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RESEARCH ARTICLE

The relationship between occlusal support zones and blood glucose levels: the moderating role of carbohydrate and fiber intake frequency

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ABSTRACT

Blood glucose levels are influenced by carbohydrate and fiber intake. A diet high in carbohydrates and low in fiber can elevate blood glucose levels. The impact of carbohydrate and fiber intake is mediated by masticatory function, which depends on the occlusal contact of the posterior teeth. The aim of this study was to examine the relationship between the occlusal support zone and blood glucose levels, with the frequency of carbohydrate and fiber consumption acting as moderating variables. This research employed an observational analytic design using a cross-sectional method. The sample consisted of 33 elderly individuals, aged 60 to 74 years, from Kalibening Village, Dukun Subdistrict, Magelang Regency, selected through accidental sampling. Blood glucose levels were measured using the Accu-Chek test, occlusal support zones were assessed with the Eichner index, and the frequency of carbohydrate and fiber intake was recorded through a 4-day food diary questionnaire. The examination data were analyzed using path analysis. The results of the analysis showed no significant direct relationship between the occlusal support zone and blood glucose levels ($p = 0.76$; $r = 0.003$). However, when the frequency of carbohydrate consumption was included as a moderating variable, a significant relationship was found ($p = 0.008$). In contrast, when the moderating variable was the frequency of fiber consumption ($p = 0.97$), no significant relationship was observed. The study concludes that there is a relationship between the occlusal support zone and blood glucose levels in the elderly, with the frequency of carbohydrate consumption as a moderating variable. However, no relationship was found between the occlusal support zone and blood glucose levels when the frequency of fiber consumption was the moderating variable.

Keywords: blood glucose; elderly; frequency of carbohydrate eating; frequency of fiber eating; occlusal support zone

INTRODUCTION

Blood glucose is the product of carbohydrate metabolism and serves as a primary energy source for the body.[1] Maintaining blood glucose levels is essential, as it is the sole nutrient utilized by the brain, retina, and gonadal germ epithelium, requiring sufficient quantities to meet energy demands.[2] Normal blood glucose levels two hours after eating should be below 140 mg/dL.[3] Elevated blood glucose levels can lead to cellular dehydration, and glucose loss in the urine can cause the kidneys to undergo diuresis, resulting in fluid and electrolyte depletion.

Prolonged high blood glucose levels can damage various tissues, including blood vessels, and cause peripheral neuropathy, which leads to abnormal function of peripheral nerves, malfunctioning of the autonomic nervous system, and chronic diabetes mellitus. These damages can disrupt cardiovascular reflexes, impair bladder control, reduce sensation in the extremities, and cause other symptoms associated with peripheral nerve damage.[2]

High carbohydrate consumption and low fiber intake may contribute to elevated blood glucose levels.[1] Masticatory ability can influence an individual's diet. Mastication is the mechanical process of breaking down food in the oral cavity before swallowing and digestion.[4] Poor masticatory function often leads to a preference for soft, carbohydrate-rich foods over harder, fiber-containing foods.[5] Masticatory performance is dependent on the occlusal contact of the teeth, making the occlusal support zone crucial for optimal mastication.[4]

The occlusal support zone refers to the occlusal contact of teeth in the molar and premolar

regions.[6] To achieve maximal occlusal support, the molar and premolar teeth are expected to remain intact. However, maintaining this maximum occlusal support zone is challenging, especially in the elderly. The results of the Basic Health Research show that the age group over 65 years has an average MT (Missing Teeth based on the DMFT index) score of 10.1. This means that each individual has an average of 10 missing teeth.[7] This problem is related to various functional and physical changes in the oral cavity of the elderly.[8]

The aim of this study is to determine the relationship between the occlusal support zone and blood glucose levels in the elderly, with the frequency of carbohydrate and fiber consumption as moderating variables. The following is the schematic outline of this study:

MATERIALS AND METHODS

This study employed an observational analytic method with a cross-sectional approach. It was conducted at community health center for the elderly (*Pos Pelayanan Terpadu* (Posyandu) Lansia) in Kalibening village, Dukun subdistrict, Magelang regency, Central Java. The study subjects were 33 elderly individuals aged 60–74 years who had no history of diabetes mellitus. Data were collected on occlusal support zones, blood glucose levels, and the frequency of carbohydrate and fiber intake. The occlusal support zones were categorized using the Eichner Index. Category A includes individuals with four occlusal support zones and is further divided into A1 (complete dentition), A2 (missing teeth in one arch), and A3 (missing teeth in both arches). Category B includes individuals with one to three occlusal support zones and is divided into B1 (missing teeth with three occlusal support zones), B2 (missing teeth with two occlusal support zones), and B3 (missing teeth with one occlusal support zone). Category C includes individuals with no occlusal support zones and is divided into C1 (teeth in both arches), C2 (teeth in one arch), and C3 (edentulous).[6] These categories were further grouped into five conditions as follows: A1, A2, and A3 were grouped into Condition 5, B1 into Condition 4, B2 into Condition 3, B3 into Condition 2, and C1, C2, and C3 into Condition 1.

Blood glucose levels were measured using the Accu-Chek test. A postprandial blood glucose test was administered two hours after eating. The elderly participants were instructed to eat two

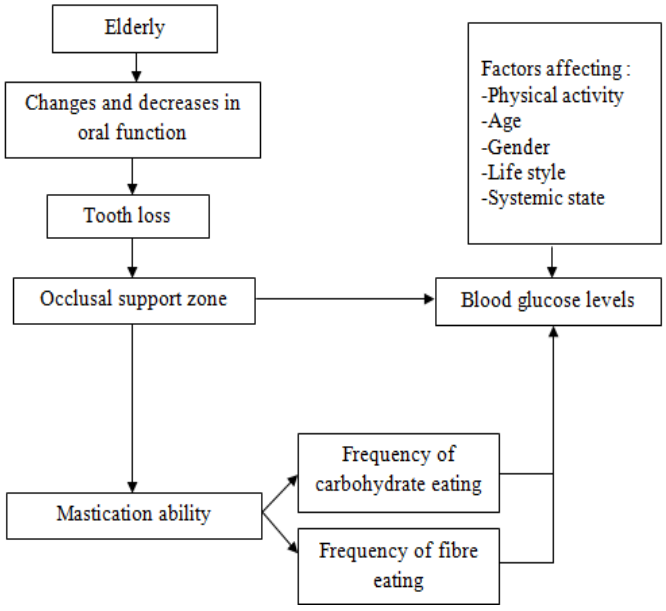

Figure 1. Schematic outline

hours before coming to the Posyandu. Normal postprandial blood glucose levels are below 140 mg/dL. Blood glucose levels between 140–199 mg/dL indicate prediabetes, and levels of 200 mg/dL or higher suggest diabetes.[3]

The frequency of carbohydrate and fiber consumption was recorded using a 4-day food diary questionnaire. The elderly participants were asked to document all foods consumed over a four-day period in the provided questionnaire. The data obtained were ordinal and ratio data. Ordinal data were converted into interval data using the Successive Interval method (MSI). Ratio and interval data were analyzed using path analysis. Path analysis was performed using a computer with a significance level of $p < 0.05$ (95% confidence level). This study has received approval from the Ethics Committee of the Faculty of Dentistry, Universitas Gadjah Mada, under No. 0008/KKEP/FKG-UGM/EC/2019.

RESULTS

Data from the examination of occlusal support zones, frequency of carbohydrate and fiber consumption, and blood glucose levels are presented in Table 1. As shown in Table 1, there appears to be a tendency for individuals with smaller occlusal support zones to exhibit higher blood glucose levels. Furthermore, within Condition 1, elderly participants consuming a diet with a higher proportion of carbohydrates compared to fiber tended to have higher average blood glucose levels than those with other dietary patterns.

Path analysis, a regression analysis technique incorporating moderating variables, was employed to analyze the data. The ordinal data pertaining to occlusal support zones were initially converted into interval data using the Successive Interval Method (MSI). Path analysis could proceed if all data met the parametric assumptions.

As depicted in Figure 2, the direct relationship between occlusal support zone and blood glucose levels exhibited a significance value of 0.76 ($p > 0.05$), indicating no significant association between these two variables. However, when the frequency of carbohydrate consumption was introduced as a moderator, the relationship between occlusal support zone and blood glucose levels became significant with a p-value of 0.008 ($p < 0.05$) and an R-squared value of 0.33. These results suggest that the occlusal support zone and frequency of carbohydrate consumption have a significant impact on blood glucose levels in the elderly population, with these factors accounting for 33% of the variation in blood glucose levels. The remaining variance is attributed to other influencing factors. Notably, the R-squared value for the

Table 1. Distribution of blood glucose levels based on occlusal support zone condition and frequency of carbohydrate and fiber consumption

OSZ	Blood glucose level ($\bar{x}$ mg/dL)		
	C > F	C = F	C < F
1	145 ± 49.9	109 ± 14	91
2	154 ± 37.2	0	113 ± 34.6
3	140 ± 82.7	0	0
4	78	0	0

OSZ : Occlusal support zone
$\bar{x}$: Average
C : Carbohydrate
F : Fibre

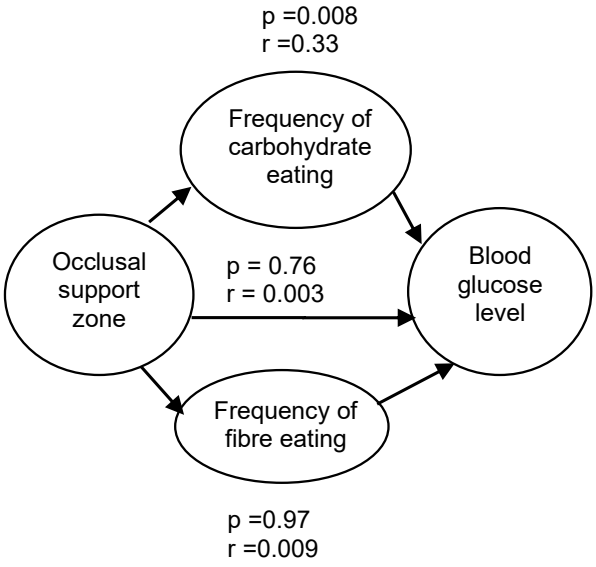

Figure 2. The relationship between occlusal support zone, blood glucose levels, and frequency of carbohydrate and fiber consumption as a moderating variable

moderated relationship (0.33) was higher than that for the direct relationship (0.003), suggesting that the moderating effect of carbohydrate consumption frequency significantly influenced the association between occlusal support zone and blood glucose levels. The derived regression equation is Y = 34,522 - 26,999x (occlusal support zone) + 6,401x (frequency of carbohydrate consumption), where Y represents the dependent variable (blood glucose).

Figure 2 further reveals that the relationship between occlusal support zone and blood glucose levels when moderated by the frequency of fiber consumption exhibited a significance value of 0.97 ($p > 0.05$), indicating no significant association between these variables under this condition.

DISCUSSION

The data indicates a tendency for elevated blood glucose levels to be associated with minimal occlusal support zones and excessive carbohydrate consumption. In the elderly, a high intake of carbohydrates and a low intake of fiber can contribute to increased blood glucose levels.[1]

Carbohydrates serve as a primary energy source for cells, particularly in the form of glucose.[1] Excessive carbohydrate intake can lead to elevated blood glucose levels, making them difficult to regulate within normal limits.[9] Consequently, higher carbohydrate consumption is often correlated with higher blood glucose levels.[1] Conversely, consuming a high amount of fiber can help lower blood glucose levels.[10] Fiber aids in blood glucose control by slowing down gastric emptying, reducing glucose absorption, and improving insulin sensitivity.[11]

The direct analysis between occlusal support zone and blood glucose levels (sig. = 0.76; r = 0.003) revealed no significant relationship between the two variables. However, when introducing the frequency of carbohydrate consumption as a moderating variable, a significant relationship emerged (sig. = 0.008) among the three variables. The relationship between carbohydrate intake and blood glucose levels is directly proportional, meaning that higher carbohydrate consumption leads to higher blood glucose levels.[1] Consumed carbohydrate are converted into glucose in the body. Excessive carbohydrate intake can result in elevated blood glucose levels in both blood vessels and the body.[9]

In contrast to the frequency of carbohydrate consumption, the frequency of fiber consumption as a moderating variable did not demonstrate a significant relationship between occlusal support zone and blood glucose levels (sig. = 0.97). These findings diverge from the other research which established a relationship between fiber consumption and blood glucose levels.[10] This relationship is inverse, indicating that higher fiber consumption is associated with lower blood glucose levels. Fiber exerts its blood glucose-lowering effect by binding to food and forming a gel, increasing the viscosity of the food. This gel-like substance delays gastric emptying and digestion, leading to a prolonged feeling of fullness and reduced food intake. Additionally, the prolonged digestion process can decrease nutrient absorption, including glucose.[11] The discrepancy in results may be attributed to the sole focus on the frequency of fiber consumption within a four-day period without measuring the weight (in grams) of fiber consumed. In contrast, the study by Immawati and Wirawanni quantified fiber consumption by weight (in grams), providing a more detailed analysis of fiber intake.[10]

CONCLUSION

In the elderly population of Kalibening village, Dukun subdistrict, Magelang regency, a significant relationship was observed between occlusal support zone and blood glucose levels when moderated by the frequency of carbohydrate consumption. However, no significant relationship was found between occlusal support zone and blood glucose levels when moderated by the frequency of fiber consumption.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

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