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INFLUENCE OF FREQUENCY OF FERMENTED MILK PRODUCTS CONSUMPTION IN PERSONS WITH HYPERINSULINEMIA AND ELEVATED BODY MASS ON THE DEGREE OF INSULIN RESISTANCE

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Summary

Fermented dairy products with a low percentage of fat play a role in modulating the function of β-cells of the pancreas and increased sensitivity to insulin. The purpose of this research is to verify the influence of the type and quantity, of consumed fermented milk products (yogurt and kefir), on the degree of insulin resistance, through Homeostatic Model Assessment for Insulin Resistance (HOMA-IR). The research was conducted on 175 people, from whom 103 women and 73 men, aged 25 to 75 years, with hyperinsulinemia and have increased body mass. Respondents were interviewed with a survey questionnaire that refers to the frequency, quantity, and type of consumed fermented milk products with different percentages of fats. From the obtained results, 56 (32%) have a habit of daily consumption, and the most frequently used daily amount is 250 mL in 127 (74.70%) participants. Statistical significance (p=0.015) was determined between the frequency of consumption and HOMA-IR in the age group between 41 and 55 years. The participants of this age group who have a higher value of the index tend to consume fermented milk products more often, which leads to the conclusion that the consumption of the fermented milk products can have an impact on HOMA-IR in this age group. The statistical analysis of the results obtained for the age groups: 25 to 40 years, and 56 to 75 years showed that there is no significant difference between the frequency of fermented dairy products consumption and HOMA-IR index of the subjects in the groups.

Keywords: hiperinsulinemia, nutrition, fermented dairy products, insulin resistance

Introduction

Lifestyle diseases are conditions resulting from our lifestyle, work habits, and daily functioning (Balwan et al., 2021). Metabolic syndrome (MetS) is a cluster of comorbid conditions including obesity, hypertension, and disordered carbohydrate and lipid metabolism (Alberti et al., 2009; Dobrowolski et al., 2022). Abdominal obesity and insulin resistance are among the most prominent factors contributing to the development of MetS, along with other associated health issues, sedentary lifestyles, the aging process, and hormonal imbalances (Grundy et al., 2005). The distribution of body fat is also a critical factor; an increased proportion of visceral fat relative to subcutaneous adipose tissue can lead to a greater degree of insulin resistance. This is attributed to the release of non-esterified fatty acids that accumulate in other tissues and internal organs, thereby exacerbating insulin resistance (Swarup et al., 2022). In the development of metabolic syndrome, the changes often commence with the onset of hyperinsulinemia, followed by an increase in body mass. In such instances, the initial visible symptom of metabolic alterations is the increase in body mass (Crofts et al., 2016). Type 2 diabetes (T2D) is usually preceded by increased insulin resistance, i.e. decreased insulin sensitivity, which can be assessed by the insulin resistance index (HOMA-IR) (Vladu et al., 2022). Insulin resistance is closely linked to hyperinsulinemia. Both insulin resistance (IR) and inadequate insulin secretion are the primary pathogenic factors contributing to impaired glucose tolerance (IGT) and the onset of type 2 diabetes (T2D) (Kelly et al., 2014; Crofts et al., 2015). Mortality associated with hyperglycemia and overweight/obesity is estimated at 6% and 5%, respectively (Wylie-Rosett & Jhangiani, 2015).

Diet and lifestyle play a significant role in influencing hyperinsulinemia (Crofts et al., 2016). The consumption of low-fat fermented dairy products, such as yogurt, has shown positive effects in preventing glucose intolerance and the development of type 2 diabetes. Research indicates that consuming 200 g of yogurt per day results in a 57% risk reduction for the development of MetS and a 22% risk reduction for T2D, while consuming 244 g of yogurt per day leads to an 18% risk reduction, and 80 g of yogurt per day results in a 14% risk reduction compared to a diet without yogurt (Cheraghi et al., 2016; Fernandez et al., 2017).

Milk contains multiple components that promote insulin sensitivity, including calcium, magnesium, potassium, vitamin D, protein, and other compounds (Fumeron et al., 2011; Aune et al., 2013). Additionally, the positive impact of whey protein on the regulation of certain hormones related to satiety, lipid metabolism, and insulin secretion has been observed (Elwood et al., 2010). Cis-9, trans-11 conjugated linolenic acid present in milk products has been shown to play a role in regulating body weight

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(Moloney et al., 2007; Mozaffarian et al., 2010). Furthermore, the lactic acid bacteria found in fermented products have an impact on gut microbiota and sensations of satiety (Sluijs et al., 2012; García-Burgos et al., 2020). On the other hand, the consumption of dairy products with a high energy content, such as full-fat dairy products, may lead to adverse metabolic effects (Struijk et al., 2013). As per a meta-analysis conducted by Tong et al. (2011), individuals with the highest consumption of milk and dairy products had a 14% lower risk of developing type 2 diabetes (T2D) compared to those who consumed fewer or no dairy products. The same authors also observed an inverse correlation between the consumption of full-fat dairy products and the risk of T2D, a correlation that was evident only in the case of skimmed milk and low-fat dairy products. The association has not been confirmed for full-fat dairy products (Tong et al., 2011). The consumption of full-fat dairy products, including cheese with 25% and 32% fat, or reduced-fat cheese with 13% and 16% fat, does not have a direct impact on fasting glycemia, fasting insulin, or HOMA-IR (Raziani et al., 2016). Fermentation enhances the nutritional value of yogurt compared to milk, as it improves the bioavailability of certain trace elements, including calcium, magnesium, and vitamin B_{12}, which are associated with a reduced risk of type 2 diabetes (T2D) (Pittas et al., 2007). Dietary guidelines in the United States suggest a daily consumption of 3 cups of fat-free or low-fat (up to 1%) milk, yogurt and dairy products. Similarly, in the UK, low-fat, low-sugar dairy products are recommended as part of the Eatwell Guide, but no specific quantity recommendations are provided (Middleton et al., 2016).

Materials and methods

In this study, a group of 175 individuals, consisting of 71 men and 104 women, who had been diagnosed with hyperinsulinemia and had elevated body mass, were included. All participants were aged 25 or older and had a body mass index (BMI) indicating excessive weight gain or obesity. Through survey questionnaires, participants were interviewed regarding the quantities and frequencies of dietary product consumption. Additionally, the same criteria were applied to assess the inclusion and inquire about the frequency, amount, and percentage of fat content in fermented dairy products, specifically yogurt and kefir, in their diet. The data collected through subjective responses served as the basis for further analysis (Delinikolova & Jankuloska, 2022). The degree of insulin resistance, as calculated using the formula for Homeostatic model assessment for insulin resistance (HOMA-IR), is obtained by dividing the product of fasting glucose (mmol/L) and fasting insulin (mIU/L) by 22.5 (Matthews, 1985). The degree of obesity is calculated using the formula for Body Mass Index (BMI), which involves the ratio of body mass (kg) to the square of body height $(m)^2$ (Weir, 2023). The analysis was conducted using Python software, specifically version 3.4 (Payton, 2014). To test the hypotheses, Pearson's chi-square (χ^2) test was applied at a significance level of α=0.05 (Ludbrook, 2008).

Results and discussion

The anthropometric characteristics of the subjects were as follows: In women, the average age was 34.33 ± 12.66 years, the average height was 163.48 ± 6.69 cm, and the average weight was 86.44 ± 13.35 kg. For men, the average age was 47.06 ± 11.00 years, the average height was 172.26 ± 7.24 cm, and the average weight was 98.11 ± 12.48 kg. From these parameters, average BMI values were derived, with values of 32.21 ± 3.57 kg/m^2 in women and 33.02 ± 3.32 kg/m^2 in men. For the purposes of the study, the subjects were categorized into three age groups: 25 to 40 years, 41 to 55 years, and 56 to 75 years. In both sexes, the most prevalent BMI range was ≥ 30 (kg/m^2) and < 35 (kg/m^2) in the age groups of 25 to 40 years, accounting for 24% of women and 20% of men.

Body mass, expressed as a percentage, for all subjects within each gender and age group is shown in Figure 1.

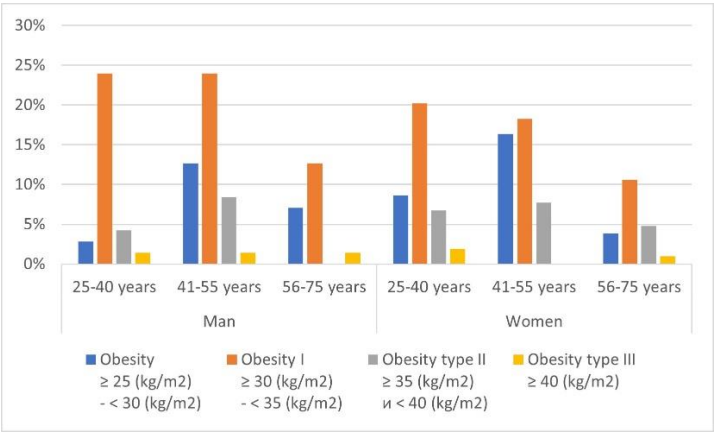

Figure 1. Body mass by sex and age in all age groups

The degree of insulin resistance was determined using the HOMA-IR formula. In women, fasting glucose levels were 6.10 ± 0.46 mmol/L, and fasting insulin levels were 18.87 ± 5.04 mIU/L. In men, fasting glucose measured 6.24 ± 0.51 mmol/L, while fasting insulin was 19.14 ± 4.35 mIU/L. The mean HOMA-IR for all subjects was 5.21 ± 1.44. Of the 175 subjects, the majority, 130 individuals, exhibited high insulin resistance (HOMA-IR ≥ 3.8), 44 subjects had moderate insulin resistance (HOMA-IR = 2.6 to 3.8), and only one subject had low insulin resistance (HOMA-IR < 2.6). This analysis confirms that all subjects exhibit hyperinsulinemia or a pre-diabetic condition, putting them at risk of developing type 2 diabetes (T2D) (Delinikolova & Jankuloska, 2022).

The results regarding the consumption of dairy products, such as yogurts and kefir, are shown in the Figure 2.

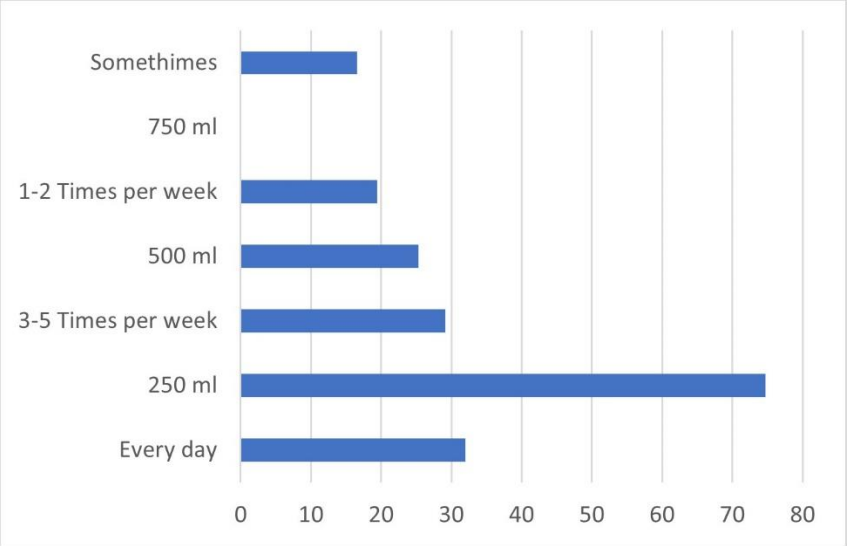

Figure 2. Fermented dairy products (quantity and frequency)

The results indicate that dairy products, such as yogurt and/or kefir, are a part of the subjects' diet. A significant portion of respondents have a daily consumption habit, with 32% of them incorporating these products into their diet every day. Additionally, 29.14% consume them three to five times a week. There is also a percentage of individuals who consume yogurt and kefir once to twice a week, accounting for 19.42%, and occasionally, with a percentage of 6.57%. Regarding the quantity of consumption, 74.70% of those who consume yogurt and kefir do so in the amount of 250 mL, while 25.29% consume 500 mL. Only a small portion, 2.8% of the total respondents, do not consume yogurt and kefir at all.

The dependence of HOMA-IR and the consumption of fermented milk products was tested. This was done by formulating the following hypotheses:

H_o: HOMA-IR index and frequency of consumption of fermented dairy products are independent variables.

H_1: HOMA-IR index depends on the frequency of consumption of fermented dairy products.

The statistical analysis of the results confirmed that the frequency of consumption of fermented dairy products has a statistically significant difference with the HOMA-IR index of the subjects in the most numerous (N= 77) age group of subjects, aged between 41 and 55 years ($\chi^2(4) = 12.415$, $p < 0.015$).

The distribution of the number of subjects in each of the categories related to the HOMA-IR index and their weekly consumption of yogurt and kefir, as shown in Figure 3, indicates correlation with the level of insulin resistance observed in the subjects in the age group between 41 and 55 years. In other words, individuals with higher HOMA-IR index values tend to consume yogurt and kefir more frequently on a weekly basis.

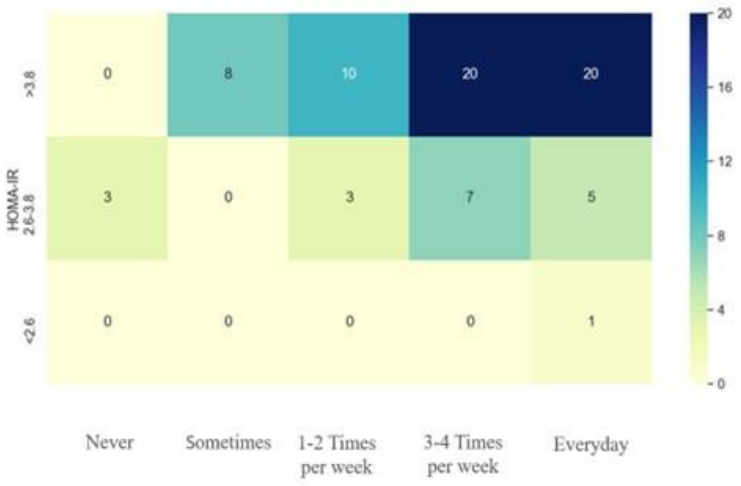

Figure 3. Fermented dairy (yogurt and kefir) and HOMA-IR

The statistical analysis of the results obtained for the age groups: 25 to 40 years, and 56 to 75 years showed that there is no significant difference between the frequency of consumption of fermented dairy products and HOMA-IR index of the subjects in the groups ($p > 0.05$).

The results of the analysis regarding the consumption of products with varying levels of fat content are presented in Figure 4.

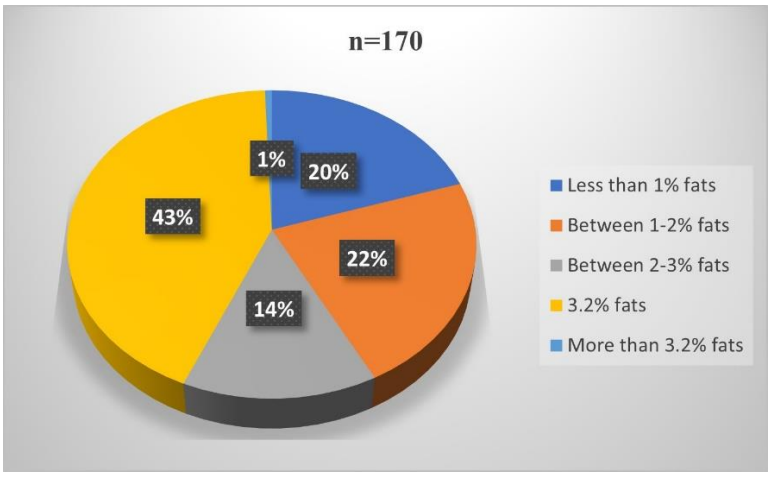

Figure 4. Fermented dairy products (% fat content of yogurt and kefir)

From Figure 4, it is evident that the most commonly consumed fermented dairy products (yogurts and kefir), at 43%, are those with a full-fat content of 3.2%. Approximately 22% of the subjects consume fermented dairy products with fat content between 1% and 2%, while 14% choose products with fat content between 2% and 3%. About 20% of the subjects prefer fermented dairy products with low fat content. The results indicate that the more frequent consumption of full-fat and semi-fat fermented dairy products partially explains the high HOMA-IR values in the subjects who consume them.

Conclusion

The conducted research has led to the conclusion that diet can influence the insulin resistance index and hyperinsulinemia. Further exploration is needed to better understand the effects of nutrition and other factors, such as lifestyle, genetic characteristics etc., in order to promote public health and prevent the progression of type 2 diabetes in the modern society.

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