Open Access
eISSN: 2508-9056

Exercise Medicine

Exercise Medicine 2024; 8:2 | https://doi.org/10.26644/em.2024.002

Research Article

Prevalence of Type 2 Diabetes Risk in a Higher Education Community of North-Eastern Portugal: a Prospective Cross-sectional Observational Analysis

Carlos M. Duarte[1], Pedro Magalhães[1,2], Laissa S. Saldanha[1], José E. Teixeira[1-5] and José Bragada[1,2*]

[1] Department of Sport Sciences, Instituto Politécnico de Bragança (IPB), 5300-253 Bragança, Portugal
[2] LiveWell—Research Centre for Active Living and Wellbeing, Polytechnic Institute of Bragança, Bragança, Portugal
[3] Polytechnic of Guarda (IPG), 6300-559 Guarda, Portugal
[4] SPRINT—Sport Physical activity and health Research & Inovation Center, 6300-559 Guarda, Portugal
[5] Research Centre in Sports Sciences, Health and Human Development (CIDESD), 5001-801 Covilhã, Portugal

Article Information

History:
Received: February 23, 2024
Accepted: August 7, 2024
Published: August 23, 2024

Keywords:
type 2 diabetes
academic community
FINDRISC
public health
prevention

ABSTRACT

Objectives: Type 2 diabetes (T2D) is considered one of the most prevalent diseases worldwide. The aim of this study was to analyse the risk of developing T2D in a higher education community of Bragança, North-Eastern Portugal.

Methods: The observational, cross-sectional and prospective sample comprised 3021 individuals, aged between 18 and 64 years old, of whom 1759 were women (mean age 24.16 ± 8.80 years) and 1263 were men (mean age 23.37 ± 8.70 years). The Finnish Diabetes Risk Score (FINDRISC) questionnaire was employed to estimate the risk of developing T2D over the next 10 years.

Results: The results indicated that approximately 37 (1%) participants in the sample exhibited a high risk of developing T2D, 117 (4%) participants exhibited a moderate risk, 660 (22%) participants exhibited a slight risk, and 2206 (73%) participants exhibited a low risk. A higher T2D risk was observed in the staff group in comparison with the other groups ($p < 0.001$). Furthermore, body mass index (BMI) and waist circumference (WC) were the variables that most contributed to the increased risk of developing T2D ($X^2 = 1034.5$; $p < 0.001$).

Conclusions: In conclusion, the study reported a low T2D risk for the higher education community of Bragança in the Portuguese North-Eastern region. However, the risk of T2D was found to be higher in the staff group than in the student group. The FINDRISK questionnaire may be applied for the early diagnosis of T2D risk factors.

INTRODUCTION

Diabetes is a chronic disease that affects the endocrine system and is normally characterized by a hyperglycaemic state [1]. In turn, chronic hyperglycaemia may result in a deficiency in insulin secretion and action [1,2]. Diabetes has seen a high prevalence worldwide in recent years, with an estimated 422 million people living with the disease in 2014. Also, future perspectives have been reported an exponential growth of this disease, which may reach 700 million people within 20 years [3,4]. In Portugal, the latest epidemiological reports from 2018 demonstrated that the type 2 diabetes (T2D) was responsible for approximately 4% of deaths in Portuguese population and is still responsible for spending 0.8 of the country's gross domestic product (GDP) for its control [5]. Worldwide, the spending on the treatment of T2D in 2015 was approximately US$ 1.3 trillion, and this cost is also growing exponentially, as it is expected to reach US$ 2.5 trillion by 2030 [5,6].

Diabetes disease is mainly classified into different types, type 1 diabetes (T1D), T2D and gestational diabetes (GD) [7]. Hence, the T1D is predominantly characterized as an autoimmune disease, in which there is an increase of glucose

***Correspondence:** José Bragada, Department of Sports Sciences, Instituto Politécnico de Bragança (IPB), 5300-235 Bragança, Portugal
Tel: +351-27-333-0663
E-mail address: jbragada@ipb.pt

in the bloodstream due to a dysfunction of pancreatic beta (β) cells, resultant of the autoimmunity aggression by T cells [8,9]. The T2D diagnosis has two specific factors, namely the endocrine system dysfunction caused by the onset of insulin resistance, expressed by a peripheral insulin resistance, as well as a progressive failure of pancreatic insulin secretion and the body's insufficient ability to produce enough insulin to suppress its needs [4,10]. The GD was diagnosed when a woman, with no previous history of T2D, registers uncontrolled glucose values in the bloodstream during pregnancy. This dysregulation is driven by insulin resistance promoted by the release of hormones that influence its action, hormones such as growth hormone, corticotrophin-releasing hormone or lactogen [11,12].

The T2D is considered the most prevalent type of diabetes, and it is estimated that one in two adults has this type of diabetes, although, in many cases, the disease is not diagnosed [3,4]. The T2D is currently one of the most leading causes of death worldwide, with 6.7 million deaths, and a growing trend that points to a 5% increase in premature deaths [4]. This type of diabetes is currently a disease of great concern due to its high prevalence (> 90% of cases of diabetes) with an exponential growth trend, making it one of the main public health problems [13]. The growth of T2D is mainly due to the increasing prevalence of risk factors associated with this type of diabetes. Waist circumference (WC), body mass index (BMI), gender, ethnicity, physical activity (PA) rates, smoking, eating habits, family history, hypertension, and treatments using medications, such as β-blockers and diuretics, are factors that have been identified over time that increase the risk of T2D developing [14,15]. Screening through non-clinical means at an early stage has a high relevance in the control and prevention of this metabolic disease. Applying non-invasive methods such as the American Diabetes Association (ADA) Risk Test questionnaire [16], and/or the Finnish Diabetes Risk Score questionnaire (FINDRISC) [17] allows simple and rapid assessment, enabling instant alerts to individuals at risk of developing the disease. With this, high risk individuals may seek clinical evaluation for the diagnosis of diabetes and primary changes in lifestyles and habits.

Specifically, the FINDRISC is a risk score test, created by Lindström & Toumilehto [17], with the aim of tracking cases at high risk of developing T2D and thus being an effective tool in disease prevention. The FINDRISC questionnaire assigns a risk score at the end of the test based on the answers given to each of the questions regarding risk factors [18]. Each question is related to a risk factor associated with T2D. The FINDRISC questions to estimate the global risk of developing T2D, BMI, WC, sedentary lifestyle, consumption of vegetables or fruits, use of medication to control blood pressure, episodes of hyperglycaemia and a family history of diabetes. The Finnish national diabetes prevention program used the FINDRISC test for large-scale screening to warn and try to control the course of the disease [19]. This study shows that the use of this test is a very useful tool, as it allows screening the risk of T2D in many individuals, making viable an early and rapid intervention, with clear benefits for their health. Other studies corroborate this idea, having concluded that the use of this tool contributes to a primary prevention of the disease in the general population, being able to reach many individuals due to its easy and quick application [20,21]. Dantas et al. [22] confirmed a greater effectiveness of the FINDRISC questionnaire as a screening tool for T2D. In this regard, FINDRISC allows to identify and track individuals at high risk of developing T2D, being a valid and effective strategy for primary prevention, as well as enabling early action on modifiable risk factors for the development of the disease. Two other studies were carried out in Portugal using this same tool. The first, Valente & Azevedo [23]examined the T2D risk in patients registered in Amarante Health Center (HC), reporting that 1 in 8 users of this HC had a high risk of developing the disease. In another study, Viveiros et al. [24] revealed that the application of the FINDRISC questionnaire found that 1 in 4 study participants had a high risk of developing T2D in a 10-year period. Thus, the results of different studies show the high importance of this type of questionnaire in identifying individuals at greater risk of developing T2D, making laboratory screening more efficient and effective, as well as identifying cases of the disease that may not be diagnosed. Thus, both studies demonstrated that FINDRISC can be applied for an early intervention and, thus, contain the onset of the disease [23,24]. This study intends to update previously carried out previous epidemiological studies in higher education student [25,26]. However, this reality has been fundamental in hospital or HC contexts, i.e., in primary care, with work contexts being little studied, therefore populations at risk who do not attend health services [22–24]. More specifically, the higher education is little studied in this area, however the increase in ageing workforce justifies the premature diagnosis of with metabolic health problem during working life since this can improve the quality and average life expectancy after retirement [3,4].

Thus, this study aimed to predict the risk of developing T2D in the community of Polytechnic Institute of Bragança (IPB), understand which T2D risk factors have a greatest impact on this disease, and raise the awareness of the IPB population through screening for T2D problems. We hypothesized that the older age group (staff group) has a higher risk of developing T2D than the younger age group (students). Also, we hypothesize that overweight and obesity represent the most prevalent risk factors among the IPB academic community. As well, we expected that the practice of physical activity is inversely proportional to the T2D risk score.

METHODS

Research Design and Sample

This was an observational, cross-sectional, and prospective study that aimed to estimate the risk level for T2D in the ac-

ademic community of the Polytechnic Institute of Bragança (IPB). The eligible sample comprised a total number of 10,556 individuals from the IPB community. Of these, only 3021 individuals participated in the study, of which 1759 were female (58.23% with an average age of 23.4 ± 8.7 years) and 1262 were male (41.77% with an average age of 24.2 ± 8.9 years). This study was approved by the Ethics Committee of the IPB on May 31st, 2021, with reference number 43/2021 and an informed consent was completed by all participants at the time of their participation.

Data Collection

Selection Criteria

The sample was selected from cross-sectional, observational, and prospective research conducted in IPB community. For individuals to be eligible to be part of the sample, they could not have any of the exclusion criteria defined for the study. Therefore, they had to be students, teachers, or non-teaching staff of the IPB and not have a confirmed diagnosis of T2D. The exclusion criteria: i) not to be a student/staff/researcher of the IPB; ii) individual with a confirmed diagnosis of type 1 or type 2 diabetes (T1D or T2D). From this, research sample included 2716 students (21.40 ± 4.23 years) and 1667 were staff members (44.01 ± 11.73 years). After ensuring the validity of the participation of each of the potential subjects, the sample was selected as shown in Figure 1.

FINDRISC Score

The diabetes risk assessment questionnaire used in the National Programme for Diabetes Prevention and Control (PNPCD) [21] of the Directorate-General for Health (DGS) from Portugal was used in this study, adapted from the questionnaire developed by researchers from Finland, known as the Finnish Diabetes Risk Score (FINDRISC) [20]. This questionnaire allows for a wide-ranging screening due to its ease of application and for being a non-evasive tool. This tool assigns a risk score which dictates the probability, for those who answer the questionnaire, of developing T2D over a 10-year period. The FINDRISC's survey items were blood pressure, age, waist circumference, BMI, exercise, food, usage of antihypertensive medication, history of elevated blood glucose, and family history of diabetes mellitus [20,21]. The questionnaire comprises five risk intervals [21]: i) low risk (<7 points), ii) mild risk (7–11 points), iii) moderate risk (12–14 points), iv) high risk (15–20 points), v) very high risk (>20 points) [17,18]. Using the score obtained from the questionnaire, it was possible to divide the subjects who had an increased risk of developing T2D and those who did not have an increased risk of developing T2D. A score of 9 points was considered the cut-off value, where subjects with a risk score of less than or equal to 9 points were considered to be in the group with no increased risk (SR) of developing T2D and subjects with scores above 9 points were considered to be in the group with an increased risk (R) of developing T2D [14,15].

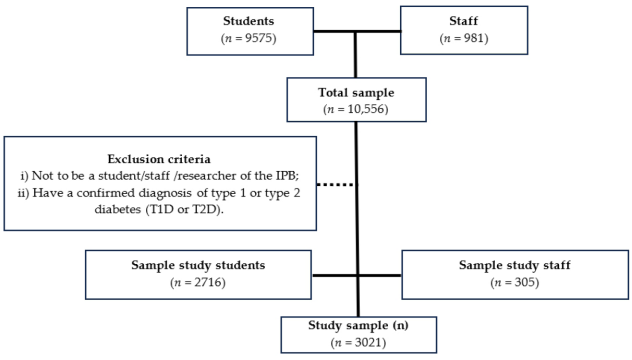

Figure 1. Timeline of selection of the study sample.

Sociodemographic variables

The sociodemographic variables were selected according to previous epidemiological reports [22–24], specifically: sex (male, female or undefined), marital status (i.e. single, divorced, married or widowed), education (i.e. primary, secondary, basic or higher) and professional activity at the Higher Education institution under study.

T2D risk factors

T2D risk factors were assessed as independent variables. The risk result is obtained by adding the score recorded in each of the answers regarding the different risk factors included in the questionnaire: age, BMI, WC, PA, fruit and vegetable consumption, hypertension medication, history of hyperglycaemia and family history. Of these factors, the history of hyperglycaemia and family history are the factors with the greatest impact on the final estimation of the risk of T2D, contributing with a maximum score of 5 points for each one of those factors. On the other hand, fruit and vegetable consumption is the factor with the lowest impact, with a maximum score of 1 point. The FINDRISC questionnaire established a cut-off value of 9 points to classify respondents as at-risk or non-risk [17]. Additionally, the consumption of cigarettes, alcoholic beverages and the practice of PA (i.e., more than 30 minutes per day, including activities of daily living) and physical exercise practice (i.e., sedentary - 0/1 session per week; active – more than 2 sessions per week). PA and exercise were defined by ACSM standards [27]. Participants were also asked about their personal history of cardiovascular disease (i.e., cerebrovascular disease, coronary heart disease, peripheral vascular disease, diabetic foot, retinopathy, nephropathy, neuropathy or other).

Anthropometric Measures

The WC and body mass were measured by a flexible measuring tape and a Tanita MC 780-PMA® bioimpedance scale (Tanita Corporation, Tokyo, Japan) respectively, as well as a folding screen for greater privacy in the measurement process with minimal clothing. The average of three measurements was used to calculate body mass, height, and WC to the closest 0.1 International Units (IU). The WC (cm) was

measured at the junction of the lower border of the lower perceptible rib and the top of the iliac crest. For the WC measurements, the following gender-specific criteria were taken into account: WC ≥ 88 cm for women and WC ≥ 102 cm for males [28]. The measurement was taken three times by the same researcher, and the average was chosen for further examination. The Intra-class correlation Coefficient (ICC) revealed an almost perfect agreement (ICC = 0.90). BMI was calculated by dividing weight (kg) by the square of height (m^2) [15,17].

Procedures

The procedures were structured based on previous Portuguese studies that used the same questionnaire for their studies [22,24]. In a preparatory phase, with the purpose of making the IPB community aware of the study, an email was prepared with a brief description including the variables and the aims of the study, which was addressed to each of the directors of the different schools from IPB and people responsible for the research laboratories, as well as central and social services of the institution. On this basis, the risk group and the no-risk group were defined. The questionnaire was applied by a digital format from OutSystems® platform. To share the questionnaire, two simple access modes were created to make the access process faster and more intuitive. A QR Code was created by the researchers with direct access to the questionnaire, and also a short link.

Then, the information about the study was disseminated to the respective IPB communities (students and staff) through institutional email addresses. To distribute the questionnaires to students and teaching staff of the IPB, the research team visited the classrooms of the different schools of the institution and the workstations of the staff and researchers where they explained the aims of the study and asked for their collaboration in completing the questionnaire.

Before answering the questionnaire, participants were asked to give their informed consent to participate in the study, which was provided at the beginning of the questionnaire, and so that the results could be used in the present investigation. After completing the informed consent, the participants should answer whether they have T1D or T2D. If they answered that they did not have either type of diabetes, they moved on to the part of the questionnaire concerning the assessment of the risk of developing T2D. After completing all the questions of the questionnaire, the specific risk level for developing in the next 10 years and BMI level was automatically calculated by the software, giving each participant a final outcome.

Statistical Analysis

An exploratory analysis was performed to verify the normal distribution of variables. The data of quantitative variables were reported through the mean as a measure of central tendency and the standard deviation as a measure of dispersion. The data of qualitative variables were expressed through the absolute and relative frequency. The significance value adopted to determine the existence of statistically significant differences for the tests performed was $p < 0.05$.

The chi-square (X^2) test or Fisher's exact test was applied whenever to explore the association between the independent variables under study with the presence or absence of risk of developing T2D [29,30]. The Cramer`s V test was also performed to understand the strength of the association of each variable with the presence of risk for T2D. The Cramers' V test is divided into five degrees of intensity of association, negligible (0.00–0.10), weak (0.10–0.20), moderate (0.20–0.40), relatively strong (0.40–0.60), strong (0.60–0.80) and very strong (0.80–1.00) [30]. To understand the meaning of the association of variables, the analysis of adjusted residues was performed. JASP (JASP Team, 2019; jasp-stats.org) and IMB SPSS 26 (Armonk, NY: IBM Corp) for MacOS® software were used for data processing and analysis.

RESULTS

Sample Characterization

Table 1 showed significant differences reported between students and staff. Staff members were the highest percentage of subjects with risk factors associated with T2D disease, considering only the risk factors that were significantly associated with the risk of developing this disease ($p < 0.05$ to $p < 0.001$). The risk factor "family history of diabetes" was the only risk factor that was more present in the students than staff group. The variables height and PA did not show statistically significant differences between the groups studied.

Figure 2 shows that approximately 96 per cent of the students had a low or slight risk of developing T2D over a 10-year period. This value was clearly higher than that observed in the staff group, where the percentage of participants in this ranges was approximately 84 per cent. In the student group, the moderate risk range is only 3%, and in the high risk range, approximately 1%. In the group of employees, the values was appreciably higher, with approximately 15% of participants in the moderate risk range and approximately 5% in the high-risk range. Considering the total sample (students and employees), about 5% had an increased risk of developing T2D in the next 10 years.

Association of Socio-Demographic Variables and Risk Variables from the FINDRISC Questionnaire with the Risk of Developing T2D

In one hand, the variables marital status, level of PA, level of education and number of alcoholic beverages showed a significant association with the risk of T2D ($p < 0.05$). On the other hand, the variables gender, smoking habit, and consumption of alcoholic beverages showed no association with the risk of T2D. Analyzing the variables in Table 2, for the variable civil status ($X^2 = 168.5$; $p < 0.001$), it is possible

Table 1. Sample characterization by group of students and IPB staff

Variables (% (n))	Students 90 (n=2716)	Staff 10 (n=305)	Total (n=3021)	p
Age (years) [mean ± SD]	21.4 ± 4.2	44.0 ± 11.7	23.7 ± 8.8	<0.001
Waist circumference (cm) [mean ± SD]	78.1 ± 18.6	85.02 ± 12.0	78.7 ± 18.1	<0.001
BMI [MED (Q1; Q3)]	15.4 (21.2; 25.3)	17.2 (22.2; 27.1)	22.4 (21.3; 25.6)	<0.001
Body mass (kg) [mean ± SD]	68.4 ± 13.8	71.3 ± 12.9	68.9 ± 19.6	0.002
Height (m) [mean ± SD]	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	0.079
Physical activity [% (n)]	50 (1370)	50 (154)	51 (1524)	0.972
Eat vegetables/fruit [% (n)]	43 (1176)	76 (233)	47 (1408)	<0.001
Hypertension drugs [% (n)]	2 (56)	12 (37)	3 (93)	<0.001
Blood sugar history [% (n)]	4 (113)	7 (21)	4 (134)	<0.001
Family history of diabetes [% (n)]	59 (1610)	49 (148)	58 (1758)	<0.001
T2D risk score [MED (Q1; Q3)]	4 (3; 6)	7 (4; 10)	5 (3; 7)	<0.001

Abbreviations: BMI—Body mass index; WC—Waist circumference. Statistically significant differences at $p < 0.05$. It is possible to observe that about 96% of the students had a low or slight risk of developing T2D in a period of 10 years. This value is clearly lower when observing the values of the group of staff, where this interval is approximately 84%.

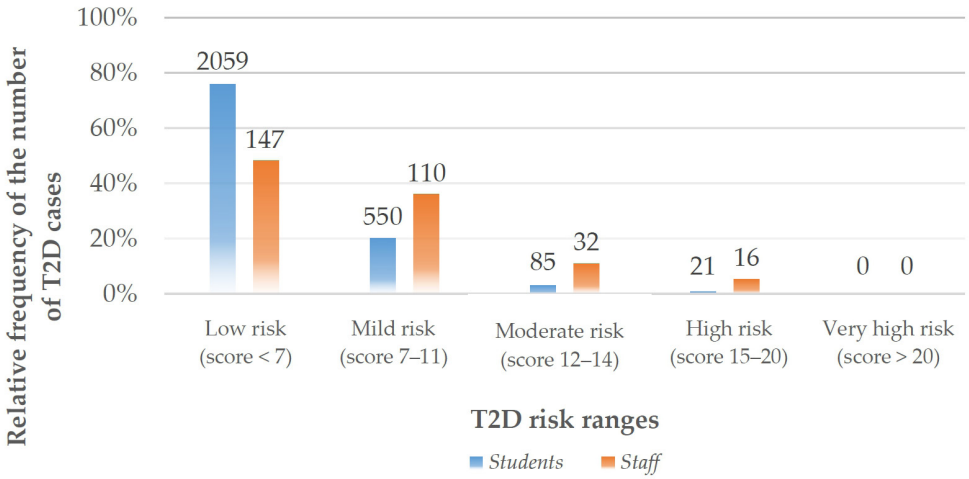

Figure 2. Number of students and staff by the five levels of risk of developing T2D.

Table 2. Association between socio-demographic variables and T2D risk

Variables	Risk	AR	No risk	AR	Total (%)	X^2	p
Sex							
Male (%)	126 (10)	-1.0	1136 (90)	1.0	1265 (42)	0.9	0.333
Female (%)	195 (11)	1.0	1564 (89)	-1.0	1759 (58)		
Civil Status							
Married (%)	69 (34)	11.1	136 (66)	-11.1	205 (7)	168.5	<0.001
Divorced (%)	16 (42)	6.3	22 (58)	-6.3	38 (1)		
Single (%)	234 (9)	-12.8	2533 (94)	12.8	2767 (92)		
Widow(er) (%)	2 (18)	0.8	9 (82)	-0.8	11 (0.4)		
Education level							
Primary (%)	5 (31)	4.5	11 (68)	-4.5	16 (0.5)	47.1	<0.001
Basic (%)	4 (67)	2.7	2 (33)	-2.7	6 (0.2)		
Secondary (%)	119 (8)	-5.7	1458 (92)	5.7	1577 (50)		
Superior (%)	193 (14)	5.0	1229 (86)	-5.0	1422 (47)		

Risk—Group of participants who have an increased risk of developing T2D over a 10-year period; No Risk—Group of participants who do not have an increased risk of developing T2D over a 10-year period; X^2—Chi-square test value; $p < 0.05$—statistically significant association; Adjusted Residues (AR)—Residual's value obtained by performing the Chi-square test.

to observe that married and divorced participants are positively associated with the risk of developing T2D. For the variable level of education ($X^2 = 47.1$; $p < 0.001$), it is observed that only the study participants who had secondary education were associated with the group of individuals with no risk of developing T2D.

In Table 3, no association was found between the risk of developing T2D and any of the variables analyzed, including

Table 3. Association between lifestyle variables and the risk of developing T2D

Variables	Risk	AR	No Risk	AR	Total (%)	X^2	p
Physical activity							
Sedentary (%)	250 (57)	5.5	1506 (58)	-5.5	1756 (58)	0.29	0.588
Active (%)	189 (43)	-3.5	1076 (42)	3.5	1265 (42)		
Smoking habits							
Yes (%)	69 (11)	0.7	533 (89)	-0.7	602 (20)		
No (%)	236 (10)	-1.2	2064 (90)	1.2	2300 (76)	1.8	0.414
Former smoker (%)	16 (13)	1.0	103 (87)	-1.0	119 (4)		
Consumption of alcoholic beverages							
Yes (%)	66 (25)	0.1	547 (75)	-0.1	613 (20)	0.01	0.899
No (%)	255 (11)	-0.1	2153 (89)	0.1	2408 (80)		
Number of alcoholic beverages							
1 to 5 beverages/day (%)	68 (16)	-0.1	419 (16)	0.1	487 (32)		
6 to 10 beverages/day (%)	6 (1.4)	0.1	40 (1.5)	-0.1	46 (1.9)	0.27	0.966
> 11 beverages/day (%)	3 (0.7)	-0.9	19 (0.7)	0.9	22 (1.4)		

Risk—Group of participants who have an increased risk of developing T2D over a 10-year period; No Risk—Group of participants who do not have an increased risk of developing T2D over a 10-year period; X^2—Chi-square test value; $p < 0.05$—statistically significant association; Adjusted Residues (AR)—Residual's value obtained by performing the Chi-square test.

Table 4. Association between the risk variables of the FINDRISC questionnaire (age, waist circumference and BMI) with the risk of developing T2D

Variables	Risk	AR	No Risk	AR	Total (%)	X^2	p
Age							
<45 years old (%)	240 (9)	-15.4	2600 (92)	15.4	2840 (94)		
45–54 years old (%)	47 (40)	10.5	71 (60)	-10.5	118 (4)	245.0	<0.001
55–64 years old (%)	31 (54)	10.7	27 (47)	-10.7	58 (2)		
>64 years old (%)	3 (60)	3.6	2 (40)	-3.6	5 (0.2)		
Waist circumference							
Men under 94 cm (%)	19 (2)	-11.1	992 (98)	11.1	1011 (34)		
Men 94–102 cm (%)	54 (31)	8.8	123 (69)	-8.8	177 (6)		
Men over 102 cm (%)	54 (72)	17.5	21 (28)	-17.5	75 (2)	1034.5	<0.001
Women under 80 cm (%)	27 (2)	-13.4	1290 (98)	13.4	1317 (44)		
Women 80–88 cm (%)	83 (27)	9.7	227 (73)	-9.7	310 (10)		
Women over 88 cm (%)	84 (64)	20.3	47 (36)	-20.3	131 (4)		
BMI							
<25 kg/m^2 (%)	70 (3)	-20.3	2064 (97)	20.3	2134 (71)		
25–30 kg/m^2 (%)	130 (19)	7.8	567 (81)	-7.8	697 (23)	731.8	<0.001
>30 kg/m^2 (%)	121 (64)	24.5	69 (36)	-24.5	190 (6)		

Risk—Group of participants who have an increased risk of developing T2D over a 10-year period; No Risk—Group of participants who do not have an increased risk of developing T2D over a 10-year period; X^2—Chi-square test value; $p < 0.05$—statistically significant association; Adjusted Residues—Residual's value obtained by performing the Chi-square test.

PA, smoking habits, consumption of alcoholic beverages, and number of alcoholic beverages.

Table 4 shows that participants under 45 years old were more likely to have no T2D risk. Regarding WC, participants with lower WC (men < 94 cm and women < 80 cm), in both genders, obtained statistically significant associations ($X^2 = 1034.5$; $p < 0.001$) with no risk of developing T2D. Individuals with a BMI below 25 kg/m^2 was people without risk of developing T2D, whereas individuals with a higher BMI are at risk of developing the disease.

In Table 5, it is evident that all variables, except for the consumption of vegetables/fruit, show the existence of a significant positive association between the variables that were identified as risk factors for T2D in the FINDRISC questionnaire, and the risk of developing T2D ($p < 0.05$). A significant association between PA practice and having no risk of developing T2D was observed ($X^2 = 70.2$; $p < 0.001$). In turn, participants who answered negatively to the same question were faced with a significant association with being at risk of developing T2D.

The study found a positive association between taking medication for hypertension and previous episodes of hyperglycemia and the risk of developing T2D. Participants who responded positively to the questions on taking medication for hypertension and on occurrences of previous hyperglycaemia states were associated with the risk of developing this disease, while those who answered with no were associated with having no risk of developing the disease.

Table 5. Association between the risk factors, "physical activity practice", "vegetable/fruit consumption", "hypertension medication", "hyperglycaemia" and "family history" of the FINDRISC questionnaire and the risk of developing T2D

Variables	Risk	AR	No Risk	AR	Total (%)	X^2	p
Practices physical activity							
Yes (%)	91 (6)	-8.4	1433 (94)	8.4	1524 (51)	70.2	<0.001
No (%)	230 (15)	8.4	1267 (85)	-8.4	1497 (50)		
Vegetable/fruit consumption							
Sometimes (%)	177 (11)	0.7	1435 (89)	-0.7	1612 (53)	0.5	0.499
Everyday (%)	144 (10)	-0.7	1265 (90)	0.7	1409 (47)		
Hypertension drugs							
Yes (%)	58 (63)	16.6	34 (37)	-16.6	92 (3)	274.5	<0.001
No (%)	263 (9)	-16.6	2666 (91)	16.6	2929 (97)		
Hyperglycemia							
Yes (%)	77 (57)	17.9	58 (43)	-17.9	135 (4)	320.5	<0.001
No (%)	244 (8)	-17.9	2642 (92)	17.9	2886 (96)		
Family History							
No (%)	54 (4)	-9.6	1209 (96)	9.6	1263 (42)		
Yes: grandparents: aunt(s). 1st cousin (%)	153 (10)	0.4	1259 (89)	-0.4	1412 (47)	235.2	<0.001
Yes: parent: siblings or children (%)	114 (33)	14.3	232 (67)	-14.3	346 (11.45)		
Total (%)	321 (11)		2700 (89)		3021 (100)		

Risk—Group of participants who have an increased risk of developing T2D over a 10-year period; No Risk—Group of participants who do not have an increased risk of developing T2D over a 10-year period; X^2—Chi-square test value; $p < 0.05$—statistically significant association; Adjusted Residuals—Value of residuals obtained by performing the Chi-square test. Hypertension Medications—Control of hypertension disease through drugs.

Table 6. Cramers'V test for the risk variables from the FINDRISC questionnaire that have a significant association with the risk of T2D

Variables	Cramers'V	Qualitative ES
Age (years)	0.3	Moderate
WC (cm)	0.6	Strong
BMI (kg/m^2)	0.5	Strong
Practices physical activity (%)	0.2	Weak
Hypertension drugs (%)	0.3	Moderate
Hyperglycemia (%)	0.3	Moderate
Family History (%)	0.3	Moderate

Abbreviations: BMI—Body mass index; ES—Effect size; WC—Waist circumference. Note: Cramers' V test assumes values between 0 and 1, where 0 refers to no association and 1 to a very strong association [30].

Cramers'v Test for Socio-Demographic Variables and the Risk Variables of the FINDRISC Questionnaire

Except for gender, smoking habit, alcohol consumption and vegetable consumption, all factors show a significant association ($p < 0.05$) with the risk of developing T2D. However, the variable WC and BMI, showed the strongest association with the variable, referring to WC being closer to 1 than to 0 (Table 6).

On the other hand, the variable with the lowest Cramer's v value was the practice of PA. Thus, being the variable with the weakest association among the risk variables. Therefore, overall, the WC is the variable that recorded a stronger association, while the variable "number of alcoholic beverages" is the one that showed a weaker association.

DISCUSSION

This study aimed to predict the risk of developing T2D in a higher education community of Bragança, North-Eastern Portugal. It was observed that the older group (staff members) had a higher risk of developing T2D than the younger group (students). Among the academic community of the IPB, overweight and obesity were the most prevalent risk factors. Additionally, the practice of PA was inversely proportional to the T2D risk score. These results confirm the findings for the preponderance of BMI and WC as risk factors for T2D.

Based on the analysis of the results, the present study revealed that the risk of developing T2D in the IPB population is about 10%. That is, 1 in 10 individuals in this population had a real risk of developing the disease. In comparison with previous results that used the same screening methodology and the same risk assessment questionnaire, the results of the present study differ from previous investigations carried out in Portugal. In an investigation by Dantas et al. [22], approximately 49% of the study sample was at risk of developing T2D in 10 years. In another research carried out by Viveiros et al. [24] the values found were like those of the

work of Dantas et al. [22], with 42% of participants in this study having a moderate to very high risk of developing T2D. The study carried out by Valente & Azevedo [23], considered as one of the first studies carried out in Portugal using the FINDRISC questionnaire, obtained significantly higher values than all the above-mentioned studies, concluding that approximately 70% of participants had a moderate to very high risk of developing T2D over a 10-year period.

The differences between the values presented in previous works and the present investigation can be partially explained by two factors: the age of the individuals under study and the institution where the data was collected. More recently, a research conducted by Aris et al. [26] in 2020 in Malaysia, studied a group of university students from Kebangsaan University. This study applied the FINDRISC questionnaire to understand the risk of this population developing T2D, and they concluded that 5.6% of respondents were at moderate risk of developing T2D and 0.3% at high risk. These values show some similarity with the results of the present research, especially when compared with the results described in the group of students where approximately 3% of the participants were at moderate risk of developing T2D and 1% at high risk. In addition to these similarities, it is still possible to observe that the mean risk score of both investigations match, with the investigation carried out by Aris et al. [26] recording a mean risk score of 5.23 points and the present investigation a mean risk score of 5.04 points.

Current research analyzed the association between risk factors and socio-demographic factors with the level of risk of developing T2D over a 10-year period. The analysis of the results showed that, in relation to the socio-demographic variables, only the variables "gender", "smoking habits" and "alcohol consumption" were not associated with the risk of developing T2D. These results contradict the current literature, which states that smoking habits [31] and alcohol consumption [32] affect an individual's risk of developing T2D. Smoking habits increase the risk of developing T2D, and, on the other hand, the moderate consumption of alcoholic beverages seems to be associated with a slight reduction of this same risk. The results in relation to alcohol consumption contradict the literature, in the sense that they may be due to the fact that most of the respondents are of a younger age group and although they consume alcohol regularly, they are associated with a low risk of developing T2D, leading us to believe that alcohol consumption does not contribute positively to the higher risk of T2D [33].

Looking at the risk factors included in the FINDRISC questionnaire, contrary to what would be expected, one of the variables considered as a risk variable did not show a significant association with the risk of T2D. This variable was the "consumption of vegetables/fruit", which may also help to explain its reduced contribution to the calculation of the final risk, adding only one point for those who do not regularly consume vegetables/fruit. All the remaining variables obtained a significant association with the risk of T2D. The other variables that were shown to be associated with T2D follow the same logic as those described above and in the literature. The variables WC and BMI were the ones that showed the strongest positive association with the risk of T2D. A stronger association for these two variables was expected, since they are directly linked to higher levels of body adiposity which, in turn, may contribute to the etiological process of peripheral resistance to insulin action and T2D. In fact, a subject in a state of obesity has a greater amount of free fatty acids in the body which are stored in different organs in the form of fat, resulting in an increased state of reactive oxygen species production, oxidative stress, and chronic inflammation. This pro-inflammatory state plays an important role in the development of insulin resistance, the main cause of T2D development [34].

This research can be considered as a reference point for the reality of young people in Portugal regarding T2D, due to the high sample size of young people and the existence of a huge sample diversity among them, considering that most young people diverge from the different regions of the country. Thus, it is possible to predict that in Portugal, young people aged between 18 and 25 years old are at low risk of developing T2D, thus anticipating that 4 out of every 100 young people in Portugal are at risk of developing T2D over a 10-year period. The results of the present study are in line with the literature that considers obesity a public health problem with exponential growth with high prevalence worldwide and with great influence on T2D disease [35]. This exponential increase in the risk of developing diabetes is worrying, which is why the definition of exercise-based strategies and the promotion of active lifestyles are fundamental to reducing the prevalence of all the components of metabolic syndrome, in this specific case T2D [15].

Practical Applications, Future Perspectives and Study Limitations

This research aims to raise awareness about a growing public health issue worldwide, including in Portugal. By using the FINDRISC [17] questionnaire through an online application, the study helped inform and alert participants about their individual risk of developing T2D over a 10-year period. In fact, as the workforce ages and retirement is postponed, individuals are exposed to longer periods of sedentary work, stress, and potentially unhealthy lifestyle habits, which are risk factors for developing conditions like T2D. This can be particularly relevant if proper health and wellness programs are not in place to support employees in maintaining healthy lifestyles and physically active as they age [35].

However, it should be noted that the questionnaire was applied during the COVID-19 pandemic. This limitation meant that the study took longer, as it was necessary to comply with all the health regulations imposed. Consequently, the questionnaire was administered room by room in each of the IPB's schools and services, which made it impossible to collect other types of data that could complement the research since this study could not impact on the running of

teaching activities or the IPB's support services. Therefore, in order to reach the largest number of subjects, only body mass, body circumference and WC values were collected.

Another limitation is that it was not possible to quantify the number of packets of cigarettes consumed by each participant each year, which could have been an important variable for understanding the real impact of smoking on the onset and control of T2D, as was observed in relation to the number of alcoholic drinks [31,32]. The questionnaire used for this study, FINDRIC [24] is assumed as a limitation of the study. Although this same questionnaire is integrated in the national program for the prevention and control of diabetes, it always evidences subjective nature as it is always dependent on the answers of each participant, which participants, which may not fully correspond to reality.

CONCLUSIONS

Older individuals (members of staff) had a higher risk of developing T2D than younger ones (sudents). BMI and WC were higher associated with the risk of developing T2D in the IPB population. In general, the risk of developing T2D within the IPB community was considered low, however the concern should be centered on the greater risk of developing T2D among older people. Thus, it may be important to implement strategies in the work context to promote the practice of PA in middle-age and older adults, in a way to control and prevent T2D risk factors.

ACKNOWLEDGEMENTS

This article is a result of the project "Green Health-Digital strategies in biological assets to improve well-being and promote green health" (Norte-01-0145-FEDER-000042), supported by North Portugal Regional Operational Programme (NORTE 2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF). This project was supported by the National Funds through FCT—Portuguese Foundation for Science and Technology (UIDB/DTP/04045/2020). The authors also express acknowledgement to all medical staff, patients, and human resources of the two primary health care centers.

Institutional Review Board Statement

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the local Ethical Committee from Polytechnic Institute of Bragança, on 31 May 2021 ethical code 43/2021.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

1. Punthakee Z, Goldenberg R, Katz P. Definition, Classification and Diagnosis of Diabetes, Prediabetes and Metabolic Syndrome. Can J Diabetes. 2018; 42:S10–15.
2. Cole JB, Florez JC. Genetics of Diabetes Mellitus and Diabetes Complications. Nat Rev Nephrol. 2020; 16:377–390.
3. Lovic D; Piperidou A; Zografou I, Grassos H, Pittaras A, Manolis A. The Growing Epidemic of Diabetes Mellitus. Current Vascular Pharmacology. 2020; 18:104–109.
4. Cho NH, Shaw JE, Karuranga S; Huang Y, da Rocha Fernandes, JD, Ohlrogge AW, Malanda, B. IDF Diabetes Atlas: Global Estimates of Diabetes Prevalence for 2017 and Projections for 2045. Diabetes Research and Clinical Practice. 2018; 138:271–281.
5. Raposo JF. Diabetes: factos e números 2016, 2017 e 2018. Revista Portuguesa de Diabetes 2020; 15:19–27.
6. Riddle MC, Herman WH. The Cost of Diabetes Care—An Elephant in the Room. Diabetes Care. 2018; 41:929–932.
7. Kleinberger JW; Pollin TI. Personalized Medicine in Diabetes Mellitus: Current Opportunities and Future Prospects. Annals of the New York Academy of Sciences. 2015; 1346:45–56.
8. Primavera M, Giannini C, Chiarelli, F. Prediction and Prevention of Type 1 Diabetes. Frontiers in Endocrinology. 2020; 11:531291.
9. Bertachi A, Ramkissoon CM, Bondia J, Vehí J. Automated Blood Glucose Control in Type 1 Diabetes: A Re-view of Progress and Challenges. Endocrinología, Diabetes y Nutrición (English ed.) 2018; 65:172–181.
10. Ahmad E, Lim S, Lamptey R, Webb DR, Davies MJ. Type 2 Diabetes. The Lancet. 2022; 400:1803–1820.
11. Lende M, Rijhsinghani A. Gestational Diabetes: Overview with Emphasis on Medical Management. Int J Environ Res Public Health. 2020; 17:9573.
12. Mack LR, Tomich PG. Gestational Diabetes: Diagnosis, Classification, and Clinical Care. Obstetrics and Gyne-cology Clinics. 2017; 44:207–217.
13. Cannata F, Vadalà G, Russo F, Papalia R, Napoli N, Pozzilli P. Beneficial Effects of Physical Activity in Diabetic Patients. J Funct Morphol Kinesiol. 2020; 5:70.
14. Teixeira J, Bragada J, Coelho J, Pinto I, Magalhaes P. Sensibility and Specificity Analysis for Waist-to-Height Ratio, Body Mass Index and Waist Circumference as a Screening Criterion for Metabolic Syndrome in an Adult North-East Portuguese Population. Obes Facts. 2022: 15:210–211.
15. Magalhaes P, Teixeira J, Bragada J, Duarte C, Bragada J. Prevalence of Type 2 Diabetes, Impaired Fasting Glucose, and Diabetes Risk in an Adult and Old-

er North-Eastern Portuguese Population. Healthcare. 2023; 11:1712.
16. American Diabetes Association. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes—2019. Diabetes Care. 2019; 42:S13–28.
17. Lindström J, Tuomilehto J. The Diabetes Risk Score: A Practical Tool to Predict Type 2 Diabetes Risk. Diabetes Care. 2003; 26:725–731.
18. Candeias AC, Pipa C, Boavida JM, Correia LG, Pereira M, Almeida M, Duarte R. Programa nacional de prevenção e controlo da diabetes. Revista Portuguesa de Diabetes. 2007; 2(4):5–13.
19. Saaristo T, Moilanen L, Korpi-Hyövälti E. et al. Lifestyle Intervention for Prevention of Type 2 Diabetes in Primary Health Care: One-Year Follow-up of the Finnish National Diabetes Prevention Program (FIN-D2D). Diabetes Care. 2010; 33:2146–2151.
20. Gabriel R, Acosta T, Florez K, Anillo L, Navarro E, Boukichou N, Acosta-Reyes J, Barengo NC, Lindström J, Tuomilehto JO, et al. Validation of the Finnish Type 2 Diabetes Risk Score (FINDRISC) with the OGTT in Health Care Practices in Europe. Diabetes Res Clin Pract. 2021; 178:108976.
21. Silvestre MP, Jiang Y, Volkova K, Chisholm H, Lee W, Poppitt SD. Evaluating FINDRISC as a Screening Tool for Type 2 Diabetes among Overweight Adults in the PREVIEW:NZ Cohort. Primary Care Diabetes. 2017; 11:561–569.
22. Dantas R, Azevedo T, Alves M, et al., Utilização do FINDRISC no Rastreio da Diabetes em Utentes Assintomáticos. 2017; 12(1):45–51.
23. Valente T, Azevedo L. Estudo RADAR - Risco aumentado de diabetes em Amarante. Revista Portuguesa de Me-dicina Geral e Familiar. 2012; 28:18–24.
24. Viveiros AS, Borges M, Martins R, Anahory B, Cordeiro MS. Estudo LIDIA: Risco de Diabetes Mellitus Tipo 2 Numa População Rural Dos Açores. Revista Portuguesa de Endocrinologia, Diabetes e Metabolismo. 2015; 10:124–127.
25. Ortiz MCA, Zanetti ML. Levantamento dos fatores de risco para diabetes mellitus tipo 2 em uma instituição de ensino superior. Rev. Latino-Am. Enfermagem. 2001; 9:58–63.
26. Aris A, Khalid MZM, Yahaya H, Yoong LO, Ying NQ. Type 2 Diabetes Risk Among University Students in Malaysia. Curr Diabetes Rev. 2020; 16:387–394.
27. American College of Sports Medicine. ACSM's Guidelines for Exercise Testing and Prescription; Lippincott Williams & Wilkins, 2013; ISBN 978-1-4698-2666-0.
28. Misra A, Wasir JS, Vikram NK. Waist Circumference Criteria for the Diagnosis of Abdominal Obesity Are Not Applicable Uniformly to All Populations and Ethnic Groups. Nutrition. 2005; 21:969–976.
29. Agresti, A. An Introduction to Categorical Data Analysis; John Wiley & Sons, 2018; ISBN 978-1-119-40526-9.
30. Bland M. An Introduction to Medical Statistics; Oxford University Press, 2015; ISBN 978-0-19-251839-2.
31. Fagard RH.; Nilsson, P.M. Smoking and Diabetes—The Double Health Hazard! Primary Care Diabetes. 2009; 3:205–209.
32. Baliunas DO.; Taylor, B.J.; Irving, H.; Roerecke, M.; Patra, J.; Mohapatra, S.; Rehm, J. Alcohol as a Risk Factor for Type 2 Diabetes: A Systematic Review and Meta-Analysis. Diabetes Care. 2009; 32:2123–2132.
33. Teixeira J, Bragada J, Bragada J, Coelho J, Pinto I, Reis L, Magalhaes P. The Prevalence of Metabolic Syn-drome and Its Components in Bragança District, North-Eastern Portugal: A Retrospective Observational Cross-Sectional Study. Revista Portuguesa de Endocrinologia Diabetes e Metabolismo. 2022; 17(1-2):51-57.
34. Teixeira JE, Bragada JA, Bragada JP, Coelho JP, Pinto IG, Reis LP, Fernandes PO, Morais J.E, Magalhães PM. Structural Equation Modelling for Predicting the Relative Contribution of Each Component in the Metabolic Syndrome Status Change. Int J Environ Res Public Health. 2022; 19:3384.
35. Black CD, Black CM, Pensions GB. Working for a Healthier Tomorrow: Dame Carol Black's Review of the Health of Britain's Working Age Population; The Stationery Office, 2008; ISBN 978-0-11-702513-4.