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Cycling to Regulate Random Blood Glucose Levels in Individuals with Diabetes

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Abstract

BACKGROUND: In Indonesia, the four pillars of diabetes management include health education, food planning, physical exercise, and drug adherence. However, the most common imprudence in those four pillars was ignoring physical activity. Cycling has become a new social activity and a lifestyle among the community during the COVID-19 pandemic. It is an aerobic exercise that increases insulin receptor sensitivity.

AIM: This study aims to analyze the effect of cycling on Random Blood Glucose (RBG) levels in individuals with diabetes.

METHODOLOGY: This paper used a quasi-experiment pre-post test design with the control group. It utilized total sampling with 60 respondents. The independent variable was cycling using a dynamic bicycle. Meanwhile, the dependent variable was RBG levels with a glucometer as the instrument. The procedure in the intervention group was cycling using a dynamic bicycle twice a week with a distance of 2–3 kilometers each session. The data analysis used a paired T-test and independent sample T-test.

RESULTS: After cycling, the independent T-test result was p = 0.00 (p < 0.05). Thus, there was a difference in the mean RBG levels between the intervention and control groups after cycling. There was a decrease in mean RBG levels in the intervention group (206.67 ± 69.887 in pre-test and 114.60 ± 30.395 in post-test). In addition, the paired T-test resulted in p = 0.00 (p < 0.05). Thus, there was a difference in the intervention group's mean RBG levels before and after cycling

CONCLUSION: Cycling can lower RBG levels in individuals with diabetes.

Introduction

Various epidemiological studies indicate a trend increase in the incidence and prevalence of diabetes mellitus in the world [1]. The incidence of diabetes cases has increased every year. Theoretically, individuals with type 2 diabetes (T2D) are mostly the elderly. However, a previous study in 2013 showed that most of them were adults-approximately 382 million [2]. Epidemiological data states that between 2013 and 2035, the number of people with diabetes will reach 210 million [3], [4]. It is due to ignorance about the disease and non-adherence to dm management. In Indonesia, the four pillars of diabetes management include health education, food planning, physical exercise, and drug adherence [5]. However, The most common imprudence in those four pillars was ignoring physical activity [6].

Research on the effect of exercise on blood glucose levels has been widely carried out. A study evaluated the impact of aerobic exercise and walking using the continuous glucose measurement method. The study revealed that acute moderate-intensity aerobic exercise before breakfast reduced the morning blood glucose rise in individuals with T2D. In addition, prior research also evaluated the effect of 12 weeks of moderate-intensity activity on blood glucose responses using the Generalized Estimating Equations. The study found that moderate-intensity exercise training for 12 weeks was safe for individuals with T2D [3], [6].

Those studies only focused on exercise, walking [7], and moderate-intensity exercise for 12 weeks [6]. Research on cycling to regulate RBG levels in individuals with diabetes is still minimal. Cycling has become a new social activity and a lifestyle among the community during the COVID-19 pandemic [8]. Cycling is an aerobic exercise that increases insulin receptor sensitivity to convert glucose into energy through metabolism. In addition, it impacts the endocrine system to regulate the pancreas gland in producing insulin to manage blood glucose levels [9].

Therefore, this study aims to analyze the effect of cycling on Random blood glucose (RBG) levels in individuals with diabetes. This article can contribute as a policy recommendation for managing diabetes.

Methods

Study design

This article used a quasi-experiment pre-post test design with the control group [10]. The population was individuals with diabetes registered at Tanah Kali Kedinding Public Health Center (PHC), Surabaya. Inclusion criteria were (1) Individuals with diabetes without complications (2) Do routine checks at the Tanah Kali Kedinding PHC once a month (3) Diabetes management without using diabetes medication (4) Complying with the guidelines diet management as evidenced by recording the evaluation in the diabetic patient's diet guide [11]. This research used total sampling with 60 respondents, 30 respondents in the intervention group, and 30 in the control group. The independent variable was cycling using a dynamic bicycle. Meanwhile, the dependent variable was RBG levels. The authors measured RBG levels 30 min before the first cycling schedule and 30 min after the last cycling schedule with a glucometer as the instrument. We did this research from February to March 2021.

Data collection

The cycling procedure in this study refers to previous research with slight modifications [12]. Before cycling (pre-test), the authors measured RBG levels in intervention and control groups. Then, the procedure in the intervention group was cycling using a dynamic bicycle carried out jointly by the researchers and the respondents. The cycling schedule was divided into three groups, and each group consisted of 10 respondents. The cycling schedule was twice a week with a distance of 2–3 kilometers each session. Respondent's speed was adapted to road conditions-for example, traffic jams. Meanwhile, the control group was not given any intervention during the study. However, after the pre-test, we provided health education about the benefits of cycling to regulate blood sugar to fulfill the principle of fairness in ethics. 30 min after the last cycling (post-test), the researchers remeasured RBG levels in intervention and control groups [12]. The authors and respondents followed the COVID-19 prevention health protocol guidelines during the study. We used disposable medical masks or two layers of cotton cloth masks. In addition, we always kept hand hygiene by cleaning hands with hand sanitizer or using soap and running water for 20 s and avoiding touching the face area. Furthermore, we maintained a minimum distance of 1 meter.

Data analysis

After collecting data, the data was processed with editing, coding, tabulating, and scoring. The data analysis used a paired T-test to compare RBG levels before and after cycling in intervention and control groups. In addition, an independent sample T-test to compare RBG levels of intervention and control groups before and after cycling. Furthermore, we did homogeneity analysis in the characteristics of respondents to control the confounding factors. The homogeneity analysis for age and educational levels variables used the Mann-Whitney test, while for gender and diabetes duration variable utilized the Chi-square test [13].

Ethical clearance

This article was declared ethically feasible by the Health Research Ethics Committee of Universitas Nahdlatul Ulama Surabaya with certificate number 121.1/EC/KEPK/UNUSA/2021. Data collection began with informed consent and used anonymous names for respondents.

Results

Table 1 shows the characteristics of respondents in this article.

Table 1: Characteristics of respondents by age, gender, educational levels, and duration of diabetes

Characteristics of respondents	Control group		Intervention group		Homogeneity test
	Frequency	Percentage	Frequency	Percentage	
Age (years)					p = 1.00
45-54	5	16.7	4	13.3	
55-65	16	53.3	18	60	
66-74	9	30	8	26.7	
Sex					p = 0.75
Male	9	30	11	36.7	
Female	21	70	19	63.3	
Educational Level					p = 0.87
Elementary School	4	13.3	5	16.7	
Junior High School	6	20	9	30	
Senior High School	18	60	15	50	
University	2	6.7	1	3.3	
Duration of diabetes (years)					p = 0.37
<5	21	70	27	90	
>5	9	30	3	10	
Total	30	100	30	100	

Table 2: Random blood glucose (RBG) levels before and after cycling in the control and intervention groups

Variable	Control group (Mean ± SD)	Intervention group (Mean ± SD)	mean Difference	95% CI	p^*
RBG levels before cycling	176.57 ± 88.627	206.67 ± 69.887	−30.100	−71.349; 11.149	0.149
RBG levels after cycling	182.70 ± 81.518	114.60 ± 30.395	68.100	36.305; 99.895	0.00

*$p < 0.05$ based on independent t-test, RBG: Random blood glucose, SD: Standard deviation.

Most respondents in the control group were 55–65 years old (53.3%) and female (70%). In addition, most of them graduated from Senior High School (60%), and their diabetes duration was <5 years (70%). Meanwhile, most respondents in the intervention group were 55–65 years old (60%) and female (63.3%). In addition, most of them graduated from Senior High School (50%), and their diabetes duration was <5 years (90%). All homogeneity tests resulted in p > 0.05 (p = 1.00 in age variable, p = 0.75 in sex variable, p = 0.87 in educational level variable, and p = 0.37 in diabetes duration variable). Thus, there were no differences in the characteristics of respondents between the control and intervention groups (Table 1).

Before cycling, the independent T-test result was p = 0.149 (p > 0.05). Thus, there was no significant difference in the mean RBG levels between the intervention and control groups before cycling (176.57 ± 88.627 in the control group and 206.67 ± 69.887 in the intervention group). Meanwhile, after cycling, the independent T-test result was p = 0.00 (p < 0.05). Thus, there was a difference in the mean RBG levels between the intervention and control groups after cycling-182.70 ± 81.518 in the control group and 114.60 ± 30.395 in the intervention group (Table 2).

There was an increase in the average RBG levels in the control group (176.57 ± 88.627 in pre-test and 182.70 ± 81.518 in post-test). In addition, the paired T-test resulted in p = 0.342 (p > 0.05). Thus, there was no difference in the mean RBG levels before and after the intervention in the control group. Meanwhile, there was a decrease in mean RBG levels in the intervention group (206.67 ± 69.887 in pre-test and 114.60 ± 30.395 in post-test). In addition, the paired T-test resulted in p = 0.00 (p < 0.05). Thus, there was a difference in the intervention group's mean RBG levels before and after cycling (Table 3).

Discussion

Identification of RBG levels before cycling

There was no significant difference in the mean RBG levels between the intervention and control groups before cycling. Before cycling, the mean RBG levels in the intervention group were 206.67 mg/dL (Table 1). It is categorized as hyperglycemia.

Most respondents in this study were 55–65 years old (Table 1). According to the World Health Organization (WHO), the age is classified as elderly. One of the risk factors for diabetes is age. The elderly have impaired glucose tolerance due to insulin resistance. So that there are changes in body composition and diet also decreased activity and neurohormonal function [14].

In addition, most respondents in this paper were females (Table 1). Sex was also a risk factor for diabetes. The incidence of diabetes was higher in females than males. It was due to decreased estrogen hormone levels after menopause. The changes in hormone levels would trigger fluctuations in RBG levels [15].

Furthermore, most respondents graduated from Senior High School (Table 1). According to the Law of the Republic of Indonesia on National Education System Number 20 the Year 2003, it is classified as secondary education. Another risk factor for diabetes was educational level. Education could affect a person's ability and knowledge to implement healthy living behaviors, especially diabetes management [16].

Moreover, the duration of diabetes in most respondents was <5 years (Table 1). A study showed an independent association between diabetes duration and microvascular events in T2D diabetics. The study reported that for each 5-year increase in diabetes duration, the risk of microvascular events was increased by 28% [17].

There were no differences in the characteristics of respondents between the control and intervention groups (Table 1). Characteristics of respondents were confounding factors in this paper. Thus, we controlled confounding factors by analyzing homogeneity in the characteristics of respondents.

Identification of RBG levels after cycling

There was a difference in the mean RBG levels between the intervention and control groups after cycling, in the control group were 182.70 mg/dL while in the intervention group were 114.60 mg/dL (Table 2). Respondents who regularly cycled had lower average

Table 3: Changes random blood glucose (RBG) levels before and after cycling in the control and intervention groups

RBG levels	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	95% CI	T	p^*
Control group	176.57 ± 88.627	182.70 ± 81.518	−19.119; 6.853	0.966	0.342
Intervention group	206.67 ± 69.887	114.60 ± 30.395	72.701; 111.432	9.723	0.00

*$p < 0.05$ Based on paired t-test, RBG: Random blood glucose, SD: Standard deviation.

RBG levels than respondents who did not. It is in line with a previous study. The study revealed that more active individuals had lower RBG levels than less active ones [12].

Physical exercise can improve insulin sensitivity. A study revealed that physical activity must fulfill frequency 3–5 times per week, with light and moderate intensity, and duration 30–60 min per session [6]. Cycling is an aerobic exercise that can increase insulin receptor sensitivity to convert glucose into energy through metabolism. Cycling impacts the endocrine system because the endocrine system regulates the pancreas gland that produces insulin to regulate RBG levels [9]. Cycling affects the endocrine system because the endocrine system regulates the pancreas gland that produces insulin to regulate RBG levels). Insulin is a carbohydrate homeostatic protective hormone. It reduces RBG levels by promoting stored glucose utilization, storage, and metabolic conversion. In addition, it increases the sensitivity of insulin work. The glucose will be used as energy and can reduce glucose levels in the blood [18].

The effect of cycling on RBG levels

There was a difference in the intervention group's mean RBG levels before and after cycling. Before cycling, the mean RBG levels in the intervention group were 206.67 mg/dL-hyperglycemia. Meanwhile, after cycling, the mean RBG levels in the intervention group were 114.60 mg/dL-normoglycemia (Table 3). Cycling affected decreased RBG levels in individuals with diabetes. Respondents with hyperglycemia experienced lower RBG levels after regular cycling with the direction of the researchers. Both males and females who cycled experienced a decrease in RBG levels.

Meanwhile, there were increased RBG levels in pre-test and post-test in the control group. In pre-test were 176.57 mg/dL and in post-test were 182.70 mg/dL (Table 3). In the control group, respondents did not do the physical activity by cycling but only controlled their diet so that RBG levels tended to increase. Research showed that decreased physical activity could increase the incidence of diabetes [19]. During physical activity, muscles will increase the burning of glucose and cause reduced blood sugar levels.

A prior study showed that dynamic physical activities involving the main muscles would cause increased permeability in contracting muscles. So that insulin receptors will be more sensitive during exercise [20]. Cycling is an activity that depends on the availability of oxygen to help burn energy sources. It also depends on the organs' optimal work to transport oxygen so that the combustion process of energy sources can run perfectly. In cycling sports, there is the burning of stored carbohydrates, fats, and a small portion (± 5%) of protein stored in the body to produce ATP (adenosine triphosphate). As a result, it causes RBG levels to return to normal [12].

The frequency of exercise in this study met the minimum standard of 2 times per week. According to the American Diabetes Association (ADA), people with diabetes should do at least 150 min of aerobic physical activity per week with moderate intensity. The ADA also encourages people with T2D without contraindications to exercise twice a week. Cycling is one of the physical activities that people with diabetes can do [21].

A combination of four pillars in diabetes management is crucial. It includes medication and diet adherence for people with diabetes. Respondents who always follow therapy regularly and adhere to diet will cause a decrease in RBG levels [11], [22]. Effective health education will create self-management and increased adherence to the recommendations of health workers [23]. The successful management of T2D needs patient acceptance and adaptation to changes due to diabetes disease. In addition, they must build commitment to comply with diabetes management. Optimal health increases the quality of life in people with diabetes [11].

Limitations

There may be some possible limitations in this study. First, the study does not analyze psychological status as confounding factors. Second, the small sample examined limits the generalizability of the finding in this study.

Conclusion

Cycling can lower RBG levels in individuals with diabetes. Further research should evaluate the use of the stationary bicycle for speed consistency in cycling. In addition, it must measure continuous glucose monitoring to analyze changes after physical activity by cycling.

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