This was a laboratory experimental study with a pretest-posttest only controlled group design on male white rats with type 2 diabetes mellitus (T2DM).
This design allows researchers to measure the effectiveness of a treatment (intervention) in the experimental group by comparing it with the control group. This study was conducted at the Animal House Laboratory of Medicine, UMI, from March to May 2024.
Population and Sample
The experimental animals used in this study were healthy male white rats weighing 180–200 grams. The estimated sample size using the Federer formula, obtained 4 male white rats in each group and each group was added with 1 male white rat as a reserve so that the total number of samples was 30 male white rats. This study used six groups:

1. Group 1: normal mice, no treatment was given.
2. Group 2: negative control, mice were given alloxan (170 mg/kgBW) + HFD (4 ml/day).
3. Group 3: positive control, mice were given alloxan (170 mg/kgBW) + HFD (4 ml/day) and metformin (45 mg/kgBW/day).
4. Group 4: mice were given alloxan (170 mg/kgBW) + HFD (4 ml/day) and a combination of Chinese betel leaf water extract (100 mg/kgBW) and mango leaf water extract (100 mg/kgBW).
5. Group 5: mice were given alloxan (170 mg/kgBW) + HFD (4 ml/day) and a combination of Chinese betel leaf water extract (150 mg/kgBW) and mango leaf water extract (150 mg/kgBW).
6. Group 6: mice were given alloxan (170 mg/kgBW) + HFD (4 ml/day). mg/kgBW) + HFD (4 ml/day) and given a combination of Chinese betel leaf water extract (200 mg/kgBW) and mango leaf (200 mg/kgBW).

Research Variables

The dependent variable in this study was blood glucose levels, while the independent variable was HFD.

Operational Definitions

1. Random blood glucose levels are the results of blood sugar tests taken from random samples without fasting.
   HFD is a diet high in fat.
2. Working Procedures
   Blood glucose levels were measured using the Autocheck device with glucose strips.

Data Analysis

Data analysis was performed using SPSS. The data obtained were collected and presented as mean ± standard deviation (SD). Normality and homogeneity tests were performed. If the data were normally distributed and homogeneous, an ANOVA test was performed. If the data were not normally distributed and homogeneous, a Kruskal-Wallis test was performed.

RESEARCH RESULT

Blood glucose (BGD) measurements were taken before HFD administration and again after, at week 4 of HFD administration. The following results were obtained:

Table 1. Blood glucose levels before and after HFD administration.

Kelompok	KGD awal	KGD minggu ke-4 pemberian HFD
K1	**90,40** ± 6,02	**102,60** ± 16.25
K2	86,4 ± 5,02	103,00 ±11,13
K3	88,20 ± 3,11	**99,40** ± 5,22
K4	89,20 ± 4,54	100,60 ± 5,41
K5	**81,40** ± 2,70	101,60 ± 8,20
K6	88,00 ± 6,28	100,40 ± 10,18
p	0,104**	0,995**

Note: **Kruskal Wallis Test

K1: normal, K2: negative control, mice induced with alloxan (170 mg/kgBW) + HFD (4 ml/day), K3: positive control, mice induced with alloxan (170 mg/kgBW) + HFD (4 ml/day) and given metformin (45 mg/kgBW/day), K4: mice induced with alloxan (170 mg/kgBW) + HFD (4 ml/day) and given a combination of Chinese betel leaf water extract (100 mg/kgBW) and mango leaf (100 mg/kgBW), K5: mice induced with alloxan (170 mg/kgBW) + HFD (4 ml/day) and given a combination of Chinese betel leaf water extract (150 mg/kgBW) and mango leaf (150 mg/kgBW), K6: mice induced with alloxan (170 mg/kgBW) + HFD (4 ml/day) and given a combination of Chinese betel leaf water extract (200 mg/kgBW) and mango leaves (200 mg/kgBW)

After the experimental animals were acclimatized for 2 weeks, a BCG examination was performed. The lowest BCG was found in the initial BCG, namely in K5 (Mean = 81.40 ± SD = 2.70) while the highest BCG was in K1 (Mean = 90.40 ± SD = 6.02). Then the lowest BCG was in the 4th week, namely in K3 (Mean = 99.40 ± SD = 5.22) and the highest BCG was in K1 (Mean = 102.60 ± SD = 16.25). The results of the Kruskal Wallis test p > 0.05 indicate that there was no significant difference between groups in the initial BCG, BCG when given HFD.

DISCUSSION

Initial blood glucose (Blood Sugar) examinations before HFD administration in male white mice showed no significant differences because all experimental groups had not yet been treated. Furthermore, no significant differences were found after 4 weeks of HFD administration, although a slight increase in the average Blood Sugar began to occur from week 3. In this study, HFD administration of 4 ml/day for 4 weeks did not increase Blood Sugar to hyperglycemia. This is likely due to the insufficient duration of HFD administration, which resulted in insulin resistance not yet developing in the test animals. According to

Chen et al. (2023), the time required for HFD induction to induce insulin resistance in mice is 10 weeks. 7 Meanwhile, in Stott N et al. (2020), the time required to induce hyperglycemia was 12 weeks of HFD administration. 8

A study conducted by Three F et al. (2023), which administered HFD for 4 months, found that prolonged HFD consumption resulted in free fat content in plasma cells, which impaired insulin sensitivity. 9 Excessive HFD consumption leads to insulin resistance due to saturated fatty acids, which can interfere with insulin function. High levels of fatty acids cause changes in the way pancreatic β-cells secrete insulin. Dysfunction of pancreatic β-cells in releasing insulin leads to impaired blood glucose regulation. Insulin resistance can also be caused by oxidative stress. Oxidative stress damages acinar cells, triggering pancreatic autodigestion, which ultimately leads to pancreatic β-cell necrosis.

CONCLUSIONS AND SUGGESTIONS

Based on the research results, it was concluded that feeding a high-energy feed (HFD) for 4 weeks was unable to increase blood glucose levels in male white mice, leading to hyperglycemia.

Based on these results, it is recommended that future researchers administer a high-energy feed for a longer period to assess its effect on increasing blood glucose levels.

THANK-YOU NOTE

The author would like to express his gratitude to the lecturers, research colleagues and all parties who have helped and supported the writing of the journal entitled "The Effect of Providing a High Fatty Diet on Male White Mice".

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