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Professional paper

FRUIT CONSUMPTION AND ITS INFLUENCE ON THE DEGREE OF INSULIN RESISTANCE

Eleonora DELINIKOLOVA*, Vezirka JANKULOSKA, Tatjana BLAZHEVSKA, Viktorija STAMATOVSKA

Faculty of Technology and Technical Sciences, Veles, "St. Kliment Ohridski" University- Bitola, Dimitar Vlahov 57, 1400 Veles, Republic of North Macedonia
[*]Corresponding author e-mail: eleonora.delinikolova@uklo.edu.mk

Abstract

Fruit is rich in fiber, antioxidants, and phytochemicals that can have beneficial health effects. Its consumption is recommended for the primary prevention of many chronic diseases, but opinions are divided regarding its preventive role in the development of hyperinsulinemia and diabetes.
The purpose of this research is to assess the influence of the frequency and quantity of fruit consumed on the degree of insulin resistance (expressed through HOMA-IR), in people who have hyperinsulinemia and increased body mass. Through a survey questionnaire, 104 women and 71 men answered questions related to the representation of fruit in their diet. All 175 subjects were older than 25 years, had an increased body mass index (BMI>25 kg/m2), and diagnosed hyperinsulinemia. Most of the respondents, 95 (55.23%) consume fruit in a quantity less than 250g, the most common frequency of intake in 57 (32.57%) is from three to five times a week. There is a statistical dependence between the HOMA - IR index and the frequency of eating fruit every week, among respondents aged between 41 and 55. Women consume a larger quantity of fruit every week, and it was notable that those with a lower HOMA - IR index consume a smaller amount than those with a higher value on this index.
Fruit is recommended as part of the diet for people with insulin resistance, but it should be represented in adequate quantities, to take advantage of its benefits.

Keywords: insulin resistance, HOMA-IR, nutrition, fruit.

1. Introduction

Hyperinsulinemia is an important etiological factor in the development of metabolic syndrome (MS), type 2 diabetes (T2D), cardiovascular disease (CVD), cancer, and premature mortality (Miranda et al., 2005; Janssen, 2021; Alemany, 2024). Hypersecretion of insulin and hyperinsulinemia could occur before insulin resistance and contribute to the occurrence of T2D and CVD (Zhang et al., 2021). It is characterized by higher levels of circulating insulin, to achieve an integrated response in glucose reduction. This is a load on the endocrine pancreas, which is why β-cell decompensation paves the way for the development of T2D (Vaidya et al., 2023). Diet plays a key role in the emergence and development of MS (Zimmermann & Aeberli, 2008). Fruit holds an important place in dietary recommendations due to its high content of vitamins, minerals, phytochemicals, antioxidants, dietary fiber, etc. (Slavin & Lloyd, 2012). Fruit also contains sugars (fructose, glucose, and sucrose), which vary among species and may cause insulin to rise after eating (Park, 2021). However, there is no confirmation that fructose present in fruit, if consumed in optimal amounts, has a negative impact on the control of glycemia in T2D (Christensen et al., 2013; Mamluk et al., 2017).
Additionally, the glycemic index (GI) describes the blood glucose response after consuming carbohydrate-containing foods, compared to a reference food such as glucose or white bread. While glycemic overload (GO), considers the food and the amount of food consumed. In people with diabetes, it is recommended to choose foods with low GI (Venn & Green, 2007; Muraki et al., 2013). For persons with hyperinsulinemia and diabetes, the recommendations regarding

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the amount of fruit consumption are the same as for the general population and they range from 400 to 450 g per day (United Kingdom Eatwell Plate, 2007; Canada's Food Guide, 2007; USDA, 2010; WHO, 2011).

2. Materials and methods

To determine the impact of the amount, frequency, and type of consumed fruit, on the degree of insulin resistance, a group of 175 people was selected, according to the following entry criteria: older than 25 years, with an elevated body mass index, and present hyperinsulinemia. In terms of gender representation and age, 104 respondents were women, and 71 were men.
Data was collected through subjective statements obtained via interviews using a questionnaire. Body mass index was calculated according to the formula, body weight in kilograms (kg) divided by the square of height in meters (m2) (Khanna et al., 2022). The degree of insulin resistance was calculated by multiplying fasting glucose (mmol/L) by fasting insulin (mlU/L) and then dividing the product by 22.5 (Matthews, 1985) The Python software (version 3.4), was used for data analysis (Payton, 2014). Hypotheses were tested at a significance level of α=0.05 using Pearson's hi-square (χ^2) test (Ludbrook, 2008).

3. Results and discussion

Subjects had the following mean values of anthropometric characteristics: mean age in females was 34.33 ± 12.66 years and in males was 47.06 ± 11.00 years. For the study, the subjects were divided into three age groups, 25 to 40 years, 41 to 55 years, and 56 to 75 years. The women had an average height of 163.48 ± 6.69 cm and an average body weight of 86.44 ± 13.35 kg. The average BMI was 32.21 ± 3.57 kg/m2. The men had an average height of 172.26 ± 7.24 cm and an average body weight of 98.11 ± 12.48 kg. The average BMI was 32.21 ± 3.57 kg/m2.
In women, the mean fasting glucose level was 6.10 ± 0.46 mmol/L, with a corresponding fasting insulin level of 18.87 ± 5.04 mIU/L. Among men, the mean fasting glucose level was measured at 6.24 ± 0.51 mmol/L, with a fasting insulin level of 19.14 ± 4.35 mIU/L. The overall mean HOMA-IR value across all subjects was determined to be 5.21 ± 1.44 (Delinikolova & Jankuloska, 2022).
In the study group, the representation of fruits in the diet was assessed based on the frequency and quantities of their consumption.
Presented and graduated by amount and frequency of intake, the majority of subjects, 95 (55.23%), consumed less than 250 g of fruit, with the most prevalent frequency of intake, in 57 of them (32.57%), being three to five times per week. 55(31.42%) have a habit of daily consumption. The recommended amount is insufficiently represented in 45(25.71%) of the subjects who consume once to twice a week, as well as in those 15(8.57%) who do it sometimes or do not consume at all 3(1.71%).
Fifty-six respondents (32.55%) stated that they consume the recommended amount of fruit, ranging from 250 to 500g, while ten respondents (5.81%) consume more than 500g (Figure 1).

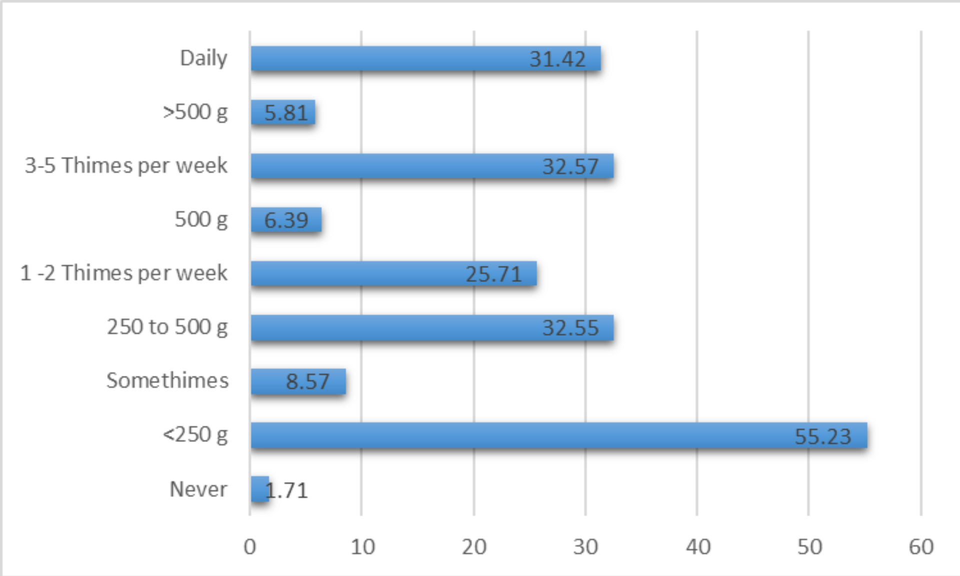

Figure 1. Percentage of fruit in the diet (quantity, frequency)

The hypothesis that the frequency of fruit consumption every week depends on the age of the subjects was tested using the Chi-square test of independence at a significance level of $\alpha=0.05$. The resulting p-value of 0.2007 indicates that the frequency of weekly fruit consumption is not dependent on the age of the subjects. For this reason, the largest age group, 41 to 55 years, was selected to test the dependence between the HOMA-IR index and the frequency of fruit consumption. Figure 2 provides data on the dependence between HOMA-IR and the frequency of eating fruit.

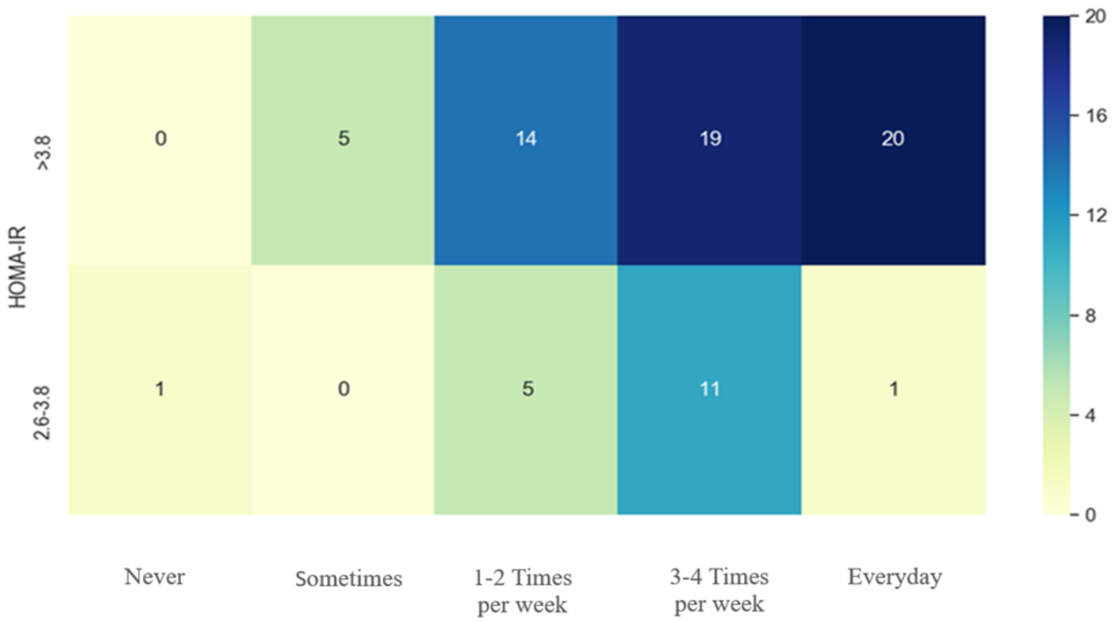

Figure 2. Fruit consumption frequency/ HOMA-IR

On the data thus divided, the following hypotheses were tested:

H_0: HOMA-IR index and the frequency of weekly fruit consumption are independent variables, against the alternative hypothesis

H_1:The HOMA-IR index is contingent upon the frequency of fruit consumption.

The results of the hi-square test of independence yielded the following outcomes:

Table 1. X2 test: Fruit consumption frequency/ HOMA-IR

α	*p - value*	*Degrees of freedom*	X^2 *- value*
0.05	0.01886828684	4	11.8041963145

Since, p-value is lower than the value of the significance level α, the null hypothesis is rejected, i.e. there is a statistical dependence between the HOMA-IR index and the weekly frequency of fruit consumption among subjects aged between 41 and 55 years.

Subjects were asked to indicate their primary fruit preference, aiming to understand their selection preferences. They were given two groups to choose from. The first group of fruits included: bananas, watermelon, cherries, grapes and pineapple (a group of fruits with a higher GI), while the second group included: apples, oranges, peaches, plums and pears (a group of fruits with a lower GI). Figure 3 shows the representation of these groups and the corresponding amounts consumed at one meal, for the age group from 41 to 55 years. More subjects opted for the second group of fruits.

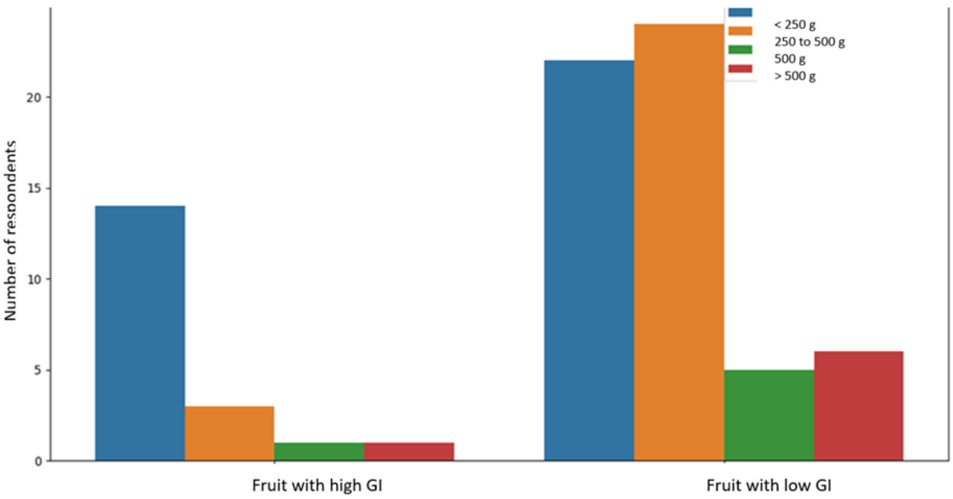

Figure 3. Representation of fruit quantities according to GI

Respondents who eat fruits with a lower GI, tend to consume larger quantities of them.

The study by Muraki et al. (2013) suggests that there is significant heterogeneity in the composition of fruits and their association with the risk of T2D. Greater use of specific fruits, especially blueberries, grapes, and apples, is significantly associated with a lower risk of T2D, while greater use of fruit juices carries a greater risk. In conclusion, these findings support recommendations to enhance the consumption of various whole fruits, with particular emphasis on blueberries, grapes, and apples, as part of measures for diabetes prevention.

As the responses for weekly consumption frequency and the amount consumed were categorical, they have been transformed into numerical features. When answering the question about the frequency of weekly consumption of fruit, the following substitution was made from categorical to numerical marks (Table 2).

Table 2. Weekly fruit consumption amount

Categorical variable	**< 250 g**	**250 to 500 g**	**~ 500 g**	**>500 g**
Numerical variable	200	375	450	600

Figure 4, provides a graphical representation of the weekly fruit consumption amount, among men and women aged between 41 and 55 years, categorized by their HOMA-IR index. Based on Figure 4, it is observed that women tend to consume a greater quantity of fruit every week. Additionally, individuals with a lower HOMA-IR index consume a smaller amount compared to those with a higher index value.

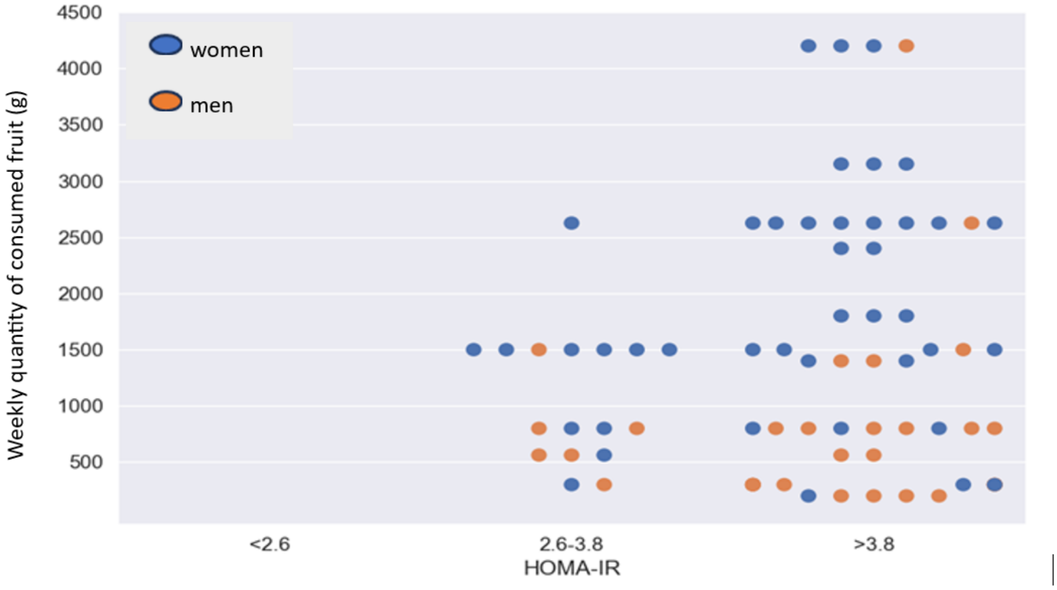

Figure 4. Weekly quantities of consumed fruit by gender

The analysis of the data revealed that the weekly fruit consumption quantities are dependent on age. Hence, the hypothesis regarding the dependency between the subjects' HOMA-IR index and their weekly fruit consumption amounts was tested across all age groups (Figure 5).

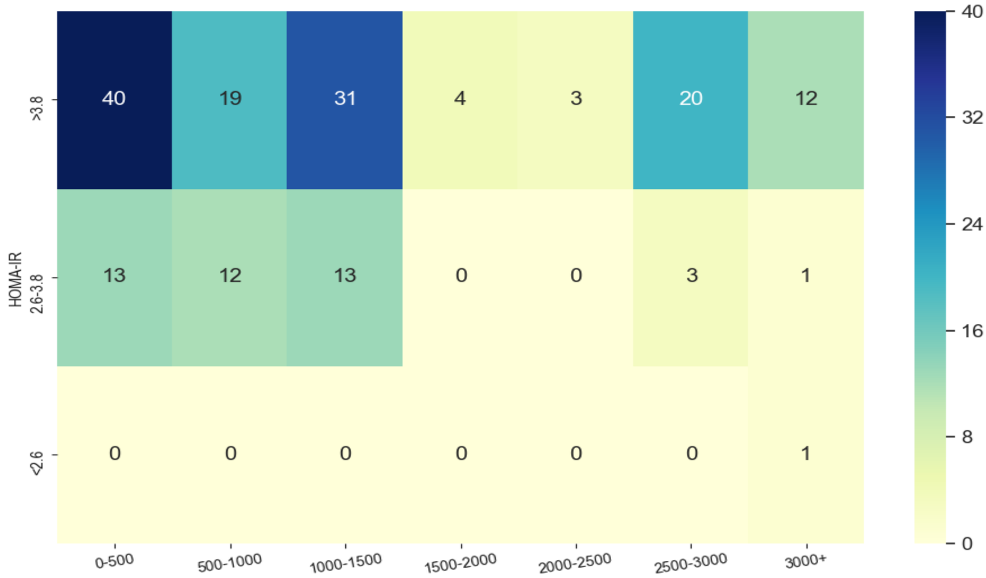

Figure 5. Weekly fruit consumption zmount (g) / HOMA-IR

For the Chi-squared test of independence, the hypotheses were tested:

H_0: HOMA – IR index and the consumed amount of fruit every week (given in grams), are independent variables, against the alternative hypothesis.

H_1:HOMA- IR index depends on the amount of fruit consumed on a weekly basis.

The statistical test resulted in a p-value of approximately 0.13, suggesting that the null hypothesis cannot be rejected at the specified level of significance α=0,05. That is concluded that the amount of fruit consumed in a week has no impact on the HOMA-IR index of the respondents.

4. Conclusion

As part of the dietary recommendations, fruit should also be included in the diet of people with hyperinsulinemia. Consuming an adequate amount and appropriate types of fruit can provide preventive benefits in addressing certain health conditions, such as hyperinsulinemia. In this study, the majority of respondents did not consume fruits in the recommended amount and opted for fruits with a higher glycemic index (GI). A higher intake of these fruits could potentially have a significant impact on the HOMA-IR index Hence, for individuals already afflicted with certain health conditions and obesity, there should be an emphasis on enhancing education regarding overall nutrition and lifestyle habits. This will enable the potential positive impact of fruits as components of a healthy and balanced diet.

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