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Association Between Prebiotic or Probiotic Consumption and Risk of Type 2 Diabetes Mellitus in the General Adult Population

Yetişkin Popülasyonda Prebiyotik veya Probiyotik Tüketimi ile Tip 2 Diyabetes Mellitus Riski Arasındaki İlişki

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ABSTRACT

Introduction: Decrease in microbiota diversity increases risk of diabetes by increasing harmful metabolites and activating insulin resistance pathways. Adequate prebiotic and probiotic food consumption may be a potential tool in order to prevent type 2 diabetes.

Aim: The aim of the research was to examine at the relationship between probiotic and prebiotic consumption and the risk of type 2 diabetes.

Method: A cross-sectional research design was used in this study. Data was obtained from December 2021 and June 2022 using Personal Information Form, Assessment of Probiotic and Prebiotic Food Consumption Form, and Finnish Type 2 Diabetes Risk Questionnaire via online survey. General adults were included in this study. Univariate analysis, logistic and multiple linear regression analyses were conducted.

Results: Of 401 adults, 51.6% were male and 78.80% were under 45 years of age. 89% of the sample stated they consumed prebiotic-probiotics. Logistic regression analysis showed that prebiotic-probiotic consumption was not a significant predictor of low (p = 0.127), mild (p = 0.381), moderate (p = 0.819), high (p = 0.588) and very high risk of type 2 diabetes (p = 0.998). In the research, linear regression research revealed that there was no meaningful connection between prebiotic-probiotic consumption status and type 2 diabetes risk (β = -0.072; p = 0.151).

Conclusion: This research shown that using probiotics or prebiotics did not increase the risk of type 2 diabetes. Thus, more research is required to determine the relation between the usege of probiotics or prebiotics and the risk of type 2 diabetes.

Keywords: Adult; diabetes mellitus; prebiotics; probiotics; type 2.

ÖZ

Giriş: Mikrobiyota çeşitliliğindeki azalma, zararlı metabolitleri artırarak ve insülin direnci yolaklarını aktive ederek diyabet riskini artırmaktadır. Bu nedenle, yeterli prebiyotik ve probiyotik gıda tüketiminin tip 2 diyabetin önlenmesi için potansiyel bir araç olabileceği düşünülmektedir.

Amaç: Bu çalışmanın amacı prebiyotik ve probiyotik tüketimi ile tip 2 diyabet riski arasındaki ilişkiyi araştırmaktır.

Yöntem: Bu çalışmada kesitsel araştırma deseni kullanılmıştır. Veriler Aralık 2021 ve Haziran 2022 tarihleri arasında Kişisel Bilgi Formu, Probiyotik ve Prebiyotik Gıda Tüketiminin Değerlendirilmesi Formu ve Finlandiya Tip 2 Diyabet Risk Anketi kullanılarak çevrimiçi bir anket aracılığıyla toplanmıştır. Sağlıklı yetişkinler bu çalışmaya dahil edilmiştir. Tek değişkenli analiz, lojistik ve çoklu doğrusal regresyon analizleri kullanılmıştır.

Bulgular: Araştırmaya katılan 401 yetişkinin 51,6%'sı erkek olup, 78,80%'i 45 yaşın altındadır. Örneklemin 89,5%'si prebiyotik ve probiyotik tükettiğini ifade etmiştir. Lojistik regresyon analizi prebiyotik-probiyotik tüketiminin düşük (p = 0,127), hafif (p = 0,381), orta (p = 0,819), yüksek (p = 0,588) ve çok yüksek tip 2 diyabet riskinin (p = 0,998) anlamlı bir belirleyicisi olmadığını göstermiştir. Çalışmada doğrusal regresyon analizi prebiyotik-probiyotik tüketme durumu ile tip 2 diyabet riski arasında anlamlı bir ilişki olmadığını göstermiştir (β = -0,072; p = 0,151).

Sonuç: Bu çalışma, prebiyotik veya probiyotik tüketiminin tip 2 diyabet riski ile ilişkili olmadığını göstermiştir. Bu nedenle, prebiyotik veya probiyotik tüketimi ve tip 2 diyabet riskini inceleyen daha çok araştırmanın literatüre kazandırılmasına ihtiyaç bulunmaktadır.

Anahtar Kelimeler: Diabetes Mellitus; prebiyotikler; probiyotikler; tip 2; yetişkin.

Introduction

Type 2 diabetes is one of the most prevalent chronic illnesses in the world (Sun et al., 2022). It is stated that 529 millions of people globally have diabetes in 2021, and approximately There will be 1.31 billion diabetics worldwide by 2050 (Ong et al., 2023). Type 2 diabetes has a number of risk factors, and microbial dysbiosis may potentially be linked to diabetes, according to multiple studies (Kamarlı Altun & Akar Yıldız, 2017; Kim, Keogh & Clifton, 2018; Kassaian et al., 2019; Lee, Sears & Maruthur, 2019). Microbial dysbiosis raises the risk of diabetes and insulin resistance pathways by altering the composition of bile acids and producing more dangerous byproducts from the fermentation of proteins and carbs (Bock et al., 2021; Wang et al., 2021). Therefore, healthy microbiota of gut is important for reducing diabetes risk (Rinninella et al., 2019). There is evidence in the literature that bioactive agents such as prebiotics and probiotics can have an effect on the gut microbiota (Venema and Do Carmo, 2015; Rinninella et al., 2019; Bock et al., 2021; Chaudhari and Dwivedi, 2022).

Prebiotics are basically indigestible food elements that help small amounts of bacteria in the digestive tract grow and function (Bock et al., 2021). Prebiotics have been shown in numerous trials to enhance postprandial glucose response, decrease appetite, and promote gut microbial fermentation (Colantonio, Werner and Brown, 2020; Ojo et al., 2022; Paul et al., 2022). Live microorganisms called probiotics are meant to improve gut health and microbiota (Chaudhari and Dwivedi, 2022). Several studies have shown that different probiotic strains improve the microbiota of gut fermentation, reduce fasting, improve postprandial glucose response, induce weight loss, reduce calorie intake, and improve glucose tolerance (Ardeshirlarijani et al., 2019; Bock et al., 2021; Wang et al., 2021). In this way, it is known that prebiotic and probiotic consumption is effective in the process leading to diabetes (Kamarlı Altun & Akar Yıldız, 2017; Kim, Keogh & Clifton, 2018; Kassaian et al., 2019; Jiang et al., 2022).

Nowadays, there is an opinion that probiotics and eating prebiotic foods could serve as useful instruments in preventing type 2 diabetes by influencing the microbiome (Kim, Keogh & Clifton, 2018; Ahmad et al., 2019; Ardeshirlarijani et al., 2019; Lee, Sears & Maruthur, 2019; Jiang et al., 2022). The impact of this on reducing health risks and especially slowing down the process of chronic disease cannot be ignored. The relation between the usage of probiotics or prebiotics and the preventing of type 2 diabetes in the prediabetes group or the management of type 2 diabetes has been the subject of numerous studies in the literature (Bock et al., 2021; Wang et al., 2021; Chaudhari & Dwivedi, 2022; Ojo et al., 2022). At the same time, these studies mostly evaluated the effectiveness of prebiotic-probiotic supplements on diabetes risk or metabolic control in diabetes (Ardeshirlarijani et al., 2019; Colantonio, Werner and Brown, 2020; Bock et al., 2021; Paul et al., 2022; Ojo et al., 2022). Nevertheless, there is insufficient data regarding the connections between daily prebiotic or probiotic containing food intake and the potential of being diagnosed with type 2 diabetes mellitus. In this context, it is important to add more articles to the literature evaluating the relationships between the possibility of developing diabetes and probiotic-prebiotic consumption. Consequently, our objective was to investigate the connections between prebiotic or probiotic usage and the risk of type 2 diabetes in people in general. Therefore, this study will advance our knowledge of the connections between prebiotic or probiotic usage and the overall risk of type 2 diabetes in people. Additionally, this study will contribute to evidence-based studies and practice by health professionals.

Aim

The aim of the research was to examine at the possible relationship between probiotic and prebiotic consumption and the risk of type 2 diabetes.

Research Questions

1. Is there a relationship between consuming probiotics and prebiotics and the risk of type 2 diabetes?

2. Does consumption of probiotics and prebiotics affect the potential for type 2 diabetes?

Method

Study Design

This web-based study is cross-sectional in design. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement guided its design and reporting. recommendations for the reporting of observational research (Von Elm et al., 2014).

Study Setting

The research data were gathered online between December 2021 and June 2022 using a Google form. The form was transmitted via web-based applications such as whatsapp and e-mail. A reminder e-mail was sent two weeks after submission.

Study Population and Sample

In the study, snowball sampling method was used from the general adult population in Turkey between December 2021 and June 2022. The study's sample consisted of 372 individuals, with a power of 0.97 and a standard error of 0.05 (Dean, 1996; Sezer, Özdoğan Lafçi, Korkmaz and Dağdeviren, 2021). The sample size was intended to be 8% larger than the computed number in order to account for the non-response rate. The research process could be completed with 401 adults. The criteria for inclusion and exclusion were used to choose the research participants. The following were the inclusion criteria: (1) 18 years of age or older; (2) being literate in the Turkish language; (3) freely agreeing to take part in the research. The exclusion criteria were as follows: (1) being pregnant or breastfeeding; (2) being diagnosed with cancer; (3) being diagnosed with autoimmune disease; (4) using immunosuppressive medication; (5) being diagnosed with diabetes mellitus.

Data Collection Tools

A Personal Information Form: Researchers developed this form based on appropriate research (Raygan et al., 2018; Kassaian et al., 2019; Sezer et al., 2021; Wang et al., 2021). It includes questions regarding socio-demographic and general health status. Socio-demographic questions included age, gender, education and employment status in a health-related field. General health status questions consist of perceived health status, smoking and alcohol consumption.

Assessment of Probiotic and Prebiotic Food Consumption Form: This form was used to assess probiotic and prebiotic food consumption. This form included two question. First question consist of probiotic and prebiotic food list prepared by researchers based on the relevant literature (Chaudhari & Dwivedi, 2022; Venema & Do Carmo, 2015; Zeratsky, 2022). Probiotics like yoghurt, soup made

from dried yoghurt, kephir, yoghurt and water, pickles, and olives are included in this list, along with prebiotics like whole meal / mixed grains, garlic, onions, tomatoes, bananas, vegetables, legumes like broccoli, cauliflower, radish, and cabbage, and oilseeds like almonds and pistachios (Köse, Aydın, Ozdemir and Yesil, 2019; TBSA, 2019). Second question include the question "Have you consumed prebiotic or probiotic foods listed above at least once a day in the past 4 weeks?". This question was prepared to assess regular probiotic and prebiotic food consumption based on the relevant literature (Kellow, Coughlan & Reid 2014; Mahboobi, Rahimi & Jafarnejad, 2018; Raygan et al., 2018; Kassaian et al., 2019; Dong, Xu, Chen & Bhochhibhoya, 2019; Barengolts, Smith, Reutrakul, Tonucci and Anothaisintawee., 2021). For this question, yes answers were categorized as consuming prebiotics or probiotics and no answers as not consuming.

Finnish Type 2 Diabetes Risk Questionnaire: The Finnish Type 2 Diabetes Risk Questionnaire (FINDRISC) was used to assess type 2 diabetes mellitus risk within the following ten years for general adults in this study. It was developed by Lindström and Tuomilehto in 2003. Turkish version of the questionnaire was evaluated by the Turkish Endocrinology and Metabolism Association and recommended to be used in diabetes screenings in adults (Lindström & Tuomilehto, 2003; Diabetes Mellitus Research and Education Group, 2022). It includes eight question. In FINDRISC, age (0, 1, 2, 3 and 4 points), body mass index (0, 1 and 3 points), waist girth (0, 3 and 4 points and evaluated differently in women and men), physical activity (0 and 2 points), frequency of vegetable and fruit consumption (0 and 1 point), history of antihypertensive treatment (0 and 2 points), history of hyperglycemia (0 and 5 points) and family history of diabetes (0, 3 and 5 points) are evaluated. The score of the questionnaire ranged from 0 to 26. In terms of diabetes risk within ten years, a total score of <7 points is considered low risk, 7 - 11 points is considered mild risk, 12 - 14 points is considered moderate risk, 15 - 20 points is considered high risk, and > 20 points is considered very high risk (Lindström & Tuomilehto, 2003).

Ethical Considerations

The ethical approval was obtained from Burdur Mehmet Akif Ersoy University Non-Interventional Clinical Research Ethics Committee (Date: 03.11.2021 and No: GO2021/373). In the study, the general principles of the Declaration of Helsinki were followed. The first page of the online survey provided the participants with information on the purpose and methodology of the study before they began. The data of the participants was kept private in accordance with Google's privacy policies. Volunteers continued to fill out the form, if they approved the informed consent on the first page of the online survey.

Data Collection

The data collection phase was carried out online with Google Forms between December 2021 and June 2022. During the data collecting, the personal information form, assessment of probiotic and prebiotic consumption form, and FINDRISC questionnaire were used. We distributed the survey through personal contacts or web-based applications such as WhatsApp. A reminder was given to participants to only respond once.

Data Analysis

IBM SPSS Statistics for Windows version 29.0 used to analyze data. (IBM Corp., Armonk, NY, USA). The normalcy test was analyzed using graphical techniques, as well as skewness and kurtosis tests. The mean and standard deviation of continuous values were displayed, while frequency and percentage were used to represent categorical variables. The chi-square test and Fisher's exact test were used to compare the usage of prebiotics or probiotics and no consumption for sociodemographic and FINDRISC variables. Mann Whitney Group differences were examined using a U test. The binary logistic regression analysis was performed to explore the relationship between FINDRISC levels and prebiotic or probiotic consumption and no consumption. In addition, multivariate linear regression analysis was performed to evaluate the relationship between FINDRISC total score and groups. The correlation between the predictor variables was determined using the variance inflation factor (VIF). Variables whose VIF was equal to or more than 10 were excluded from regression analysis. In every analysis, p values of less than 0.05 were deemed statistically significant.

Results

Sociodemographic and the Finnish Type 2 Diabetes Risk Characteristics of the Participants

A total of 401 adults took part in the study. In the prebiotic-probiotic consumption group, 50.4% of the participants were female, 69.4% had a postgraduate, 95.3% were employed, 55.7% perceived state of health as good, 77.2% and 77.4% were no consumption of smoke and alcohol. In the no prebiotic-probiotic consumption group, 69.0% were male,50.0% had a postgraduate, 95.2% were employed, 59.5% perceived state of health as good, 83.3% and 85.7% were no consumption of smoke and alcohol (Table 1).

Although there were no appreciable differences among the groups consuming and not consuming prebiotics and probiotics in terms of sociodemographic characteristics such as working status, perceived health status, smoking and alcohol consumption, there was only a difference in terms of gender and educational status (Table 1).

The FINDRISC characteristics of the are presented in Table 2. In the prebiotic-probiotic group, 77.7% were aged 45 years or younger, 43.5% had a BMI of 25 kg/m^2, and 40.4% had a waist girth of 94-101 cm for men and 80 - 87 cm for women. In the no-prebiotic-probiotic group, 88.1% were aged 45 years or younger, 47.6% had a BMI of 25 - 30 kg / m2, and 47.6% had a waist girth of 94 cm or less for men and 80 cm or less for women. In addition, most of the participants in both groups did not do less than 30 minutes of physical activity per day, did not consume fruit and vegetables every day, had no history of antihypertensive medication or high blood glucose levels, or had a family history of diabetes. No statistically significant difference was found between the two groups according to FINDRISC parameters (Table 2).

It was found that there were no appreciable variations between the groups consuming and not consuming prebiotics and probiotics in terms of FINDRISC parameters such as age, waist girth, body mass index, vegetable and fruit consumption, physical activity, history of hyperglycemia, antihypertensive drug use and diabetes (Table 2).

The Score and Comparison of Type 2 Diabetes Risk

The scores and comparison of the Finnish Type 2 Diabetes Risk of the adults are presented in Table 3. The total FINDRISC score was 9.67 ± 5.13 in the prebiotic - probiotic group and 8.47 ± 4.63 in the non-prebiotic-probiotic group. There were no significant differences

Table 1: Demographic Characteristics of the Participants According to Their Prebiotic-Probiotic Consumption Groups (n = 401)

Sociodemographic Variables	Prebiotic, probiotic consumption (n = 359)		No prebiotic, probiotic consumption (n = 42)		Statistical analysis	
	n	%	n	%	Test statistics	p
Gender						
Female	181	50.4	13	31.0	5.705‡	0.017
Male	178	49.6	29	69.0		
Educational status						
Secondary	6	1.7	1	2.4	6.431‡	0.040
University	104	29.0	20	47.6		
Postgraduate	249	69.4	21	50.0		
Employment status						
Employed	342	95.3	40	95.2	0.008†	1.000
Unemployed	17	4.7	2	4.8		
Perceived health status						
Bad	7	1.9	1	2.4	0.294‡	0.863
Moderate	152	42.3	16	38.1		
Good	200	55.7	25	59.5		
Smoking						
Yes	82	22.8	7	16.7	0.830‡	0.362
No	277	77.2	35	83.3		
Alchocol consumption						
Yes	81	22.6	6	14.3	1.516‡	0.218
No	278	77.4	36	85.7		

n: number; %: percentage; †: F = Fisher's exact test; ‡: x^2 = Chi-square test.

between the two groups (p = 0.152). The highest FINDRISC level was a mild risk in the prebiotic-probiotic group and a low risk in the non-prebiotic-probiotic group. Furthermore, there were no significant differences between the two groups on FINDRISC levels (p = 0.125; p = 0.380; p = 0.820; p = 0.588; p = 0.274, respectively) (Table 3).

The FINDRISC Scores' and Comparison of Type 2 Diabetes Risk

The relationship between FINDRISC score and prebiotic - probiotic consumption and no consumption is shown in Table 4. According to binary logistic regression, prebiotic - probiotic consumption was not a significant predictor of low (OR = 0.600; p = 0.127), mild (OR = 1.360; p = 0.381), moderate (OR = 0.905; p = 0.819), high (OR = 1.310; p = 0.588) and very high risk of type 2 diabetes (OR = 0.026; p = 0.998). Furthermore, according to linear regression analysis, prebiotic - probiotic consumption or no consumption was not a significant predictor on the type 2 diabetes risk (β = -0.072; p = 0.151) (Table 4).

Discussion

Today, it has been emphasized that prebiotic-probiotic consumption modulates microbiota and has an effect on the pathways leading to diabetes (Kamarlı Altun & Akar Yıldız, 2017; Kim, Keogh & Clifton, 2018; Umirah, Neoh, Ramasamy & siong Meng Lim 2021; Jiang et al., 2022). The idea that this could slow down the chronic disease process is promising. In this research based on this, there was no significant distinction between the groups consuming pre/probiotics and those not consuming, in terms of body mass index, waist girth, blood pressure, known elevated blood glucose and use of antihypertensive drugs, which are FINDRISC parameters. The mean scores of the groups consuming pre/probiotics did not change significantly from the groups not taking them in any of the five FINDRISC levels. Current research on the microbiome of humans has demonstrated that disruption of the gut microbiome's homeostatic equilibrium contributes to poor glucose metabolism and subclinical and chronic inflammation (Miraghajani et al., 2017; Quigley, 2019; Włodarczyk and Slizewska, 2021). There are differences between the gut microbiota of obese people with Type 2 diabetes and healthy people, were reported (Patterson et al., 2016; Ahmad et al., 2019; Umirah, et al., 2021). Research shows that pre / probiotics influence glycemic status by regulating the inflammatory response, reducing oxidative stress and altering levels of gut hormones (Miraghajani et al., 2017; Kim et al., 2018; Włodarczyk and Slizewska, 2021). In this case, the idea of preventing the possibility of being diagnosed with diabetes by making the intestinal flora healthy with pre/probiotic consumption has come to the fore (Wang et al., 2021). In the literature, there are studies showing correlation or difference between pre / probiotic consumption and metabolic parameters (such as lipid profiles, blood glucose, waist girth (Cerdó, García-Santos, Bermúdez & Campoy, 2019; Rabiei, Hedayati, Rashidkhani, Saadat & Shakerhossini, 2019; Khalil, Eltahan, Elaktash & Aly, 2021) as well as those that do not indicate a relationship sufficient (Ruan et al., 2015; Sun & Buys, 2015; Zhang, Wu, Fei., 2015; Borgeraas, Johnson, Skattebu, Hertel & Hjelmesaeth, 2018; Kim et al., 2018; Wiciński, Gębalski, Gołębiewski & Malinowski, 2020; Włodarczyk and Slizewska, 2021). Similarly, studies are showing a

Table 2: Parameters of Participants' Finnish Type 2 Diabetes Risk Score According to Their Prebiotic-Probiotic Consumption Groups (n = 401)

FINDRISC Parameters	Prebiotic, probiotic consumption (n = 359)		No prebiotic, probiotic consumption (n = 42)		Statistical analysis	
	n	%	n	%	Test statistics	p
Age						
<45 years	279	77.7	37	88.1		
45-54 years	59	16.4	4	9.5	1.640†	0.630
55-64 years	14	3.9	1	2.4		
>64 years	7	1.9	0	0.0		
Body mass index (kg/m²)						
<25	156	43.5	15	35.7		
25-30	149	41.5	20	47.6	0.927‡	0.629
>30	54	15.0	7	16.7		
Waist girth (cm)						
Men <94; women <80	123	34.3	20	47.6		
Men 94-101; women 80-87	145	40.4	12	28.6	3.258‡	0.196
Men >101; women >87	91	25.3	10	23.8		
Less than 30 minutes of daily physical activity						
Yes	133	37.0	9	21.4	4.010‡	0.060
No	226	63.0	33	78.6		
Dietary consumption of fruit and vegetable						
Everyday	209	58.2	19	45.2	2.582‡	0.108
No every day	150	41.8	23	54.8		
History of antihypertensive medication						
Yes	86	24.0	9	21.4	0.133‡	0.716
No	273	76.0	33	78.6		
History of high blood glucose value						
Yes	82	22.8	5	11.9	2.647‡	0.104
No	277	77.2	37	88.1		
Family history of diabetes mellitus						
No	167	46.5	25	59.5		
First degree relatives	133	37.0	11	26.2	2.670‡	0.263
Second degree relatives	59	16.4	6	14.3		

n: number; %: percentage; †: F = Fisher's exact test; ‡: x^2 = Chi-square test.

Table 3: Univariate Analysis of the Finnish Type 2 Diabetes Risk Score Means Related to Prebiotic-Probiotic Consumption and No Consumption (n = 401)

FINDRISC levels and total score	Prebiotic, probiotic consumption (n = 359)				No prebiotic, probiotic consumption (n = 42)				Test Statistics	p
	n	%	Mean ± SD	Mean Rank	n	%	Mean ± SD	Mean Rank		
Low risk	104	29.0	0.28 ± 0.45	198.58	17	40.5	0.40 ± 0.49	221.65	6671.5†	0.125
Mild risk	136	37.9	0.37 ± 0.48	202.46	13	31.0	0.30 ± 0.46	188.56	7016.5†	0.380
Moderate risk	55	15.3	0.15 ± 0.36	200.72	7	16.7	0.16 ± 0.37	203.42	7437.5†	0.820
High risk	54	15.0	0.15 ± 0.35	201.66	5	11.9	0.11 ± 0.32	195.37	7302.5†	0.588
Very high risk	10	2.8	0.02 ± 0.16	201.58	0	0.0	0.00 ± 0.00	196.00	7329†	0.274
Total score	359	89.52	9.67 ± 5.13	203.83	42	10.48	8.47 ± 4.63	176.79	3522†	0.152

n: number; SD: Standard deviations; †: U= Mann Whitney U test.

Table 4: The Relationship between the Finnish Type 2 Diabetes Risk Score and Prebiotic-Probiotic Consumption and No Consumption (n = 401)

FINDRISC levels and total score		B	SE	Wald	p	OR	95%Cl
Low risk	Yes	-0.511	0.335	2.326	0.127	0.600	0.311 - 1.157
	No				Ref		
Mild risk	Yes	0.308	0.351	0.769	0.381	1.360	0.684 - 2.707
	No				Ref		
Moderate risk	Yes	-0.100	0.439	0.052	0.819	0.905	0.382 - 2.139
	No				Ref		
High risk	Yes	0.270	0.499	0.293	0.588	1.310	0.493 - 3.483
	No	Ref			Ref		
Very high risk	Yes	17.650	6201.900	0.000	0.998	0.026	-
	No				Ref		

Total score (Both groups)	B	SE	β	t	p	95%Cl	VIF
Constant	10.886	0.952	-	11.420	<0.001	8.996 - 12.737	-
Prebiotic-probiotic consumption and no consumption	-1.195	0.830	-0.072	-1.440	0.151	-2.827 - 0.437	1.000

CI: Confidence interval; B: Unstandardised beta coefficients; β: Standardised beta coefficients; VIF: variance inflation factor.

significant improvement in diabetes parameters in groups consuming pre / probiotics (Corb Aron et al., 2021; Ding et al., 2021), as well as those reporting minimal changes (Kaya Cebioğlu & Önal, 2019; Razmpoosh et al., 2019). The literature indicates that the results of meta-analyses and randomized controlled studies examining the efficacy of pre- and probiotic treatments differ. Our research findings have similarities and differences with the literature in this respect. However, essential to keep in mind that most studies in the literature evaluate metabolic parameters using a certain number of prebiotic, probiotic or synbiotic supplements over a certain period of time (Ardeshirlarijani et al., 2019; Kassaian et al., 2019; Colantino 2020; Bock et al., 2021; Paul et al., 2022). The method of this research differs from the literature in this respect. In existing studies, the importance of the characteristics and the working principle of the bacteria used on the intestines are emphasized in the use of probiotic supplements. It is also stated that the duration of synbiotic use is also effective on the parameters (Mahboobi et al., 2018; Raygan et al., 2018; Dong et al., 2019; Kassaian et al., 2019; Ding et al., 2021).

In this study, logistic and multiple regression analyses also showed that pre / probiotic consumption was not a significant predictor of diabetes risk. It is noteworthy that pre / probiotic consumption in studies does not directly address the risk of developing diabetes, but rather points to improvements in findings related to impaired parameters of blood glucose that indicate diabetes risk. Recent research has effectively demonstrated a remarkable relationship between insulin resistance and gut microbiota. Wu et al. (2020) reported that, rather than fasting glucose, their research linked alterations in gut microbiota to insulin resistance. Chen et al. (2021), reported in their study that higher microbiota diversity was associated with lower insulin resistance. According to the study's objectives, only people at risk for diabetes were screened in the general community; information on impaired glucose tolerance, insulin resistance, or fasting glucose levels was not gathered. In this context, based on the relevant literature, this study may not have detected a significant difference between pre / probiotic consumption and the risk of developing diabetes; however, it is thought that, this does not mean the pre / probiotic consumption will not be associated with insulin resistance and impaired blood glucose (Wu et al., 2020; Chen et al., 2021). On the other hand, Kaya Cebioğlu and Önal (2019), Razmpoosh et al. (2019), Włodarczyk and Slizewska (2021) pointed out that the duration of consumption is as important as the consumption of pre/probiotics. It is stated that it needs to be clarified which strains stabilize intestinal permeability and break the subclinical inflammation that predisposes to insulin resistance and diabetes. In this study, individuals were asked about their pre / probiotic consumption status, but no data was received regarding how long, how often and in what quantities they consumed pre/probiotic ingredients. Although this situation seems to prevent detailing the findings at this stage, it is thought to be important in terms of providing the literature with the information that in a screening conducted in the general population, no difference was detected in the diabetes risk development between groups that consumed pre/probiotics and those that did not.

Study Limitations

There are some limitations on this research. Firstly, a total of 401 general adults took part in the research over a six-month period. This could restrict how broadly the study's findings can be applied to all individuals in general. Consequently, to improve the generalizability of the findings, more cross-sectional research with larger sample numbers is advised. Furthermore, our analysis focused solely on the relationship between the risk of type 2 diabetes and the intake or lack thereof of prebiotics and probiotics. Since it is difficult to standardize the amount and frequency of prebiotic and probiotic consumption in the diet, we could not assess these values. Therefore, we could not investigate the effect of different types of prebiotics or probiotics and frequency of consumption on type 2 diabetes risk. Lastly, individual replies rather than one-to-one measurements were used to get some of the parameters, such as weight, height, and waist circumference, because the data collection process was conducted online. It is thought that obtaining the data with one-to-one measurement will increase the reliability of the results. This situation constituted another limitation of the research.

Conclusion

The study's findings indicated no correlation between the use of prebiotics and probiotics with the risk of type 2 diabetes at low, mild, moderate, high, or very high levels. To investigate the effect of prebiotic-probiotic consumption on the risk of type 2 diabetes, there is a need for randomized controlled studies with high evidence power. In addition, this study will help raise awareness among health professionals and researchers about the relationship between prebiotic or probiotic consumption and the risk of type 2 diabetes in general adults. This study will contribute to evidence-based studies and practice by health professionals and researchers. Nurses, who spend the most time with individuals in the health risk group, have roles and responsibilities in guiding individuals to consume prebiotic and probiotic foods. Studies on this subject can be guiding, especially for nurses providing primary health care services to provide research-based information on prebiotic-probiotic consumption in health education within the scope of chronic disease prevention programs.

Ethical Considerations: This study was conducted according to the Declaration of Helsinki. The ethical approval was obtained from the Burdur Mehmet Akif Ersoy University's Clinical Research Ethics Committee (Date: 03.11.2021 and No: GO 2021/373).

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