Risk of type 2 diabetes in students attending the main tertiary education institutions in Malta

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Abstract

Introduction

Students attending tertiary education are in general young, healthy adults, however they are at an increased risk for picking up lifestyle habits that together with background risks and factors related to their status as students increase the risk of diabetes later in life. This has implications for the burden of diabetes in a high-risk population and requires targeted actions from a young age to mitigate.

Aims and Objectives

This study aimed to assess the diabetes risk in tertiary education students by quantifying the prevalence of the risk, identifying the associated risk factors, and identifying measures that can help mitigate diabetes risk.

Materials and Methods

A cross-sectional study was carried out amongst students at the University of Malta and MCAST via an online questionnaire. Self-reported data provided information about the socio-demographic factors, general health factors, genetic and environmental exposures, and behavioural risks for diabetes. The risk of diabetes was quantified using the FINDRISC score tool.

Results

A total of 375 responses were collected. Most students were classified into the low-risk category of FINDRISC, while 24.8% had a slightly elevated risk, 6.1% had a moderate risk and 5.1% had a high risk of diabetes. Older age, excessive weight, having a family history of diabetes, reduced exercise levels, anxiety, and living with a partner or children were associated with an increased risk.

Conclusion

The implementation of measures that tackle the commonest modifiable risk factors with a high impact on diabetes risk can help improve the general health of the student population and improve their prospects for the future.

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List of Abbreviations

ADA	American Diabetes Association risk score
AUDIT-C	Alcohol Use Disorders Identification Test-Concise score
BMI	Body mass index
CANRISK	Canadian Diabetes Risk Questionnaire
DDS	Dietary-Based Diabetes-Risk Score
ESPAD	European School Survey Project on Alcohol and Other Drugs
FINDRISC	Finnish Diabetes Risk Score
GAD-7	Generalised Anxiety Disorder-7 item score
GDRS	German Diabetes Risk Score
IDF	International Diabetes Federation
IDRS	Indian Diabetes Risk Score
IPAQ-SF	International Physical Activity Questionnaire - Short Form
LAU	Local Administrative Units
MCAST	Malta College of Science and Technology
MeSH	Medical subject headings
NSO	National Statistics Office
NUTS	Nomenclature of Territorial Units for Statistics
OGTT	Oral glucose tolerance test
WHO	World Health Organization

Chapter 1: Introduction

1.1. Introduction

Diabetes is considered a global epidemic, with 500 million people being affected worldwide in 2019 (International Diabetes Federation, 2019). The World Health Organization estimates that around 60 million people are affected in the European Region, with projections indicating a rising trend among all ages and doubling of diabetes-related deaths between 2005 and 2030 (World Health Organization, 2021). The prevalence is predicted to increase by 51% to 700 million persons worldwide in 2045. It is considered as one of the four major non-communicable diseases afflicting the European region together with cancer, cardiovascular disease, and chronic lung diseases (International Diabetes Federation, 2019; World Health Organization, 2016).

Type 2 diabetes is highly prevalent in the Maltese islands, with a study carried out between 2014 and 2015 reporting that 10.39% of the population suffered from the disease. Of concern, diabetes was an incidental finding in 4.08% of these (Cuschieri, 2020). Similarly, the International Diabetes Federation estimated that 12% of the total adult Maltese population, or around 40,000 persons, of those aged between 20 and 79 years are affected, while a further 20,000 people are thought to be undiagnosed (International Diabetes Federation, 2019). This was significantly higher than the prevalence of diabetes in 1981, when 7.7% of the population were reported to have the

disease (Katona et al., 1983). Currently, Malta has the third highest rate of diabetes in the EU, with the high incidence and prevalence attributed to high overweight and obesity rates (OECD/European Observatory on Health Systems and Policies, 2019).

Diabetes is costly, with global expenses estimated at around 10% of the total health expenditure, or approximately $760 billion (International Diabetes Federation, 2020). In Malta, the estimated health care costs for diabetes were calculated as around 3.64% of Malta's total health expenditure annually (Cuschieri, Vassallo, Calleja, Pace, et al., 2016). The mean diabetes-related expenditure per diabetic person was calculated at more than 2,000 USD, with around 200 deaths in adults aged 20 – 79 years yearly being attributed to it (International Diabetes Federation, 2019).

Until a few years ago, type 2 diabetes was traditionally considered as a disease of old age; however, in recent years the age at diagnosis was gradually getting lower (Alberti et al., 2004; Lascar et al., 2017; E. Wilmot & Idris, 2014). Obesity, unhealthy diets, and sedentary lifestyles, particularly amongst the young, are considered the major contributors to these observations (Alberti et al., 2004; Lascar et al., 2017).

1.2. Rationale and Scope of this Study

Students enrolled in tertiary education are typically healthy young adults passing through a transitional stage in their life (Cefai & Camilleri, 2009). As they adapt to being independent adults, students may pick up unhealthy habits that may increase their risk of disease later in life (Crosnoe & Johnson, 2011; Hannon & Arslanian, 2015; Song, 2012; Walker et al., 2014). Studies examining the lifestyle habits of students have indicated poor nutritional habits, increasingly sedentary lifestyles, and high levels of anxiety and

stress, all of which increase the risk for diabetes (Almutairi et al., 2018; Beaudry et al., 2019; Cefai & Camilleri, 2009; Hauschildt et al., 2021; Tok et al., 2018). These, coupled with genetic predisposition and environmental factors such as pollution and urbanization, may contribute to increasing the risk for type 2 diabetes in this population later in life and even at a young age (Bellou et al., 2018). Despite several studies investigating the general health and lifestyle habits of students in tertiary education (Bonnici et al., 2020; Borg & Cefai, 2014; Cauchi & Mamo, 2012; Cefai & Camilleri, 2011; Cumbo et al., 2019; Cuschieri, 2021; Pizzuto et al., 2020; Purchase, 2009; Santonastaso et al., 2006; Zammit, 2014), there have not been any studies linking these to the prevalent risk of diabetes in this select population in Malta.

1.3. Aims and Objectives

The aim of this study is to assess the risk of type 2 diabetes in students attending the main educational institutions in Malta.

The objectives of this study are to:

1. Estimate the prevalence of risk for diabetes for students attending the main tertiary educational institutions in Malta,

2. Examine the associated risk factors in this select population,

3. Identify measures that can be employed to reduce the risk of diabetes of students with possible extension to the general population of young adults, including those who do not attend educational institutions.

This study will focus on young adults enrolled in tertiary education and aims to provide an indication of the lifestyle of students together with an assessment of their general health and genetic predisposition to assess their risk of developing diabetes later in life.

1.4. Expected Implications and contribution to knowledge

This study will complement the recent studies carried out locally to investigate the burden of diabetes in the Maltese islands and study the extent of the diabetogenic lifestyle on the population under study. In particular, this study will investigate the risk for diabetes in a relatively healthy population to assess whether there is a need for interventions in the form of health promotion to reach young adults in the hope of preventing development of diabetes later in life by targeting the most prevalent risk factors.

Chapter 2: Literature review

2.1. Introduction

This chapter focused on the literature concerning the risk factors for diabetes in students enrolled in tertiary education. The first section presented the results of the literature review. This is followed by a review of the grey literature and other local research providing a situational analysis of the risk factor status of students in Malta.

2.2. Literature review

The literature review helped build the conceptual framework for the dissertation. The aim was to identify research gaps, formulate the research question, the methodology, and the direction of the study.

2.2.1. The search strategy

The literature search was carried out in November 2021 using the online PubMed and Scopus databases and the EBSCOhost and Google Scholar search engines. A combination of search terms, namely “risk”, “risk score”, “risk factors”, “factors”, “type 2 diabetes”,

"diabetes", "prediabetes", "diabetes mellitus", "students", "university students", "college students", and "educational institutions", together with the MeSH (medical subject headings) terms "diabetes mellitus", "prediabetic state", "risk factors", and "risk" were used to identify the articles. Research carried out amongst students in tertiary education and that was published in English within the past 10 years was prioritised, although older papers containing relevant information were also used where appropriate. The reference section and the list of citations were used to identify relevant research that was not included in the initial list. A total of 54 papers were shortlisted and used for the review.

2.2.2. Epidemiology and aetiology of pre-diabetes and type 2 diabetes

"Prediabetes" refers to the asymptomatic stage of diabetes, during which blood glucose levels appear well controlled but insulin levels start increasing due to emerging insulin resistance (Abdallah et al., 2020; Monedero et al., 2008). It is characterised by pathological changes in end organs that if unchecked, become irreversible (Abdallah et al., 2020; Al-Shudifat et al., 2017; Xu et al., 2016). It has been implicated in an increased risk of type 2 diabetes, hypertension, dyslipidaemia, the metabolic syndrome, cardiovascular disease, and certain types of cancer (Abdallah et al., 2020; Monedero et al., 2008; Porto-Arias et al., 2017; Sapkota et al., 2020), Appropriate management and removal of the modifiable risk factors can reverse the changes and prolong the onset of more severe chronic disease; however, the challenge lies in awareness and recognition so that appropriate measures can be applied early (Al-Shudifat et al., 2017; Sapkota et al., 2020; Vardhan et al., 2012).

Type 2 diabetes and the related non-communicable diseases were historically diseases of old age, however, their prevalence in younger ages has been increasing in recent years. Both non-modifiable and modifiable factors are implicated; however, modifiable factors related to obesogenic lifestyles starting from childhood are thought to be some of the main culprits behind the soaring rates in younger people (Adegoke et al., 2017; Ali, 2016a; Amuta et al., 2016; Ashok et al., 2010; Colak, 2015; Donazar-Ezcurra et al., 2019; Granillo et al., 2016; Hao et al., 2014; Jurca-Simina et al., 2019; Lima et al., 2014; Mazzini et al., 2013; Sapkota et al., 2020; Sindhu et al., 2015; Tudpor et al., 2021; Vardhan et al., 2012; Xu et al., 2016).

The non-modifiable factors include a genetic predisposition, evident in those with a family history of diabetes (Ashok et al., 2010; Gefter et al., 2016; Saylor et al., 2018); ethnicity, with high rates of diabetes in certain ethnic groups like South Asian, African, and Afro-Caribbean populations (Ashok et al., 2010; Jurca-Simina et al., 2019; Mongiello et al., 2016); sex; and increasing age (Colak, 2015). The modifiable factors include excessive weight, limited physical activity and increasingly sedentary behaviours, calorie-rich diets, smoking, excessive alcohol consumption, and mental health issues such as anxiety and depression. Environmental factors that are implicated include urbanisation, and rapid economic, cultural, and societal changes (Ali, 2016b; Amuta et al., 2016; Ashok et al., 2010; Colak, 2015; Donazar-Ezcurra et al., 2019; Granillo et al., 2016; Gyberg et al., 2012; Jurca-Simina et al., 2019; Kolahdooz et al., 2019; Lima et al., 2014; Mazzini et al., 2013; Patil & Gothankar, 2016; Sapkota et al., 2020; Tudpor et al., 2021).

2.2.2.1. Projections and expected burden

Projections show that the prevalence of diabetes is expected to continue to increase (Jurca-Simina et al., 2019; Meo, 2016), with around 15% of the total world population expected to be affected by 2025 (Jurca-Simina et al., 2019). A disproportionate increase in prevalence is expected to occur in younger age groups (Adegoke et al., 2017; Granillo et al., 2016; Skøt et al., 2018). This worrying trend has significant implications for public health, as younger diabetics suffer from a longer exposure to hyperglycaemia and its harmful effects, causing an increased burden on health systems due to more severe diabetes-related morbidity and mortality (Abdallah et al., 2020; Amuta et al., 2016; Das, 2014; Meo, 2016; Pertseva et al., 2021; Sindhu et al., 2015; Skøt et al., 2018; Xu et al., 2016). There are also significant implications for the economy due to increased demand for human, financial, and infrastructural resources needed to deal with burden related to diabetes (Abdallah et al., 2020; Amuta et al., 2016; Ashok et al., 2010; Colak, 2015; Lima et al., 2014; Meo, 2016).

Appropriate action is required to stem the rise in incidence and prevalence. The focus should be on preventive measures rather than treatment, and for this, national strategies focusing on public education and awareness and reducing modifiable risk factors are needed, especially among young people (Bani Salameh et al., 2017; Colak, 2015; Gyberg et al., 2012; Lima et al., 2014; Meo, 2016). Successful implementation would be expected to reduce the risk of complications, and in some cases, also reverse some of the effects (Bani Salameh et al., 2017; Colak, 2015; Gyberg et al., 2012; Hao et al., 2014; Lima et al., 2014). Interventional studies reported that weight control measures, improvement in physical activity levels, and healthy eating were successful in decreasing the relative risk

of development of diabetes by 28% to 67%, with the results sustained for around 3 years after the end of the intervention (Gyberg et al., 2012).

2.2.3. Knowledge and perception of the risk of diabetes in students

Some of the studies reviewed explored the effect of knowledge about type 2 diabetes and compared this to the students' lifestyle. The assumption was that increased knowledge can be a motivator for healthier habits and an overall lower risk (Mongiello et al., 2016). The literature however suggested that knowledge did not automatically translate to practice (Alanazi et al., 2018; Hasbullah et al., 2021; Monedero et al., 2008; Mongiello et al., 2016; Morawiec et al., 2013; Özpancar et al., 2019; Xu et al., 2016), as medical students and other healthcare students did not demonstrate significantly healthier lifestyles when compared to students with no background in healthcare (Monedero et al., 2008; Morawiec et al., 2013; Pertseva et al., 2021; Sapkota et al., 2020; Vardhan et al., 2012).

When it comes to the general student population, students tended to have suboptimal levels of knowledge about the determinants of type 2 diabetes (Mongiello et al., 2016; Skøt et al., 2018; Xu et al., 2016). Those who were older, with a higher educational level (Özpancar et al., 2019; Xu et al., 2016), having a family or personal history of type 2 diabetes (Hasbullah et al., 2021), and those with a background in healthcare (Xu et al., 2016) were more knowledgeable.

Smith *et al*. (2012) demonstrated that diabetes is not on many young people's radar, with students perceiving a higher risk of developing cancer than heart disease or type 2 diabetes (Smith et al., 2012). This was attributed to popular misconceptions, such as

diabetes being traditionally seen as a disease of old age, heart disease as affecting mostly males, and increased cancer awareness campaigns amongst the young, such as the campaign for cervical cancer screening in females, leaving their impact (Smith et al., 2012). Most were also not aware of the link between overweight and obesity and development of chronic diseases, highlighting gaps in education about the consequences of unhealthy habits. This becomes more important given that overweight and obesity rates in the younger generation are increasing at alarming rates (Ashok et al., 2010; Jurca-Simina et al., 2019; Mongiello et al., 2016; Sindhu et al., 2015; Skøt et al., 2018; Smith et al., 2012).

These observations highlight the role of information campaigns and the importance of delivering accurate information in a consistent manner. More effort should be put into providing a clearer picture of the relative risks to health in younger people, particularly to increase awareness of the risks associated with unhealthy lifestyles and increasingly obesogenic environment which proportionally cause higher morbidity and mortality than cancer and can themselves also increase the risk of developing certain types of cancer in the long run (Mongiello et al., 2016; Smith et al., 2012).

2.2.4. Risk factors for diabetes among students in tertiary education

2.2.4.1. Lifestyle choices

Young adult students, despite reporting generally good health, have several modifiable risk factors for diabetes. The commonest are the lifestyle-related factors, such as low rates of exercise, unhealthy diets deficient in vegetables, fruit, and fibre and high in

calories, overweight and obesity, and high rates of psychological stress (Adegoke et al., 2017; Al-Shudifat et al., 2017; Granillo et al., 2016; Kolahdooz et al., 2019; Olatona et al., 2018; Porto-Arias et al., 2017; Sapkota et al., 2020; Tudpor et al., 2021). The implications for vulnerable groups are higher, especially in those having genetic susceptibility with a family history of diabetes, those coming from particular ethnic minorities (Kolahdooz et al., 2019), those from lower socioeconomic and minority groups, and those with multimorbidity (Beach et al., 2018; Granillo et al., 2016; Kolahdooz et al., 2019; Olatona et al., 2018).

Diabetes-related lifestyle risk factors demonstrate a cumulative effect, with the risk increasing with the number of risk factors present. Furthermore, having one lifestyle-related risk factor increases the chance of having another (Granillo et al., 2016; Hao et al., 2014; Mazzini et al., 2013; Meijnikman et al., 2018; Monedero et al., 2008). Granillo *et al*. reported a link between eating behaviours and physical activity, with those reporting limited amounts of exercise being more likely to consume bigger meals once or twice per day, whereas those with more vigorous exercise routines consume smaller meals more regularly throughout the day (Granillo et al., 2016).

Students in tertiary education are particularly prone to developing unhealthy habits as a result of situational factors related to their lifestyle (Kolahdooz et al., 2019; Porto-Arias et al., 2017). These include the transitional stage from adolescence to young adulthood and the changes they experience in their roles and responsibilities as they gain more independence, and factors related to the academic environment (Ali, 2016a; Amuta et al., 2016; Bani Salameh et al., 2017; Kolahdooz et al., 2019; Morawiec et al., 2013; Özpancar et al., 2019; Sindhu et al., 2015; Tudpor et al., 2021).

Transition to tertiary education is associated with changes in the learning method with more focus on self-directed learning, increased time spent with peers, peer pressures that affect lifestyle choices, academic stress, pressures to succeed in an increasingly competitive environment, and independent living away from their family and friends (Amuta et al., 2016; Morawiec et al., 2013; Özpancar et al., 2019; Porto-Arias et al., 2017; Sindhu et al., 2015; Tudpor et al., 2021). Moreover, students experience other changes related to their new status in society, such as increased independence from their parents or guardians with more liberty to make personal and lifestyle choices without interference, increased financial independence, and work-related stress for those who work (Amuta et al., 2016; Morawiec et al., 2013).

These factors all cause considerable strain, and in some cases can lead to stress eating, more time spent sitting down, and habits such as smoking and alcohol consumption (Amuta et al., 2016; Bani Salameh et al., 2017; Kolahdooz et al., 2019; Morawiec et al., 2013; Olatona et al., 2018; Özpancar et al., 2019; Porto-Arias et al., 2017; Sindhu et al., 2015). Together with increased stress and anxiety which are common for students, these factors predispose to increased weight that in turn may lead to insulin resistance, diabetes and other chronic diseases later on (Ali, 2016a; Bani Salameh et al., 2017; Jurca-Simina et al., 2019; Kolahdooz et al., 2019; Olatona et al., 2018; Sahu et al., 2021; Sindhu et al., 2015; Tudpor et al., 2021; Younes et al., 2019).

2.2.4.2. Overweight and obesity

Excessive weight is a major epidemic in most countries with repercussions for the population health and the economy (Ashok et al., 2010; Jurca-Simina et al., 2019;

Morawiec et al., 2013). Adipokines and inflammatory cytokines released from fat cells are implicated in reduced insulin sensitivity and other chronic metabolic diseases (Hasbullah et al., 2021; Jurca-Simina et al., 2019; Kolahdooz et al., 2019; Pertseva et al., 2021; Saylor et al., 2018; Sindhu et al., 2015). Increased fat deposition around the central abdomen occurs naturally with increasing age; however, the increasing prevalence of central obesity in youth is concerning as this promotes the development of weight-related chronic diseases at a younger age (Hasbullah et al., 2021; Hirshberg et al., 2011; Kolahdooz et al., 2019; Lima et al., 2014; Pertseva et al., 2021; Saylor et al., 2018). Apart from considerable burden on the individual, obesity in young adults also has significant implications for healthcare service planning and resources as a result of its associated morbidity and mortality (Abdallah et al., 2020; Beach et al., 2018; Jurca-Simina et al., 2019; Lima et al., 2014; Morawiec et al., 2013; Pertseva et al., 2021).

Students in tertiary education are considered at high risk of weight gain compared to the rest of the population (Hirshberg et al., 2011; Saylor et al., 2018), with Hirschberg *et al*. reporting a 6-fold faster rate of weight gain in students compared to the general population. The rates of overweight and obesity among the student population varies, with an overweight rate of 20% and an obesity rate of 10% in a study carried out in the USA (Amuta et al., 2016) to an overweight rate of 35% and an obesity rate of around 16% reported in a Mexican study (Bojorges Velázquez et al., 2013). Ethnic minorities are at higher risk (Ali, 2016a; Kolahdooz et al., 2019; Mongiello et al., 2016), with a Canadian study reporting that around a quarter of ethnic youth had increased weight (Kolahdooz et al., 2019). Similarly, non-heterosexual youth (Beach et al., 2018), and those having a concurrent family history of diabetes tend to have a higher prevalence (Hasbullah et al.,

2021). Significant gender differences were also found, with males having overall higher obesity rates than females (Hao et al., 2014; Rodriguez et al., 2021; Younes et al., 2019).

The body-mass index and the waist-to-height ratio are primarily used to measure weight disorders (Coombe et al., 2020; Saylor et al., 2018). The latter serves as an approximate measure of central obesity and an acceptable screening tool for obesity and related cardiometabolic disorders (Kolahdooz et al., 2019). It is preferred to the traditional BMI as insulin resistance is primarily associated with central obesity and may still occur in those with a normal weight (Coombe et al., 2020).

Prevention and adequate management is an important cornerstone to prevent related complications, especially as damage can be reversed if measures are applied early enough (Bani Salameh et al., 2017; Jurca-Simina et al., 2019; Lima et al., 2014; Pertseva et al., 2021; Saylor et al., 2018).

2.2.4.3. Physical activity and sedentary lifestyle

Studies show that students are increasingly leading sedentary lifestyles with limited or no effective physical activity. Lack of exercise and prolonged sedentary behaviours are recognised independent risk factors for metabolic diseases, and a number of studies reviewed showed statistically significant associations between low levels of physical activity and increased risk for diabetes (Abdallah et al., 2020; Amuta et al., 2016; Ashok et al., 2010; Bagbila et al., 2019; Beach et al., 2018; Colak, 2015; Kolahdooz et al., 2019; Sindhu et al., 2015; M. M. Singh et al., 2019; Steinberg et al., 2008; Xu et al., 2016).

Some of the barriers that contribute to reduced exercise rates in students include time constraints, motivational factors, and tiredness as a result of juggling education with

other extracurricular activities (Lima et al., 2014). Any type and intensity of exercise can provide a protective effect, with brisk walking and activities that increase lean body mass and reduce the percentage of body fat considered effective (Colak, 2015; Sindhu et al., 2015). International experts recommend a minimum of between 30 to 60 minutes of physical exercise carried out three times a week, with the duration depending on the type of exercise carried out (Morawiec et al., 2013).

The reported levels of physical activity amongst students in different countries varied; however, the general trends showed consistently low rates of students who adhered to the minimum recommended levels as advised by international organizations such as WHO (Xu et al., 2016). For example, 45% of students in a Canadian study (Kolahdooz et al., 2019) and 61.4% of students in a Turkish study (Colak, 2015) reported insufficient levels of exercise, whereas 25% of students in Texas (Amuta et al., 2016), 13.44% of students in a Polish study (Morawiec et al., 2013), and 10.5% of students in a Turkish study (Colak, 2015) were inactive.

The majority of students were more likely to partake in walking activities rather than moderate or vigorous exercise (Colak, 2015), and in general women were more likely to be physically inactive than men (Colak, 2015; Lima et al., 2014; Morawiec et al., 2013; Porto-Arias et al., 2017; Sindhu et al., 2015). Colak *et al*. reported major differences in physical activity levels between the genders, with 15.9% of inactive women compared to 5.2% of inactive men, and 17.4% of women having sufficient levels of physical activity compared to 38.5% of men.

Despite higher rates of exercise among males, a number of studies reported better diabetes risk scores for women compared to men, highlighting the importance of factoring in different risk factors and physiological sex differences such as the protective

effect of oestrogen in women (Sapkota et al., 2020), and different measurement methods that can affect the results of different tools (Colak, 2015; Sapkota et al., 2020).

2.2.4.4. Nutrition

Students are at high risk of eating disorders and consumption of unhealthy food (Granillo et al., 2016; Hirshberg et al., 2011; Özpancar et al., 2019). As they start spending longer hours away from home and in the company of their peers, students are more likely to purchase and consume food from commercial outlets. These typically stock foods with little nutritional value that is more attractive and cheaper than healthy options, and that contain excessive amounts of saturated fat, salt, and refined sugar (Amuta et al., 2016; Granillo et al., 2016; Hirshberg et al., 2011; Olatona et al., 2018; Özpancar et al., 2019; Porto-Arias et al., 2017; Rodriguez et al., 2021). Other contributing factors include irregular eating patterns, skipping breakfast, large meals (Akdevelioglu et al., 2020; Granillo et al., 2016; Morawiec et al., 2013; Olatona et al., 2018), and stress eating (Amuta et al., 2016; Özpancar et al., 2019).

Students generally consume a Westernised diet (Amuta et al., 2016; Granillo et al., 2016; Hirshberg et al., 2011; Kolahdooz et al., 2019; Özpancar et al., 2019; Porto-Arias et al., 2017; Rodriguez et al., 2021; Sindhu et al., 2015; Steinberg et al., 2008), with this observation attributed to the shift in global nutrition towards higher consumption of processed food (Hao et al., 2014; Olatona et al., 2018). In fact, students residing in countries that typically have Mediterranean cuisines showed similar results (Donazar-Ezcurra et al., 2019; Porto-Arias et al., 2017). Less than 5% of students consumed adequate amounts of fruit and vegetables (Amuta et al., 2016; Olatona et al., 2018),

whereas more than 10% consumed more than the double amount of recommended intake of added sugars (Hirshberg et al., 2011; Olatona et al., 2018). A study carried out in Nigeria found that 29% of students consumed carbonated soft drinks on a regular basis, 44% ate pastry snacks, and 32% had meat regularly. On the other hand, only 10% ate fish and around 2% consumed fruit and vegetables regularly (Olatona et al., 2018).

These eating patterns are associated with glucose dysregulation that propagates abdominal obesity and eventual development of insulin resistance (Akdevelioglu et al., 2020; Hirshberg et al., 2011; Younes et al., 2019). When taking into consideration students' risks associated with reduced physical activity and increased sedentary behaviour, the effect of eating disorders on insulin resistance can be considerable (Amuta et al., 2016; Granillo et al., 2016; Marcus et al., 2013; Özpancar et al., 2019; Porto-Arias et al., 2017; Steinberg et al., 2008).

Despite the abundant information about healthy eating, students may find barriers to adopting healthy eating habits. Healthy food is generally less accessible and available for purchase around educational campuses, and when available, the price can be prohibitive, especially when fast food options are cheaper and more attractive (Özpancar et al., 2019; Porto-Arias et al., 2017; Rodriguez et al., 2021).

2.2.4.5. Smoking and alcohol consumption

Smoking and alcohol consumption are very common among students (Morawiec et al., 2013; Olatona et al., 2018; Pertseva et al., 2021; Porto-Arias et al., 2017). Stress, efforts to fit in among their peers, peer pressure, social events, and newfound freedoms all contribute (Morawiec et al., 2013; Porto-Arias et al., 2017). Students following courses

related to healthcare showed similar rates to students in other courses, indicating that awareness of the harmful effects of these substances does not deter young adults from picking up these habits (Morawiec et al., 2013; Pertseva et al., 2021).

Most of the studies reviewed reported variable rates of students who smoke, with around 10% in a Polish study published in 2013 (Morawiec et al., 2013) and around 20% in more recent studies carried out in Nepal (Sapkota et al., 2020) and Ukraine (Pertseva et al., 2021). Similarly, the rate of alcohol consumption varied, reflecting different cultures and attitudes towards smoking and alcohol (Morawiec et al., 2013). For example, two studies carried out in the USA reported that around 5% of students drink more than 5 alcoholic drinks in a day (Amuta et al., 2016) whereas 44% binge drink (Hirshberg et al., 2011). In Poland and Ukraine, where drinking alcohol is considered a social norm, two studies reported that over 90% of students drank alcohol on a semi-regular or regular basis (Morawiec et al., 2013; Pertseva et al., 2021). The rate of drinking in a Nigerian study was much less, where only 6% of students drank regularly (Olatona et al., 2018).

Smoking and alcohol consumption are recognised risk factors for a large number of chronic diseases, including cancer, cardiovascular disease and metabolic disorders such as diabetes (Abdallah et al., 2020; Morawiec et al., 2013; Olatona et al., 2018; Özpancar et al., 2019; Pertseva et al., 2021; Sapkota et al., 2020; Saylor et al., 2018). Moreover, alcohol consumption is an independent risk factor for obesity and subsequent insulin resistance, with higher rates of consumption associated with increased risk. Males are more likely to be heavy alcohol drinkers than females (Olatona et al., 2018), whereas the rates of smoking are more or less equal for both genders (Morawiec et al., 2013).

2.2.4.6. Stress and anxiety

Stress and anxiety are common mental health issues amongst young adults, with the onset of anxiety typically occurring earlier than other common mental health conditions like depression (Granillo et al., 2016). Students are exposed to a considerable number of stressors but have limited experience in dealing with these emotions (Özpancar et al., 2019). Academic expectations, pressure to succeed and conform with peers, and changes related to the transition from adolescence to young adulthood are implicated (Granillo et al., 2016; Özpancar et al., 2019; Sahu et al., 2021).

Apart from causing mental distress and being independent risk factors for diabetes, anxiety and stress are associated with risky eating behaviours such as stress-eating and consumption of calorie-rich foods, smoking, and increased alcohol consumption (Özpancar et al., 2019; Tudpor et al., 2021). Adequate management can reduce the health risks while improving the quality of life (Granillo et al., 2016). Management can involve different measures; for example, physical activity can offset the negative emotions associated with anxiety and improve the related metabolic dysfunction, while healthy eating and reduced alcohol consumption can lower inflammation and improve wellbeing. Mental health awareness campaigns can improve mental health literacy and provide information on how to access help, whereas counselling and medical management may be needed for more severe cases (Özpancar et al., 2019; Tudpor et al., 2021).

2.2.4.7. The implications of risk factors of diabetes among younger age groups

Type 2 diabetes has a complex aetiology, with genetic, environmental, and lifestyle factors all contributing (Amuta et al., 2016; Porto-Arias et al., 2017). The increasing incidence amongst younger age groups has been attributed to an increased prevalence of childhood, adolescent, and young adult obesity that exposes younger age groups to a pro-inflammatory environment and eventual insulin resistance (Amuta et al., 2016; Bani Salameh et al., 2017; Kolahdooz et al., 2019; Porto-Arias et al., 2017; Tudpor et al., 2021). The evidence shows that young adults benefit greatly from preventive measures that protect against the harmful effects of insulin resistance (Amuta et al., 2016; Bani Salameh et al., 2017). By postponing the development of diabetes, early onset of related morbidity and mortality is reduced, with positive consequences on the future economic productivity of young adults and their expected quality of life (Bani Salameh et al., 2017; Hirshberg et al., 2011; Porto-Arias et al., 2017).

2.2.5. Quantifying the risk of diabetes and other risk factors

The literature reviewed strived to quantify the risk of diabetes among the target population and link this to different risk factors commonly present among students. Different standardized tools were used to quantify abstract factors such as risk of diabetes, obesity, level of physical activity and sedentary lifestyle, type of diet, alcohol consumption, and anxiety. These measures allowed comparison and helped to benchmark the results against official statistics so that areas of concern could be identified. The following section explores some of the scores that were used for quantifying the risk of diabetes and other risk factors.

2.2.5.1. Diabetes risk scores

Diabetes risk scores are cost-effective tools that can be used in an outpatient setting to identify individuals at risk (Al-Shudifat et al., 2017; Ashok et al., 2010; Gyberg et al., 2012). They are non-invasive and convenient methods of measuring risk, and are not dependent on the fasting status, laboratory availability and facilities, and health status at the time of the survey (Abdallah et al., 2020). Those classified as being at an increased risk can be further screened using more invasive tests, such as fasting blood glucose, HbA1c, or oral glucose tolerance tests (OGTT) to assess their glycaemic status (Al-Shudifat et al., 2017; Ashok et al., 2010; Gyberg et al., 2012; Meijnikman et al., 2018).

Risk scores are ideal for use in high-risk populations (Al-Shudifat et al., 2017; Ashok et al., 2010), and can be used as a motivational tool to encourage users to modify their lifestyle by highlighting problem areas (Ashok et al., 2010; Granillo et al., 2016; Vardhan et al., 2011). Additionally, regular screening can prevent or prolong the onset of diabetes and its complications by early detection and appropriate management (Ashok et al., 2010).

Several risk scores were cited in the literature reviewed. One of the commonest scores cited was the Finnish Diabetes Risk Score (FINDRISC), where several diabetes risk factors are scored, and the results classified in separate categories. It was validated in young adult participants, including students in tertiary education, and also in populations around the Mediterranean (Abdallah et al., 2020; Al-Shudifat et al., 2017; Ali, 2016b; Colak, 2015; Gyberg et al., 2012; Jurca-Simina et al., 2019; Kes & Can Cicek, 2021; Meijnikman et al., 2018; Morawiec et al., 2013; Özpancar et al., 2019; Porto-Arias et al., 2017; Sapkota et al., 2020).

Other similar scores cited were the German Diabetes Risk Score (GDRS) (Abdallah et al., 2020), the Canadian Diabetes Risk Questionnaire (CANRISK) (Kolahdooz et al., 2019), the

American Diabetes Association (ADA) risk score (Granillo et al., 2016; Mongiello et al., 2016), and the Indian Diabetes Risk Score (IDRS) (Ashok et al., 2010; Patil & Gothankar, 2016; Sahu et al., 2021; Sindhu et al., 2015; M. M. Singh et al., 2019; Vardhan et al., 2012). These were mostly targeted towards older participants or certain ethic groups. Another score used was the Dietary-Based Diabetes-Risk Score (DDS), which relied exclusively on the nutritional patterns to predict diabetes risk (Donazar-Ezcurra et al., 2019).

The results of these scores varied a lot in different populations, even when using the same risk score. For example, a study carried out in Kuwait indicated that more than 50% of students fell into the very high risk category of FINDRISC (Ali, 2016a), whereas studies in Burkina Faso (Bagbila et al., 2019), and Turkey (Kes & Can Cicek, 2021) reported less than 3% of students in this FINDRISC category. Studies in Romania (Jurca-Simina et al., 2019), Nepal (Sapkota et al., 2020) and Jordan (Al-Shudifat et al., 2017) reported that around 60 to 70% of students were in the low risk category, between 20 to 30% had a slightly elevated risk, 2-10% had a moderate risk, and between 0 to 5% were in the high or very high risk FINDRISC category. Similar observations were reported in studies using other risk scores, with the differences attributed to the different background risks in different populations.

2.2.5.2. Other risk scores

Apart from scores to measure the risk of diabetes, the studies reviewed also made use of scores that measured other intangible factors. For example, overweight and obesity were mainly measured using the body-mass index (BMI) (Bagbila et al., 2019; Hasbullah et al.,

2021; Özpancar et al., 2019; Sindhu et al., 2015), the waist-to-height ratio (Jurca-Simina et al., 2019; Sahu et al., 2021), and waist circumference (Hasbullah et al., 2021; Sindhu et al., 2015). Physical activity and sedentary lifestyle were measured using the International Physical Activity Questionnaire - Short Form (IPAQ-SF) (Aris et al., 2020; Colak, 2015; Hasbullah et al., 2021), whereas most of the studies examining nutritional habits used different variations of food frequency questionnaires to assess type of food consumed (Donazar-Ezcurra et al., 2019; Hasbullah et al., 2021; Porto-Arias et al., 2017).

2.2.5.3. Limitations of risk scores

Risk scores are typically based on self-reported data, depending on subjective information and contextual cues rather than objective measures. They are subject to self-report and recall bias and may not provide an accurate picture of reality (Marcus et al., 2013). Scores measuring diet and physical activity levels are particularly prone to these biases (Beach et al., 2018; Marcus et al., 2013). Beach *et al*. (2018) reported large disparities between subjective reporting and objective measurement of physical activity levels amongst youth, with 51% reporting meeting the recommended levels of exercise versus only 8% having objective measurements within the recommended guidelines. Less active, obese youth were more likely to overestimate their physical activity levels when compared to more active participants, indicating an underestimation of diabetes risk when compiling scores (Beach et al., 2018).

Risk scores can be improved by validation within the study population to ensure cultural appropriateness. This is particularly important when carrying out studies amongst groups with variable demographic, societal, and cultural differences (Kolahdooz et al., 2019).

2.2.6. The role of the health and education sectors

Young adults are frequently exposed to a barrage of information on social media and online; however, they are more likely to dismiss or ignore these messages as a result of rampant fake news and inaccurate information, especially when the messages are directed towards the general population and are not appealing to youth (Morawiec et al., 2013; Xu et al., 2016). Healthcare professionals are well-placed to provide targeted information and counsel about healthy habits to young people, especially as they are generally held in high regard. They can also motivate young people into making healthier choices and direct them to resources that can help achieve the desired changes. To improve effectiveness, healthcare staff in contact with youth should be aware of the inherent risks associated with development of chronic disease in this cohort. Appropriate training can increase awareness so that every opportunity is used to help young adults make healthy informed lifestyle choices (Alanazi et al., 2018; Gefter et al., 2016; Morawiec et al., 2013; Saylor et al., 2018; Xu et al., 2016).

The setting provided by tertiary education institutions is an ideal forum for reaching out to young people and provide information and interventions that promote healthy lifestyles (Lima et al., 2014; Saylor et al., 2018; Sindhu et al., 2015), especially as students spend a considerable part of their day on campus and with their peers (Marcus et al., 2013; Mongiello et al., 2016; Olatona et al., 2018). Most students at this stage are still in their formative years and are establishing their own habits, preferences, and vices (Lima et al., 2014; Mongiello et al., 2016). By instilling the importance of healthy habits and linking this with the risks associated with unhealthy lifestyles, young adults are more likely to make informed choices that can be maintained later in life (Alanazi et al., 2018; Amuta et al., 2016; Lima et al., 2014; Marcus et al., 2013; Mongiello et al., 2016; Olatona

et al., 2018; Saylor et al., 2018; Xu et al., 2016). Furthermore, students can act as ambassadors who can reach out to their peers and their family members (Gefter et al., 2016; Xu et al., 2016). Education is an importance aspect of this process as the stressors and pressures that students face increase the risk of them adopting health threatening behaviours instead (Alanazi et al., 2018; Lima et al., 2014; Mongiello et al., 2016).

2.2.7. Public Health, intersectoral collaboration, and risk mitigation

Public Health has a role in advocating for a health-in-all-policies approach via intersectoral collaboration to create an environment that promotes health and makes choosing a healthy lifestyle the easy choice (Lima et al., 2014; Saylor et al., 2018; Xu et al., 2016). This is important as diabetes is caused by a number of interrelated factors, and therefore, bottom-up, evidence-based, targeted approaches that address those at risk from a young age are needed so that any actions taken are effective (Amuta et al., 2016; Kolahdooz et al., 2019).

Intersectoral collaboration between Public Health and the education sector is important for effective health promotion campaigns that can highlight the link between behaviours, lifestyle, and health (Ali, 2016a; Mongiello et al., 2016; Rodriguez et al., 2021; Smith et al., 2012). Rather than concentrating on one specific disease, campaigns should focus on identifying behaviours that are linked with chronic diseases with a large burden, and whose course can be modified by modifying behaviours. The campaigns should be appealing to students and should couple knowledge and awareness with practical tips (Lima et al., 2014; Rodriguez et al., 2021; Smith et al., 2012).

The input of stakeholders from all sectors, including young students, the education and health sectors, the media, the community, and organizations that work with students, is important (Gyberg et al., 2012; Kolahdooz et al., 2019; Marcus et al., 2013; Saylor et al., 2018). Strategies targeting vulnerable and high-risk groups should be prioritized as these generally experience worse outcomes (Beach et al., 2018; Kolahdooz et al., 2019; Mongiello et al., 2016). Research to determine the baseline risk and perceptions can provide a situational analysis to help identify areas of concern and map out how to achieve the intended goals while taking into account the characteristics of the target population (Amuta et al., 2016; Granillo et al., 2016; Mongiello et al., 2016; Skøt et al., 2018).

Primary prevention interventions should focus on empowering students by improving health literacy (Al-Shudifat et al., 2017; Gefter et al., 2016; Rodriguez et al., 2021; Skøt et al., 2018). The campaigns may also need to engage family members of students and the local community given the importance of the home and surrounding environment on development of disease (Adegoke et al., 2017; Gefter et al., 2016; Kolahdooz et al., 2019; Marcus et al., 2013; M. M. Singh et al., 2019). The barriers that impede lifestyle and behavioural change and early detection of risk factors need to be addressed. Most often than not, improved knowledge about risk factors, the methods of screening, and the availability of healthcare services can address most hurdles (Kolahdooz et al., 2019; Mongiello et al., 2016; M. M. Singh et al., 2019; Skøt et al., 2018). Other barriers include difficulty to access services, cultural or language clashes, and lack of adequate social support. Culturally sensitive initiatives can help counteract some of these difficulties while at the same time address social inequities that worsen health outcomes (Bani Salameh et al., 2017; Kolahdooz et al., 2019; Mongiello et al., 2016).

Early identification of at-risk individuals can prompt action to prevent progression of disease and its complications (Adegoke et al., 2017; Bani Salameh et al., 2017; Gefter et al., 2016; Rodriguez et al., 2021; M. M. Singh et al., 2019). Interventions should target the main risk factors, primarily obesity, physical activity levels, sedentary activities, and food consumption (Gefter et al., 2016; Marcus et al., 2013). Non-invasive screening methods can improve participation while at the same time serve as a tool to improve knowledge by facilitating discussion (Amuta et al., 2016; Steinberg et al., 2008). To improve effectiveness, information campaigns, screening, and other interventions should be repeated on a regular basis. Apart from helping to drive home the importance of lifestyle and behavioural habits on health and reaching new students, repeat assessments can be used to assess the effectiveness of interventions and provide feedback for improvement in the methodology (Amuta et al., 2016; Granillo et al., 2016; Gyberg et al., 2012; Vardhan et al., 2012).

2.2.8. Concluding remarks from the literature review

Young adults attending tertiary education institutions are at a relatively impressionable age and have the motivation and energy to take up the challenge of modifying unhealthy behaviours. Promotion of healthy habits at this stage can have a beneficial effect, especially when coupled with information on the risks and complications associated with unhealthy habits and what preventive actions can be taken to prevent development of type 2 diabetes later on (Porto-Arias et al., 2017; Saylor et al., 2018; Xu et al., 2016).

2.3. Situational analysis of the local scenario

Grey literature and literature concerned with local research were perused to assess the local situation. The general demographic characteristics, health status, and lifestyle habits of students in tertiary education in Malta and the factors that increase the risk for type 2 diabetes later in life were explored.

2.3.1. Tertiary education in Malta

Tertiary education in Malta is provided mainly by the University of Malta and the Malta College for Science and Technology (MCAST), with an additional number of smaller institutions providing specialized courses. During the academic year 2019 – 2020, approximately 18,000 students were following courses in these institutions. The number of female students surpassed that of males with 1.3 females for every male student. Most were aged between 18 and 29 years, and were following full-time courses at Bachelor's level or equivalent (Balzan, 2021; Hauschildt et al., 2021; National Statistics Office, 2021; University of Malta, 2020).

2.3.1.1. Health and lifestyle research within the tertiary education environment

A review of the local literature concerning the health and lifestyle habits of students was perused to assess the prevalent trends. Most of the published literature was concerned with research carried out amongst University of Malta students, with very few studies including students attending other tertiary educational institutions. This could reflect the larger proportion of students enrolled at the University (National Statistics Office, 2021).

The latest available annual report quotes around 12,000 students enrolled (University of Malta, 2020) compared with around 7,600 students at MCAST (Balzan, 2021) and even fewer in other institutions (National Statistics Office, 2021).

2.3.2. Characteristics of the tertiary education student population in Malta

This section explores the existing literature for the demographic and lifestyle characteristics of tertiary education students in Malta. None of the studies reviewed explored these characteristics in relation to risk for developing type 2 diabetes.

2.3.2.1. General demographic characteristics

Assessment of the demographic profile of students in Malta indicated that around 70% were aged between 18 and 29 years, approximately 60% were female, and around 10% were non-Maltese (Hauschildt et al., 2021; National Statistics Office, 2021). The majority live with their parents, 15% live in student accommodation, in shared accommodation with other persons, or on their own, while 20% live with their partner or children. Similar to students in other European countries, most students in Malta are also employed and live in households with average financial income. On the other hand, a lower proportion of Maltese students had parents with high levels of educational attainment (Hauschildt et al., 2021).

2.3.2.2. General health status

The vast majority of students in Malta were healthy, with studies carried out in 2009 and in 2014 reporting that 90% considered themselves as feeling either “very healthy” or “quite healthy” (Borg & Cefai, 2014; Cefai & Camilleri, 2009). Comparison between Maltese and international students indicated that international students tended to feel better physically, emotionally, and psychologically than the Maltese (Borg & Cefai, 2014).

With regards to morbidity, a study carried out in 2009 showed that around 7% of university students reported taking medication on a regular basis, while 57% reported not taking any medication at all. The commonest health-related complaints were back pain, followed by diseases of the respiratory tract, anxiety, and depression, with the latter two being reported amongst 16.4% and 9.7% of students respectively. Anxiety and depression were commoner amongst older Maltese students, and despite affecting a sizeable proportion of the student population, very few reported taking regular medication specifically for these conditions. The authors reported that approximately 75% of students suffered from general stress, with females being more affected (Cefai & Camilleri, 2009). Interestingly, a follow up study focusing exclusively on international students attending the University of Malta showed significantly lower stress levels than their Maltese counterparts, with better social support networks and socialization opportunities, better positive outlook, and improved planning and organization skills being attributed to the improved results (Borg & Cefai, 2014). A more recent Eurostudent report published in 2021 indicated that Malta had one of the largest share of students reporting mental health issues that impacted both their academic and daily lives compared to other European countries (Hauschildt et al., 2021).

Overweight and obesity trends in students mirror the high rates observed in the general Maltese population (Gauci et al., 2018; OECD/European Observatory on Health Systems

and Policies, 2019). A study investigating eating disorders amongst female students in Malta and Italy showed significantly increased weight and a higher preoccupation with dieting and low self-esteem related to body weight amongst the Maltese (Santonastaso et al., 2006). Cefai and Camilleri reported higher rates of dieting amongst female students compared to their male counterparts. Conversely, self-reported overweight and obesity affected around a quarter of students at the University of Malta, with higher rates amongst males (Cefai & Camilleri, 2009).

2.3.2.3. Lifestyle characteristics

Cefai and Camilleri (2009, 2011) reported generally unhealthy nutritional habits amongst University students, with food high in carbohydrates, sugar, and salt favoured over healthy options (Cefai & Camilleri, 2009, 2011). Treki and Jones (2021) further reported insufficient intake of legumes, fruits, vegetables and fish, and a disproportionately high intake of meat (Treki & Jones, 2021). Unhealthy dietary habits could be a result of increased availability of calorie-rich food and snacks that are more accessible than healthy alternatives on campus (Cuschieri et al., 2019).

Studies investigating the physical activity levels and sedentary behaviour of students in tertiary education in Malta were scant, with most of the published local literature concerning younger students (Saliba, 2015). These studies showed significantly low levels of exercise and longer times spent in sedentary behaviours amongst children in primary (A. Fenech et al., 2020) and secondary school (Decelis et al., 2014a; Guthold et al., 2020) when compared to other countries, prompting concerns that such behaviour is likely to be propagated in adulthood (Guthold et al., 2020; Saliba, 2015). In fact, the report by

Cefai and Camilleri reported that only around a third of students carried out physical exercise at least twice a week, with males more likely to carry out vigorous exercise than females (Cefai & Camilleri, 2009). The trends in younger students were attributed to pressures on students to do well in school and to increased preference for sedentary leisurely activities (A. Fenech et al., 2020; Saliba, 2015). These findings are worrying, especially as Malta had one of the highest rates of inadequate levels of physical activity amongst adolescents (Guthold et al., 2020) and adults (OECD/European Observatory on Health Systems and Policies, 2019).

Studies investigating the smoking trends of students in tertiary education persistently indicated higher overall rates of smoking when compared to the general population cohort of the corresponding age. Students were however more likely to smoke on an occasional basis rather than regularly (Cauchi & Mamo, 2012; Gauci et al., 2018; Pizzuto et al., 2020). In their report, Cefai and Camilleri indicated that around 12% of all students smoked regularly (Cefai & Camilleri, 2009), with another two studies carried out exclusively amongst healthcare professional students reporting similar results (Cauchi & Mamo, 2012; Pizzuto et al., 2020). The rate of occasional smokers was 9.3% in 2009 (Cefai & Camilleri, 2009), but higher in the other studies, ranging from around 16% in medical students (Pizzuto et al., 2020), to 17.8% amongst nursing, pharmacy, dentistry and medical students (Cauchi & Mamo, 2012). No significant gender differences were reported, although the overall number of male smokers was slightly higher than that of females in all cases (Cauchi & Mamo, 2012; Cefai & Camilleri, 2009; Pizzuto et al., 2020). One of the studies highlighted the difficulties related to smoking cessation, as around 63% of students who smoke had tried to stop unsuccessfully (Pizzuto et al., 2020), whereas the studies carried out amongst healthcare professional students emphasized that knowledge

of the harmful effects of smoking had limited effect on behaviour and practices (Cauchi & Mamo, 2012; Pizzuto et al., 2020).

Alcohol consumption trends amongst university students were investigated by Cefai and Camilleri, with regular consumption reported amongst 11% of students, occasional consumption amongst 79%, and 10% who reported no alcohol use. Males reported higher overall consumption than female students (Cefai & Camilleri, 2009). Another study carried out amongst younger students as part of the European School Survey Project on Alcohol and Other Drugs (ESPAD) in 2003 comparing alcohol consumption and risk perception amongst 16-year-old students in eight European countries indicated that Malta had the sixth highest experimental consumption and the highest regular consumption of alcohol amongst students in this age cohort. Around half of students self-reported as experimental alcohol users, whereas a third claimed that they consumed alcohol on a regular basis. Only around 7.3% of students reported that they did not consume alcohol (Chomynova et al., 2009).

2.3.3. Existing policies targeting diabetes risk factors in tertiary education

Both the University of Malta and MCAST have structures in place that facilitate student engagement in healthy lifestyles, such as physical activity, healthy eating, and mental wellbeing.

The University of Malta has committed to the wellbeing of students by cementing its intentions in the strategic plan for the years 2020 to 2025. The institution is aiming to beef up the services currently being offered to ensure that the mental health needs of students are being adequately met. It aims to address stress levels, increase mental

health literacy and competencies of students and staff, and provide counselling services to those in need. Additionally, the University aims to increase the availability of healthy food options on campus, promote sports events, improve fitness infrastructure, and push for tobacco-free policies on campus. Awareness campaigns will be launched, linking these initiatives to expected improved health outcomes (Vella et al., 2020).

In addition to this, the University students' council, Kunsill Studenti Universitarji (KSU), periodically makes recommendations for actions to improve health. The earliest document available was a Health Policy document published in 2006, where the council provided recommendations for physical activity, nutrition, psychological health, tackling substance abuse including tobacco and alcohol, and access to sexual health services amongst other topics. It also referred to access to counselling and healthcare services, leisure activities, and planning of academic activities to improve health outcomes (Zaffarese et al., 2006). More recently, KSU published a document which highlighted the impact of the COVID-19 pandemic on health, and particularly mental ill-health. This document drew attention to the fact that despite the availability of student support services, few students were aware of such services and how to access them. The lack of awareness was mostly attributed to lack of promotion and communication issues between the University administration and the students (Kunsill Studenti Universitarji, 2020). The recent launch of HelpHub, a one-stop shop that serves as a first port-of-call for student support services, aims to address these shortcomings and improve access of these services (University of Malta, 2022). Mental health was also one of the topics of "Your FuturEU", a campaign funded by the EU with the aim of facilitating civic engagement in areas that concern youth. This document proposed changes to the National Mental Health strategy considering the impact that the COVID-19 pandemic has

caused, particularly on young people. It also referenced briefly smoking and excessive alcohol consumption among youth (K. Scerri et al., 2021).

Similar to the University, the MCAST wellbeing hub provides a number of health and wellness services related to mental health services and therapy, nutritional advice, sexual health, tobacco cessation, and addiction services. Some of the services are provided in collaboration with governmental and non-governmental organizations, including the Health Promotion and Disease Prevention Directorate, Sedqa, and the Foundation for Social Welfare Services. Furthermore, the Sports Department organizes a number of activities throughout the academic year to encourage physical activity, whereas a fitness centre on campus provides information on weight management programmes (MCAST, 2021).

2.4. Conclusion

Risk factors for diabetes are common in students attending tertiary education. Overweight and obesity, physical activity levels, sedentary behaviours, smoking, alcohol, and mental disorders such as anxiety and stress were the most cited risks amongst students in the literature. The use of risk scores can provide a measure of the inherent risk of diabetes among high-risk populations and can be used as motivational tools to encourage behavioural changes and improve lifestyle.

Published local literature indicates that in general, tertiary education students in Malta do not lead healthy lifestyles and have several risk factors for diabetes, including excessive weight, unhealthy nutrition, low rates of exercise and increased time spent in sedentary

activities, smoking, excessive alcohol consumption and high levels of stress and anxiety. Despite the presence of these risk factors, literature investigating the risk of diabetes in students in light of these risk factors has not been published to the best of the researcher's knowledge. The two biggest tertiary education institutions have policies in place to tackle these issues, however students may not be accessing the full potential of the services available.

Chapter 3: Materials and Methods

3.1. Introduction

This chapter outlines the methodology employed in carrying out this study, including the research design, the development of the research tool, ethical considerations, piloting of the research tool, the data acquisition protocol, and data analysis.

3.2. Research design

A cross-sectional, descriptive study using quantitative methods was chosen to answer the research question. Data collection was carried out via a self-administered questionnaire that recorded quantitative data which was then analysed to provide a picture of the diabetes risk and associated risk factors among the population under study.

3.3. Population

This study targeted the student population attending courses at the tertiary level of education in Malta. Due to constraints of time, resources, and accessibility issues, this study focused on those students attending the University of Malta and the Malta College

of Science and Technology (MCAST), which cater to the largest share of students in tertiary education (National Statistics Office, 2021).

3.3.1. Inclusion and exclusion criteria

To be included in the study, participants had to be over 18 years of age, were enrolled as students at either the University of Malta or MCAST, had access to the educational institution email, and must have provided informed consent to receive emails containing such material.

Participants younger than 18 years, those unable to give consent or who refused, students in other institutions, students enrolled for short courses of less than one scholastic year, those who did not have access to the email address of their educational institution, and staff members or participants who were not students at the time of the study were not included. Participants who indicated that they have type 2 diabetes were also excluded from the study.

3.4. The research tool

3.4.1. Questionnaire development and choice of instruments

To help answer the research question, a questionnaire that could be used to assess the characteristics of students and their risk for developing type 2 diabetes was needed. A pre-existing, validated survey tool that could be used for this purpose was not available,

and therefore the literature was perused to develop a suitable tool. In particular, the research tool used in studies that investigated the risk of diabetes in tertiary education students was assessed for the type of questions and validated tools chosen. Similar validated tools were used were possible to allow for comparability of the results, whereas validated tools that were more adequate for Mediterranean populations were used where the literature quoted more than one tool that could be used..

The final questionnaire consisted of different sections. The data collected included demographic and socio-economic factors, lifestyle habits, general health, genetic, and environmental factors, and a measure of the risk of developing type 2 diabetes.

Several validated tools were used, such as the body-mass index (Weir & Jan, 2021) and the waist-to-height ratio (Gibson & Ashwell, 2020) to measure weight and screen for central obesity, the Alcohol Use Disorders Identification Test-Concise tool to assess alcohol consumption (Babor et al., 2001); the International Physical Activity Questionnaire – Short Form to quantify physical activity (IPAQ Group, 2005); a validated literature-based adherence score to the Mediterranean diet to compare the type of diet consumed against the Mediterranean diet (Sofi et al., 2014, 2017); the Generalised Anxiety Disorder-7 item score to measure the level of anxiety (Spitzer et al., 2006), and the Finnish Diabetes Risk score to quantify the risk of diabetes (Lindström & Tuomilehto, 2003).

3.4.1.1. Body-Mass Index and the Waist-to-Height ratio

The body-mass index (BMI) and the waist-to-height ratios were required for the score measuring the risk of diabetes but were used separately to assess for weight disorders.

The BMI was classified according to the WHO classification system as per Table 1 (Weir & Jan, 2021). For waist-to-height ratio, the literature quoted a cut-off point of 0.5 to denote an increased risk (Browning et al., 2010; Yoo, 2016), however a classification system was also used to further sub-categorize respondents and facilitate comparisons (Ashwell, 2017; Gibson & Ashwell, 2020) (Table 2).

***Table 1**: BMI Categories as per WHO Classification. Source: Weir & Jan, 2021.*

BMI Category	BMI score (kg/m^2)
Underweight	< 18.5
Normal weight	18.5–24.9
Pre-obesity	25.0–29.9
Obesity class I	30.0–34.9
Obesity class II	35.0–39.9
Obesity class III	> 40

***Table 2**: Waist-to-Height ratio categories. Source: Ashwell, 2017; Gibson & Ashwell, 2020.*

Waist-to-Height ratio Category	Adult women	Adult men
Extremely slim	≤ 0.34	≤ 0.34
Slim	0.35 – 0.41	0.35 – 0.42
Healthy	0.42 – 0.48	0.43 – 0.52
Overweight	0.49 – 0.53	0.53 – 0.57
Very overweight	0.54 – 0.57	0.58 – 0.62
Obese	≥ 0.58	≥ 0.63

The waist-to-height ratio can be more sensitive for predicting the risk of diabetes in young people than the BMI, especially as it can detect those with normal weight but who have central obesity and who would be missed by the BMI. Besides this, the waist-to-height ratio provides a simpler method of classification that is not dependant on the sex or age of the study subject (Gibson & Ashwell, 2020).

3.4.1.2. Alcohol Use Disorders Identification Test-Concise (AUDIT-C) Score

The Alcohol Use Disorders Identification Test questionnaire is a 10-question screening tool developed by the World Health Organisation in 1989 and updated in 2001 for carrying out a brief assessment and screening for alcoholism (Babor et al., 2001). In 1998, a shortened version containing 3 questions that could reliably identify alcohol abuse or dependence that was more convenient for use in primary care was developed. This was dubbed the AUDIT-C tool, and it worked by scoring each item from 0 to 4 to give a final score between 0 and 12. Higher scores suggested unhealthy alcohol consumption, with the cut-off point indicative of excessive alcohol consumption for men being 4, whereas for women this was 3 (Bush et al., 1998). Review of the literature indicated that the AUDIT-C tool performed better than other common tools such as the CAGE questionnaire and conventional blood tests to detect heavy drinking and distinguish between current and past problematic drinking (Fujii et al., 2016).

3.4.1.3. International Physical Activity Questionnaire – Short Form (IPAQ-SF)

The International Physical Activity Questionnaire was developed to allow comparable measurements of the level of physical activities in various settings for adults aged between 15 and 69 years (Craig et al., 2003). A short version was also developed with recommendations to use for monitoring purposes rather than for detailed assessment (Craig et al., 2003; Rai et al., 2018). The short questionnaire records both the amount and frequency of physical activity carried out, classifying respondents into three levels: inactive, minimally active, and highly active (IPAQ Group, 2005). Furthermore, IPAQ is freely available and does not require any special permissions for use (Rai et al., 2018).

The short version of this tool was chosen for the questionnaire to help assess the level of physical activity and sedentary behaviour and compare this to other factors. Following careful data cleaning, scoring was carried out using a previously developed spreadsheet that allowed automatic scoring and classification of the respondents' level of physical activity (Cheng, 2016). The spreadsheet calculations followed the guidelines that were specifically developed for the IPAQ-SF questionnaire to classify respondents into low, moderate, and high levels of physical activity categories as per Table 3 below (Bergman et al., 2009; IPAQ Group, 2005).

***Table 3**: The IPAQ-SF scoring protocol. Source: Bergman et al., 2009.*

Physical activity category		**Description of category**
1	Low	- No reported activity, or - Some activity is reported but not enough to meet categories 2 or 3.
2	Moderate	- 3 or more days of vigorous activity for at least 20 minutes per day, or - 5 or more days of moderate intensity activity or walking for at least 30 minutes per day, or - 5 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum of 600 MET* minutes per week
3	High	- 3 or more days of vigorous activity accumulating at least 1500 MET* minutes per week, or -7 days or any combination of walking, moderate, or vigorous activities achieving a minimum of 3000 MET* minutes per week.

*MET: multiples of the resting metabolic rate. MET-minute is computed by multiplying the MET score by the minutes performed. Source: IPAQ Group, 2005

3.4.1.4. Literature-based adherence score to the Mediterranean diet

The assessment of the dietary patterns of the participants was required to investigate the diet consumed against the risk of diabetes. Traditionally, food frequency questionnaires listing different types of foodstuffs and investigating the consumption patterns for each in terms of frequency and portion size were used for such a purpose (Pérez Rodrigo et al., 2015); however, the length and complexity of interpretation of such questionnaires made these unsuitable for the purpose of this research.

The literature was perused to identify a diet that itself was considered healthy and protective against development of diabetes, and which could be used as a proxy to consumption of a healthy diet. The Mediterranean-type diet was found to be the closest diet that fit this purpose, especially given the amount of literature available in this regard that document its benefits (Ley et al., 2014; J. Salas-Salvadó et al., 2011; Jordi Salas-Salvadó et al., 2016), and also by the fact that the Maltese Dietary Guidelines are based on this dietary pattern (Health Promotion & Disease Prevention Directorate, 2016). It must be stressed however, that non-adherence to the Mediterranean diet does not imply consumption of an unhealthy diet, and therefore for the purpose of this study, the risk of development of diabetes was assessed against consumption of a Mediterranean dietary pattern rather than against consumption of a healthy diet.

A literature-based adherence score developed by Sofi *et al*. (2014) was found to be the most suitable for the purpose of this study. The MED-LITE score was developed following a meta-analysis that was carried out to investigate the relationship between the health status and adherence to the Mediterranean diet and was developed as a convenient tool that was evidence-based and practical to use to help quantify the level of adherence (Sofi et al., 2014, 2017). A validation exercise for this tool found a significant positive correlation when it was assessed against the validated MedDietScore (MDS), including

also for all the different food groups assessed in the score (Sofi et al., 2017). The score lists different food groups forming part of the Mediterranean diet, and participants choose their level of consumption for each group and are scored accordingly. The final score ranged from zero, signifying poor adherence, to 18, signifying maximal adherence (Sofi et al., 2014). This was further categorised into low adherence, with a score between 0 and 6, medium adherence, with a score between 7 and 12, and high adherence defined by a score of between 13 and 18 (Sofi et al., 2014; Treki & Jones, 2021).

3.4.1.5. Generalised Anxiety Disorder – 7 item (GAD-7) Scale

A bilateral relationship between type 2 diabetes and different psychiatric disorders has been implicated in several studies (Chien & Lin, 2016; Lindekilde et al., 2021; Naicker et al., 2017). In general, students and young adults were found to be at a higher risk of anxiety compared to other psychiatric disorders (Byrd-Bredbenner et al., 2020; Cefai & Camilleri, 2009; Hauschildt et al., 2021; LeViness et al., 2017). Given these observations, a measurement of the level of anxiety, rather than other psychiatric disorders, was thought to be the most suitable for inclusion in the questionnaire.

The Generalised Anxiety Disorder – 7 item Scale was developed by Spitzer *et al*. as a brief, self-reporting screening tool for generalised anxiety disorder consisting of 7 items. Each item is given a score between 0 and 3 to produce a final score ranging from 0 to 21. This can be further categorized by grouping scores between 0 and 4 to indicate minimal or no anxiety, scores between 5 to 9 to indicate mild anxiety, scores between 10 and 14 to indicate moderate anxiety, and scores between 15 and 21 to indicate severe anxiety (Spitzer et al., 2006).

3.4.1.6. The Finnish Diabetes Risk (FINDRISC) Score

The FINDRISC score was developed by Lindström & Tuomilehto (2003) as a prediction tool to identify those at risk of developing diabetes and those with asymptomatic disease as an alternative to the invasive and costly blood or oral glucose test. The FINDRISC score is not affected by variations in glucose levels and does not depend on the fasting status of the person, unlike more invasive tests (Lindström & Tuomilehto, 2003).

The FINDRISC tool has been validated in different populations (Canadian Task Force on Preventive Health Care, 2012; Makrilakis et al., 2011; Zhang et al., 2014). The sex, age, weight and height, waist circumference, level of physical activity, type of dietary intake, history of hyperglycaemia, and personal and family history of hypertension are scored to produce a final score, which then provides an indication of the risk for developing diabetes over 10 years. Table 4 below provides an interpretation of the results of the scoring system, together with the associated risk of developing diabetes within ten years (Lindström et al., 2010; Lindström & Tuomilehto, 2003; QxMD, 2010).

***Table 4**: Interpretation of the FINDRISC score categories. Source: Lindström et al., 2010.*

FINDRISC Score	FINDRISC category	10-year risk of developing T2DM	
		Men	Women
0-3	Very low	0.3%	0.1%
4-8	Low	0.8%	0.4%

9-12	Moderate	2.6%	2.2%
13-20	High	23.1%	14.1%
>21	Very high	~50%	~50%

3.4.2. Face validity

Face validity of the research tool was carried out to determine that the questionnaire used in the study could measure what it set out to measure (Taherdoost, 2016). Experts in the field of diabetes, physiotherapy, nutrition, and psychiatry were consulted and asked to review the sections that measured the risk of type 2 diabetes, the physical activity section, the adherence to the Mediterranean diet, and the section about anxiety respectively. Given that the tools used in the study were previously validated, the feedback received was to preserve the format of the tools and only to include explanatory notes and prompts in the IPAQ-SF tool to ensure that respondents answer the questionnaire in the format suggested. Following this, a public health specialist reviewed the whole questionnaire for coherence and to assess whether the content could be reliably used for the intended purpose.

3.4.3. Translation and reliability testing

Given that the questionnaire was aimed at students attending tertiary educational institutions, where participants are expected to have a degree of familiarity with the English language, the questionnaire was not back translated to Maltese. Reliability testing was also not required as several validated instruments were used for the different sections.

3.5. Research Approval and Ethical Considerations

3.5.1. Conditional permission and ethical approval of the study

Conditional permission to carry out the study was sought from the Academic Registrar of the University (Appendix 1) and the Data Protection Officer of MCAST prior to applying for ethical review and was reconfirmed after ethical approval was obtained.

Ethical approval from the University and Faculty Research Ethics Committee (FREC) of the University of Malta (Ref No: FRECMDS_2021_155) and from the MCAST Ethics Committee (Research Proposal number E08_2021) were granted following review of the proposal and reconfirmed following amendments carried out after the pilot study. A copy of the approvals can be found in Appendix 2 and 3.

3.5.2. Informed consent

Participants were informed about the study topic, the aims, and the objectives. The principles of anonymity and confidentiality were emphasised, including adherence to the General Data Protection Regulations.

Participants were informed that any data collected will only be used for the purpose of the study and that it will be destroyed once the study was completed. Voluntary participation, with the possibility to opt out at any point without providing any reason for

doing so, was highlighted, while refusal to participate will not affect the rights or any medical care that the participants might need. The participants were also provided with the email address of the researcher for any queries or clarifications they may need. A copy of the recruitment letter with information about the study and the consent form can be found in Appendix 4.

3.5.3. Safeguards and information about sources of help

A separate document with information about type 2 diabetes and the associated risk factors was provided to the participants. This document included information about actions that can help reduce the risk of developing diabetes later in life. Furthermore, contact details and information about the sources of help and support that can be availed of in the public sector were provided. A copy of this document can be found in Appendix 5.

3.5.4. Ensuring anonymity and confidentiality

To ensure anonymity and confidentiality, identifiable information was not collected. The general demographic information included the year of birth, the sex, the region of residence, and the nationality. Rather than collecting information about the specific locality of residence, the region of residence was limited to one of the six regions specified by the Nomenclature of Territorial Units for Statistics (NUTS) and the Local Administrative Units (LAU) at level 1 that were instituted by Eurostat to provide a consistent classification of territorial units intended for statistical purposes (Eurostat, n.d.). Similarly, information about the nationality was limited to a choice between

"Maltese", "European", and "Other (Non-European)". These helped to provide low level granularity of the data and avoid identification of participants. A copy of the questionnaire can be found in Appendix 4.

3.6. The pilot process

The research tool was piloted among a group of fifteen participants who had recently finished their studies in one of the two institutions where the study was carried out and who were not currently students. Review of the responses indicated that the questionnaire was adequate with respect to the length, complexity, and understandability of the questions.

3.6.1. Observations and changes following the pilot study

Following review of the pilot study results, some minor changes to the questionnaire were suggested. These included adding prompts under questions to increase clarity and reduce the need for data cleaning later on, such as for example, the respondents were prompted to write the year of birth using the format "YYYY" rather than using the "YY" format. Suggestions also included adding a picture to help respondents relate better to what a "standard" drink is and including the "none" option for the question asking about the amount of alcohol consumed.

3.7. Data acquisition protocol

Data collection was carried via a self-administered online questionnaire sent by email to students between the 15th of November and 20th December 2021. As per policy of both the University and MCAST, the distribution of the questionnaires was carried out by the Academic Registrar offices of the institutions on behalf of the researcher to respect the General Data Protection Regulations and ensure anonymity and confidentiality. The email was sent to those students who had previously agreed to receive such material and excluding those who had withheld consent.

This method of distribution was considered acceptable given the constraints in place at the time of the data collection period, which was carried out when COVID-19 pandemic restrictions were still in effect. At the time, both educational institutions were providing a hybrid system for students to access lectures, and therefore online distribution ensured that participation was not impacted by social distance measures and hybrid or online learning that limited physical attendance on campus (Balzan, 2021; Kunsill Studenti Universitarji, 2020).

To help improve the response rate, the researcher asked for a personalised email to be sent directly to the students' inbox rather than a link through the institution platform and for a reminder email to be sent after two weeks. This method was chosen as students attending the University and MCAST are assigned an institution email address which they are expected to check regularly and where they receive official communication related to their studies. Moreover, the distribution methodology to be used was discussed with the registrar offices of both institutions to ensure consistency in how the questionnaires were distributed, their reach, and who the intended recipients were.

Measures were taken to improve the quality of the data collection process. The survey was structured to be as concise as possible without compromising its usefulness to collect

the data required. Respondents were duly informed of the aims and objectives of the study and how much time they were expected to spend to complete the survey, while the contact details of the researcher allowed respondents to contact the researcher with any queries they might have (Appendix 4).

3.8. Data handling

3.8.1. Data cleaning, derived variables, and coding

Following the end of the data collection period, the data collected was downloaded to an Excel sheet and cleaned manually. The exercise was carried out to improve the quality of the data so that it could be used for analysis. Cleaning included recoding or modifying data to improve consistency and clarity while reducing errors and variation (Elliott et al., 2006; Taylor et al., 2020).

As the first step, the raw data was scrutinised to ensure that it made sense and was arranged appropriately in rows and columns (Taylor et al., 2020). Incomplete entries and entries where the participants indicated a personal medical history of type 2 diabetes were removed as the latter did not satisfy the inclusion criteria. Fields that had a free text input option were checked for typographical errors and where indicated, the responses were standardised to facilitate categorization (Elliott et al., 2006). For example, for the IPAQ-SF tool, participants had to input the number of hours and minutes that they spent carrying out various activities. As not all participants inputted the data according to the prompt, data cleaning was required to convert the free text to the ideal format so that the calculation and final scoring of the tool could be carried out as per guidelines for the data processing and analysis of the tool (IPAQ Group, 2005). Similarly,

data cleaning was required to convert the height and waist circumference measurements to the metric system where participants used the Imperial system instead.

The data was then grouped into variables to facilitate analysis where necessary, such as for the age and the validated tools according to the suggested groupings in the literature as mentioned in Section 3.4.1 above. The latter included the BMI, the waist-to-height ratio, and the AUDIT-C, IPAQ-SF, literature-based adherence score to the Mediterranean diet score, the GAD-7 item score, and the FINDRISC tools.

Data coding was applied to facilitate analysis using SPSS. During this process, text was converted to numerical data. The Excel document was subsequently uploaded into SPSS so that analysis was carried out.

3.8.2. Weighting

The data collected was weighted against the study population to reduce bias and improve the representativeness of the results (Lavrakas, 2008).

The University of Malta and MCAST both provided the number of male and female students, and the number of students aged between 18 and 20, 21 and 23 years, and those aged 24 years or over distributed by gender. Weighting was then carried out by using Equation 1 below, where stratum refers to a category that contains a gender and one age group in one educational institution.

***Equation 1**. Equation to calculate the weighting to be applied for each stratum.*

$$\left(\frac{Population\ stratum}{Total\ study\ population} \times Total\ sample\ population\right) \div Sample\ stratum\ population$$

In the equation, "Population stratum" refers to the number of students in each stratum; "Total study population" refers to the number of students who were invited to participate; "Total sample population" refers to the total number of respondents; and "Sample stratum population" refers to the number of respondents in each stratum. Two students who marked their gender as "non-binary" were given a weighting of zero. The results of the weighting of each stratum are presented in Table 5.

***Table 5**: Weighting applied for each stratum, as defined by the sex and age group for each educational institution.*

Sex	Age-group	Educational Institution	Sample Stratum population	Study Stratum population	Weight
Female	18-20 years	University	59	2416	0.984
Male	18-20 years	University	15	1610	2.385
Female	21-23 years	University	50	1865	0.814
Male	21-23 years	University	17	1244	1.655
Female	24+ years	University	95	2985	0.695
Male	24+ years	University	39	1989	1.164
Female	18-20 years	MCAST	22	1121	1.142
Male	18-20 years	MCAST	10	1382	3.233
Female	21-23 years	MCAST	17	411	0.536
Male	21-23 years	MCAST	5	505	2.383
Female	24+ years	MCAST	31	437	0.353
Male	24+ years	MCAST	13	539	0.883

As can be observed in Table 5, male students participated much less than female students, with those aged between 18 and 20 years and between 21 and 23 attending MCAST, and those aged between 18 and 20 years attending the University of Malta being the least represented. On the other hand, female students attending MCAST aged 24 years and older were the most over-represented.

3.8.3. Statistical analysis

Statistical analysis was carried out to help evaluate the data collected so that it could be presented in a meaningful way (Elliott et al., 2006). SPSS (IBM Corp, 2019) and Microsoft Excel (Microsoft Corporation, 2018) were used for analysis and to produce graphical representation of the results.

The weighted sample was used for the analysis with a cut-off p-value of 0.05 indicating statistical significance. Where needed, tests of normality were carried out to determine the distribution of the variable in question and help choose whether a parametric or non-parametric test was indicated. Care was taken to ensure that the assumptions indicated for each test used were not violated. Continuous datasets were used where possible to improve the sensitivity of the results, such as for example for the age, BMI and waist-to-height ratios, the GAD-7 score for anxiety, and adherence to the Mediterranean diet, whereas categorical data was used in other cases.

3.9. Conclusion

The methodology used to address the aims and objectives of this study was explained in detail in this section. The following chapter presents the findings obtained from the data analysis.

Chapter 4: Results

4.1. Introduction

The results of the data analysis are presented in this chapter.

Descriptive statistics and univariate analyses were carried out to provide a summary of the respondents' characteristics by place of study and an overview of the characteristics by sex. Further analysis was carried out with the FINDRISC score results to assess for the effect of different variables on the risk for developing type 2 diabetes. This was followed by multivariate analysis of statistically significant diabetes risk factors to remove the effect of confounding variables (Pourhoseingholi et al., 2012).

4.2. The response rate

The research tool was distributed by email to all eligible students. A total of 16,332 emails were sent, with 387 responses received by the time the link remained available for an overall response rate of 2.37%. Table 6 shows the distribution of respondents for the University and MCAST.

***Table 6**: The response rate by educational institution for all responses received.*

Educational Institution	Total Emails Sent	Responses Received	% Response Rate
MCAST	4,395	102	2.32%
University of Malta	11,937	282	2.36%
Total	**16,332**	**387**	**2.37%**

Following review of the responses, two entries were removed as the participants indicated that they were staff members, whereas another ten entries were removed as the participants indicated a medical history of type 2 diabetes or diabetes, thus making them ineligible to participate in the study. The final dataset consisted of 375 responses (Table 7).

***Table 7**: The response rate by educational institution for valid responses received.*

Educational Institution	Invalid Responses	Total Valid Responses	% Valid Responses (from total)
MCAST	2	100	2.28%
University of Malta	10	275	2.30%
Total	**12**	**375**	**2.296%**

4.3. A brief summary of the respondents' characteristics

Most respondents were from the University of Malta, female, and Maltese, while around two thirds were aged 24 years or younger and around a quarter resided in the Northern Harbour district. Approximately half of the respondents were in their first year of tertiary education, and 30% were in their final year of studies. Univariate analysis showed statistically significant differences in the analysis of the place of study by sex, age groups, and nationality. Female participants were more likely to attend the University while males were more likely to attend MCAST. Third Country Nationals attended in higher numbers at MCAST, whereas older students were more likely to be attending the University (Table 8).

The respondents' age showed a right skewed distribution with a range of between 18 and 71 years and with most respondents younger than 24 years (Figure 1). The mean age of the participants was 25.43 years (95% C.I. 24.45 – 26.41), while the median age was 21 years and the modal age 19 years. The average age for male respondents was 25.59 years (95% C.I. 23.98 – 27.19), which was slightly higher than for females at 25.43 years (95% C.I. 24.45 – 26.41), however this difference was not statistically different (p =0.26).

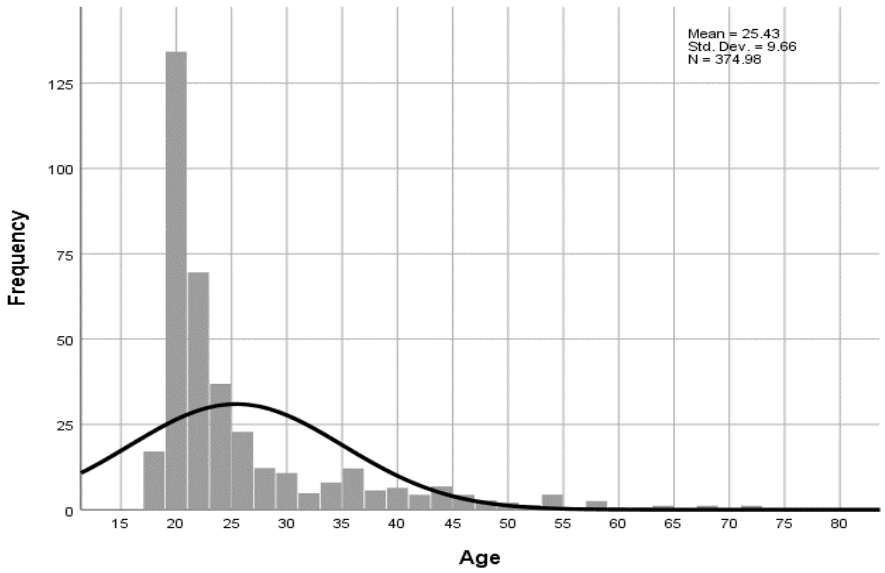

***Figure 1**: Age distribution of the respondents.*

***Table 8**: Characteristics of the respondents by place of study.*

Category	Educational Institution				% from total	p-value
	University of Malta		MCAST			
	n	column %	n	column %		
Sex						**0.007***
Male	109	39.9%	56	55.2%	44.0%	
Female	165	60.1%	45	44.8%	56.0%	
Age Categories						**0.001***
18 - 20 years	94	34.2%	57	56.9%	40.3%	
21 - 23 years	69	25.1%	21	20.8%	24.0%	
24 - 29 years	48	17.5%	8	8.2%	15.0%	
30 years +	64	23.2%	14	14.0%	20.7%	
Nationality						**<0.001***
Maltese	237	86.5%	78	77.0%	84.0%	
European	32	11.7%	7	7.3%	10.5%	
Other (Non-European)	5	1.7%	16	15.7%	5.5%	
Region of Residence						0.053*
Southern Harbour	50	18.1%	25	24.5%	19.8%	
Northern Harbour	78	28.5%	15	15.0%	24.9%	
South Eastern	42	15.3%	23	22.4%	17.2%	
Western	45	16.2%	17	16.8%	16.4%	
Northern	37	13.6%	17	16.6%	14.4%	

Gozo and Comino	22	8.2%	5	4.7%	7.3%	
Year of Course						0.383†
1st year	123	46.0%	46	49.0%	46.7%	
2nd year	87	32.4%	26	27.4%	31.1%	
3rd year	41	15.4%	12	12.7%	14.7%	
4th year	14	5.2%	10	10.3%	6.5%	
5th year	3	1.1%	1	0.6%	1.0%	
Final Year?						0.182*
No	206	75.3%	69	68.2%	73.4%	
Yes	68	24.7%	32	31.8%	26.6%	

*Pearson's chi-squared test; †Fisher's exact test

4.4. Risk of diabetes

This section presents a descriptive summary of the FINDRISC score distribution and its association with the main demographic characteristics of the respondents.

A right skewed distribution was obtained for the FINDRISC score that was confirmed with a statistically significant Kolmogorov Smirnov test of normality ($p < 0.001$) (Figure 2). Most students had a score below 8, indicating an overall very low or low risk of developing type 2 diabetes within the next 10 years, with a smaller proportion obtaining higher scores. The measures of central tendency reflected these observations, with a modal score of 0 (51 participants) followed by a score of 3 (50 participants), a median score of 5 and a mean score of 5.71 (95% C.I. 5.26 - 6.17).

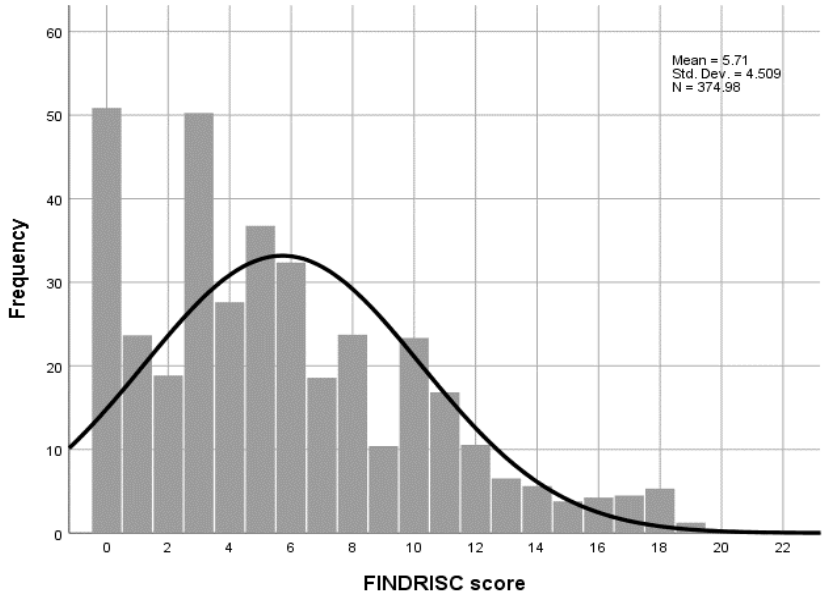

***Figure 2**: Distribution curve of the FINDRISC Scores amongst the student population.*

Figure 3 shows the distribution of participants within the different FINDRISC categories (Lindström et al., 2010; Lindström & Tuomilehto, 2003), confirming that most students fall within the very low risk categories for developing type 2 diabetes, while around 25% fall within the slightly elevated risk and slightly more than 10% have a moderate or high risk for developing diabetes (Figure 3).

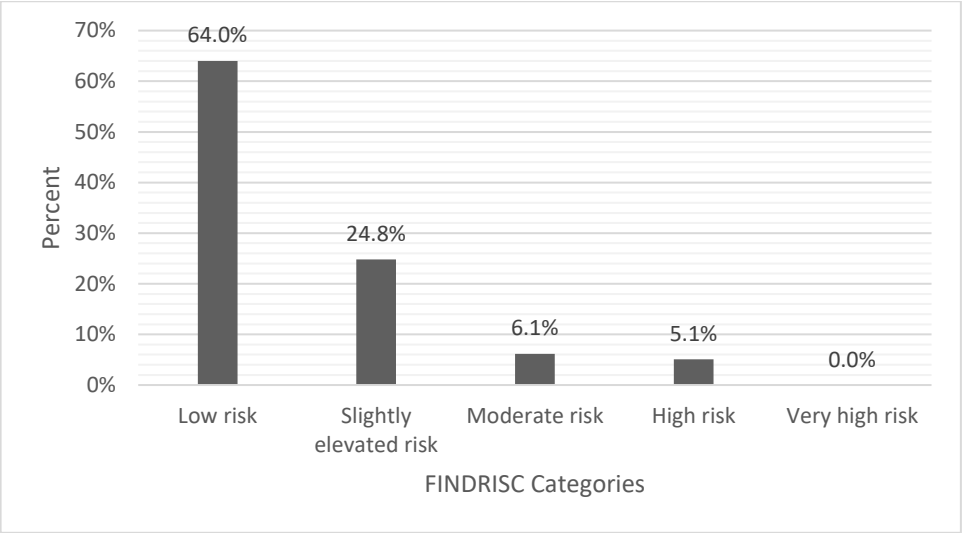

***Figure 3**: Distribution of participants as per FINDRISC classification categories.*

4.5. Univariate analysis by sex and risk of diabetes

This section provides an overview of the results of the univariate analysis carried out to investigate the relationship between the different variables. For each variable, the analysis assessed for any statistical differences according to the sex and their risk of diabetes.

When analysing categorical data, Pearson's chi-squared test or Fisher's exact test was used, depending on the size of the sample in each category. Non-parametric tests were mostly used for analysis of a continuous variable against categorical data where distribution of the continuous variable was skewed. The parametric equivalent was used where there was a Gaussian distribution of the continuous dataset. In cases where there was a maximum of two categories for the categorical data set, the Mann-Whitney test was used, whereas the Kruskal-Wallis H test was used where there were three or more categories. For continuous variables, the Spearman's Rank correlation coefficient test was used.

4.5.1. Demographic and educational characteristics

Table 9 summarises the results of the univariate analyses for the demographic and education variables by sex. Most participants were 18- to 20-year-olds, Maltese, resided in the Northern Harbour area, attended the University, and in their first year of study.

There were proportionally more females than males in all categories except in participants residing in the Southern Harbour area, Third Country Nationals, and participants who were in their 4th year of study; however, none of the results were statistically significant. Analysis of the distribution of participants between MCAST and the University of Malta showed statistically significant differences with male participants more likely to be studying at MCAST while female students more likely to be studying at the University ($p=0.007$) (Table 9).

***Table 9**: Demographic and education-related characteristics of the participants.*

Variable	Gender				% from total	p-value
	Males		Females			
	N	column %	n	column %		
Age Categories (n=375)						0.965*
18 - 20 years	68	41.3%	83	39.6%	40.3%	
21 - 23 years	40	24.3%	50	23.7%	24.0%	
24 - 29 years	23	14.0%	33	15.8%	15.0%	
30 years +	34	20.5%	44	20.9%	20.7%	
Nationality (n=375)						0.119*
Maltese	140	84.8%	175	83.4%	84.0%	
European	13	7.7%	27	12.7%	10.5%	
Third Country Nationals	12	7.5%	8	3.9%	5.5%	
Region of Residence (n=374)						0.413*
Southern Harbour	40	24.2%	34	16.4%	19.8%	
Northern Harbour	35	21.2%	58	27.8%	24.9%	
South Eastern	29	17.5%	36	17.0%	17.2%	
Western	25	15.3%	36	17.2%	16.4%	
Northern	23	13.8%	31	14.8%	14.4%	
Gozo and Comino	13	8.0%	14	6.7%	7.3%	
Place of study (n=375)						**0.007***
University of Malta	109	66.2%	165	78.5%	73.1%	
MCAST	56	33.8%	45	21.5%	26.9%	
Year of study (n=362)						0.324†
1st year	72	45.6%	97	47.6%	46.7%	
2nd year	52	33.1%	60	29.5%	31.1%	
3rd year	21	13.2%	32	15.8%	14.7%	
4th year	13	8.1%	11	5.3%	6.5%	
5th year	0	0.0%	4	1.7%	1.0%	
Final Year? (n=375)						0.638*
No	123	74.5%	152	72.5%	73.4%	
Yes	42	25.5%	58	27.5%	26.6%	

*Pearson's chi-squared test; †Fisher's exact test.

Analysis of the demographic characteristics with risk of diabetes indicated a strong positive correlation with age (p<0.001) (Figure 4) and nationality (p=<0.001), with a higher mean FINDRISC score for Maltese students compared to European and Third Country Nationals. No association was found for the sex and region of residence (Table 10).

The results of the analyses between the risk of diabetes and the place of study, year of course and final year did not show any significant association, indicating similar distribution of participants between the two institutions and educational level attainment with regards to diabetes risk. As can be observed in Table 10, the mean FINDRISC score of MCAST was slightly higher than that for University students (6.43 for MCAST versus 5.45 for the University), however the difference was not significant.

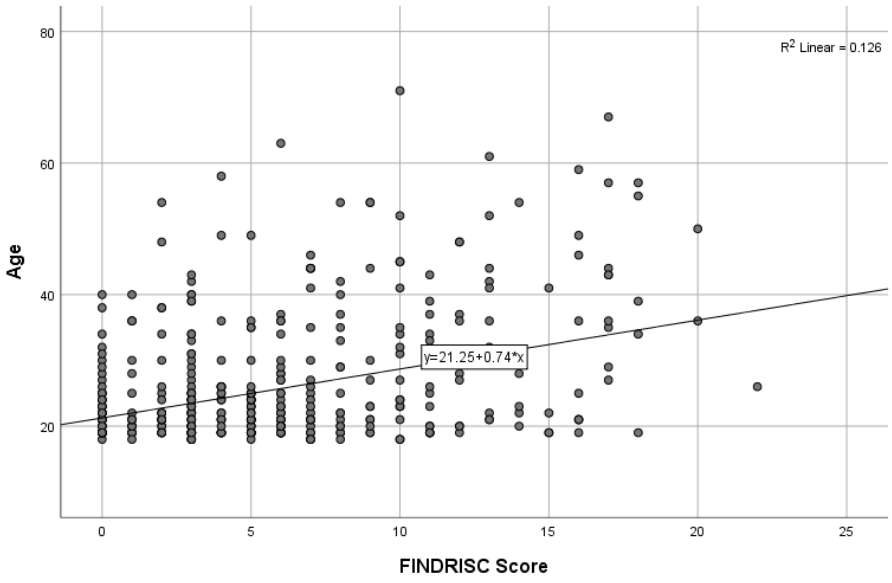

***Figure 4**: The relationship between FINDRISC score results and age.*

***Table 10**: Association between FINDRISC score results and demographic characteristics.*

Variable	n	Mean FINDRISC Score	95% Confidence Interval		p-value
			Lower bound	Upper bound	
Age (n=375)					**<0.001**[**]
Sex (n=375)					0.123[†]
Male	165	5.25	4.59	5.91	
Female	210	6.08	5.44	6.71	
Region of Residence (n=375)					0.098[§]
Southern Harbour	74	5.66	4.79	6.53	
Northern Harbour	93	5.34	4.47	6.22	
South Eastern	65	5.87	4.76	6.98	
Western	61	7.23	5.87	8.59	
Northern	54	4.76	3.49	6.02	
Gozo and Comino	27	5.25	3.46	7.05	
Nationality (n=375)					**<0.001**[§]
Maltese	315	6.08	5.57	6.59	
European	40	3.70	2.54	4.86	
Third Country National	21	4.01	2.60	5.41	
Place of study (n=375)					0.21[†]
University of Malta	274	5.45	4.94	5.97	
MCAST	101	6.43	5.46	7.40	
Year of study (n=362)					0.10[§]
1st year	170	5.84	5.13	6.55	
2nd year	113	5.74	4.97	6.51	
3rd year	53	5.88	4.64	7.13	
4th year	24	3.46	1.76	5.16	
5th year	4	5.45	-8.23	19.12	
Final year? (n=375)					0.32[†]
No	275	5.65	5.11	6.18	
Yes	100	5.90	5.01	6.80	

[**] Spearman's Rank correlation coefficient test; [†] Mann-Whitney test; [§] Kruskal-Wallis H test

4.5.2. Socio-economic characteristics

The socioeconomic characteristics of the participants were measured using the level of educational attainment of the parents or guardian, the monthly income of the main breadwinner of the household, the participant's living arrangements, and their employment status.

The majority of the participants' parents attended up to the secondary level of education, with only around a third completing tertiary education or higher. More than 60% of participants reported household monthly earnings of between €996 and €2,307, and around 70% reported living with their family which included parents or grandparents, with or without siblings. Around half of all participants were not employed (Table 11).

Assessment of the participants' characteristics by sex did not result in any statistically significant differences for the mother's level of educational attainment, the living arrangements and employment status, while significant differences were found for the level of educational attainment of the father ($p=0.028$) and legal guardian ($p=0.032$), and the monthly income of the main breadwinner of the household ($p=0.020$) (Table 11).

The results showed that there were more male students whose father attended up to a secondary level of education, whereas a higher proportion of female participants reported that their father had up to sixth form or vocational training. A higher educational attainment of the guardian was similarly reported for female students. There was a significantly higher proportion of male students living in households with a monthly income of more than €3,300, with 18.9% of male students compared to 8.4% of female students falling in this category (Table 11).

***Table 11**: Socio-economic characteristics of the participants by sex.*

Variable	Gender				% from total	p-value
	Males		Females			
	n	column %	n	column %		
Mother's level of education (n=362)						0.097*
Until secondary education	93	58.3%	95	47.0%	52.0%	
Until Sixth Form / Vocational Training	29	18.1%	42	20.8%	19.6%	
Tertiary education or higher	38	23.6%	65	32.2%	28.4%	
Father's level of education (n=346)						**0.028***
Until secondary education	75	49.0%	75	39.1%	43.5%	
Until Sixth Form / Vocational Training	22	14.2%	49	25.7%	20.6%	
Tertiary education or higher	57	36.9%	68	35.2%	35.9%	
Legal guardian's level of education (n=40)						**0.032†**
Until secondary education	12	71.9%	8	35.2%	51.0%	
Until Sixth Form / Vocational Training	0	0.0%	6	27.1%	15.5%	
Tertiary education or higher	5	28.1%	9	37.7%	33.6%	
Monthly Income of the main breadwinner in the household (n=292)						**0.02***
Below €996	5	4.1%	18	11.1%	7.9%	
Between €996 and €1565	46	34.2%	56	35.3%	34.8%	
Between €1,566 and €2,307	42	31.8%	53	33.4%	32.6%	
Between €2,308 and €3,300	15	11.1%	19	11.7%	11.4%	
Above €3,300	25	18.9%	13	8.4%	13.2%	
Living arrangements (n=376)						0.13†
Live with family (parents or grandparents, and / or siblings)	122	73.9%	144	68.4%	70.8%	
Live with partner and / or children	26	15.7%	38	18.0%	17.0%	
Live with friends or roommates	5	3.2%	14	6.5%	5.0%	
Live alone	9	5.2%	15	6.9%	6.2%	
Other	3	1.9%	0	0.2%	1.0%	
Employment status (n=375)						0.68*
Not employed	82	49.7%	97	46.1%	47.7%	
Employed part-time	48	28.8%	70	33.5%	31.4%	
Employed full-time	35	21.4%	43	20.5%	20.9%	

*Pearson's chi-squared test; †Fisher's exact test.

Assessment of the mean FINDRISC score against socio-economic variables indicated statistically higher mean FINDRISC score in the case of the educational attainment of the mother, the household income, living arrangement, and the employment status.

Students whose mother completed only until secondary level of education, those whose monthly household income was below €996, those who lived with a partner with or without children, and those who were employed on a full-time basis had significantly higher mean FINDRISC scores, especially when compared with students whose mother completed tertiary education or higher, those with a monthly household income exceeding €3,300, those living with friends or roommates, and those who were not employed (Table 12).

***Table 12**: Association between FINDRISC scores and socioeconomic characteristics.*

Variable	n	Mean FINDRISC Score	95% Confidence Interval		p-value
			Lower bound	Upper bound	
Mother's level of education (n=362)					**<0.001[§]**
Until secondary education	188	6.70	6.01	7.39	
Until Sixth Form / Vocational Training	71	5.54	4.66	6.42	
Tertiary education or higher	103	4.01	3.24	4.77	
Father's level of education (n=347)					0.055[§]
Until secondary education	151	6.48	5.73	7.23	
Until Sixth Form / Vocational Training	71	5.76	4.58	6.94	
Tertiary education or higher	125	5.12	4.40	5.85	
Legal guardian's level of education (n=40)					0.23[§]
Until secondary education	20	3.01	1.07	4.96	
Until Sixth Form / Vocational Training	6	4.56	-1.31	10.42	
Tertiary education or higher	13	5.52	2.73	8.30	
Monthly Income of the main breadwinner in the household (n=293)					**0.002[§]**
Below €996	23	7.44	5.52	9.35	
Between €996 and €1565	102	5.48	4.64	6.32	
Between €1,566 and €2,307	96	6.19	5.30	7.09	
Between €2,308 and €3,300	34	4.75	3.20	6.30	
Above €3,300	39	4.16	2.69	5.63	
Living arrangements (n=375)					**<0.001[§]**
Live with family (parents or grandparents, and / or siblings)	266	5.21	4.70	5.72	
Live with partner and / or children	64	8.24	6.97	9.51	
Live with friends or roommates	19	4.50	2.54	6.46	
Live alone	23	5.69	3.75	7.64	
Other	4	4.54	-2.15	11.24	
Employment status (n=375)					**0.002[§]**
Not employed	179	5.16	4.53	5.79	
Employed part-time	118	5.12	4.35	5.88	
Employed full-time	78	7.87	6.78	8.96	

[§] Kruskal-Wallis H test

4.5.3. General health characteristics

The general health status of the participants was measured by asking about longstanding illness or health problem, any regular medication and the number of medications prescribed, measurement of the level of anxiety, and by self-report of the weight, height, and waist circumference measurements. The self-reported body measurements were used to calculate the BMI and the waist-to-height ratio. Analysis for the weight measurements and the level of anxiety was carried out using continuous data to improve the sensitivity of the results, whereas categorical data was used for the other variables.

Around 20% of all participants reported a history of longstanding illness or health problem and a quarter reported taking daily regular medications. Assessment of the BMI and the waist-to-height ratio categories found that around 50 to 60% of participants could be classified into the healthy weight category while a third of participants can be classified as overweight or obese (Figure 5, Figure 6). Around a fifth of participants had severe anxiety, whereas only around a third were classified as having no or very minimal anxiety levels (Figure 7).

Review of the differences between the two sexes showed significant differences for the presence of longstanding illness or health problems, daily regular medication intake (Table 13), the waist-to-height ratio measurements, and the levels of anxiety using the GAD-7 score classification, while no significant differences were found between the two sexes for the BMI measurement classifications (Table 14).

Female students were significantly more likely to report a history of longstanding illness and taking up to two different medications daily when compared to males (Table 13). Males had a slightly higher mean BMI score, which however was not significantly different

than for females. On the other hand, the mean waist-to-height score for male students was significantly higher than that of female students. Significant gender differences were observed for the level of anxiety, with females having a higher mean GAD-7 score than males. Comparatively, more males reported no or minimal levels of anxiety, whereas the number of females in mild, moderate, and severe anxiety were higher (Figure 7).

***Table 13**: General health characteristics of the participants according to sex (1).*

Variable	Gender				% from total	p-value
	Males		Females			
	n	column %	n	column %		
Any longstanding illness or health problem? (n=375)						**<0.001†**
No	144	87.6%	151	72.0%	78.8%	
Yes	21	12.4%	50	23.6%	18.7%	
Prefer not to say	0	0.0%	9	4.4%	2.5%	
Do you take any regular medication? (n=375)						**0.001†**
No	136	82.1%	138	65.9%	73.0%	
Yes: 1-2 different medications daily	21	12.7%	61	28.9%	21.8%	
Yes: 3 or more different medications daily	7	4.5%	9	4.2%	4.3%	
Prefer not to say	1	0.7%	2	1.0%	0.9%	

†Fisher's exact test.

***Table 14**: General health characteristics of the participants according to sex (2).*

Variable	n	Mean score	95% Confidence Interval		p-value
			Lower bound	Upper bound	
BMI					0.059¶
Males	165	24.70	23.97	25.43	
Females	208	24.15	23.33	24.96	
Waist-to-height ratio					**0.001¶**
Males	165	0.49	0.48	0.50	
Females	208	0.47	0.46	0.48	
GAD-7 Score					**0.008¶**
Males	165	7.70	6.67	8.72	
Females	210	9.03	8.21	9.85	

¶ Mann-Whitney test

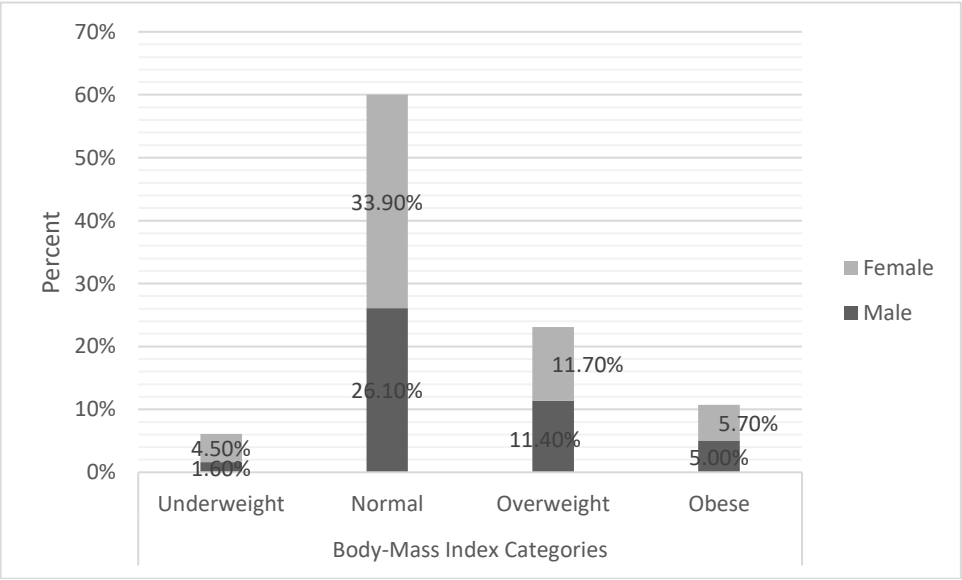

***Figure 5**: Distribution of participants into the different body-mass index categories (WHO classification system) by sex.*

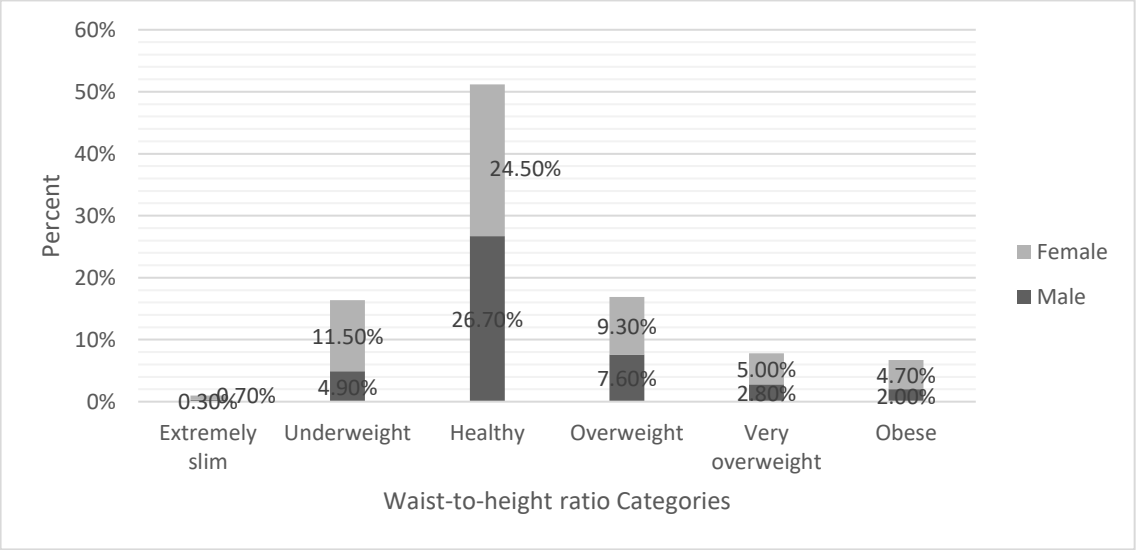

***Figure 6**: Distribution of participants into the different waist-to-height ratio categories by sex.*

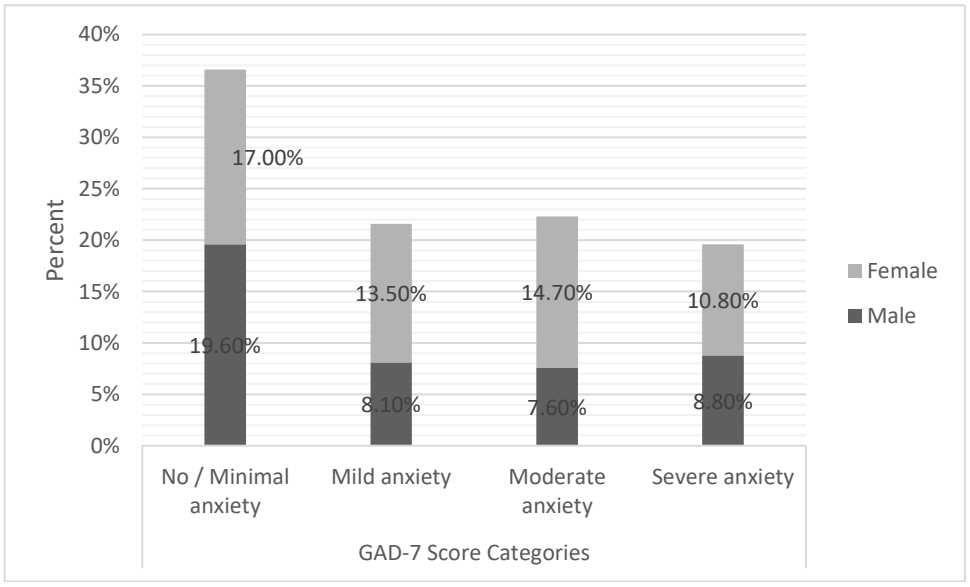

***Figure 7**: Classification of respondents according to level of anxiety as per GAD-7 score by sex.*

Assessment of the general health characteristics of students according to their risk of diabetes indicated statistically significant results for all factors (Table 15).

The presence of chronic disease and history of daily medication use were significantly associated with higher mean FINDRISC scores. In both cases, students who chose the option "Prefer not to answer" had an even higher mean FINDRISC score than those who replied in the affirmative. Correlation tests between the FINDRISC scores and the BMI, waist-to-height ratios, and the GAD-7 score all showed significant positive association with the FINDRISC scores (Table 15). Figure 8, Figure 9, and Figure 10 show the strong correlation between the risk of diabetes and these factors, with an increase in one of the scores being associated with an increase in the other score.

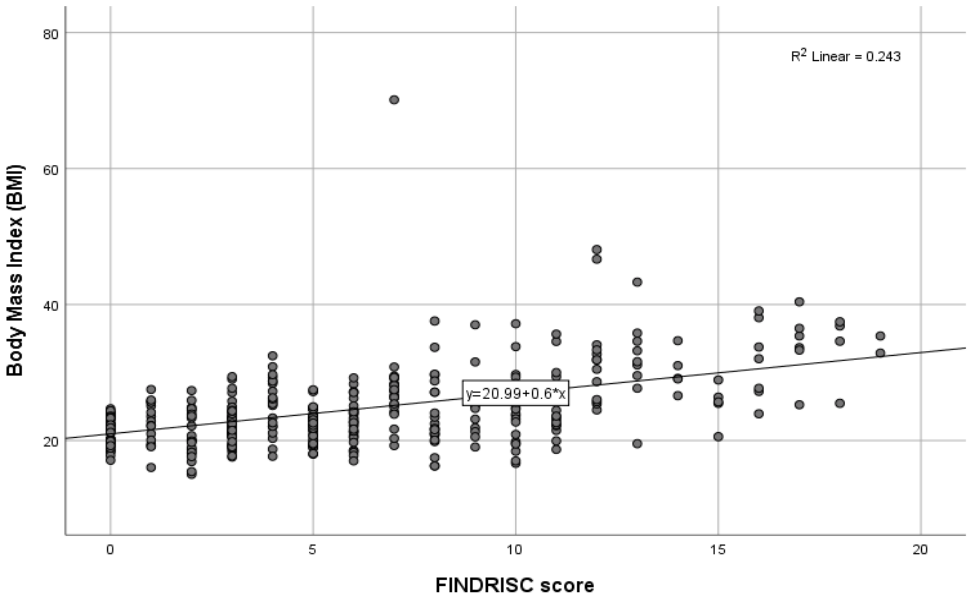

***Figure 8**: The relationship between FINDRISC scores and the BMI.*

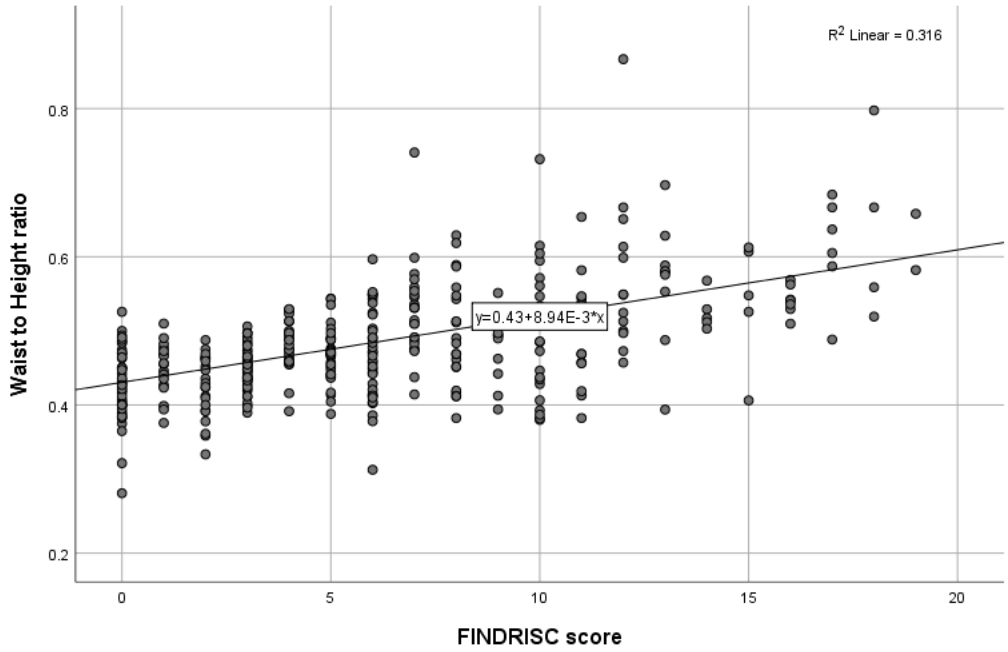

***Figure 9**: The relationship between FINDRISC scores and the waist-to-height ratio results.*

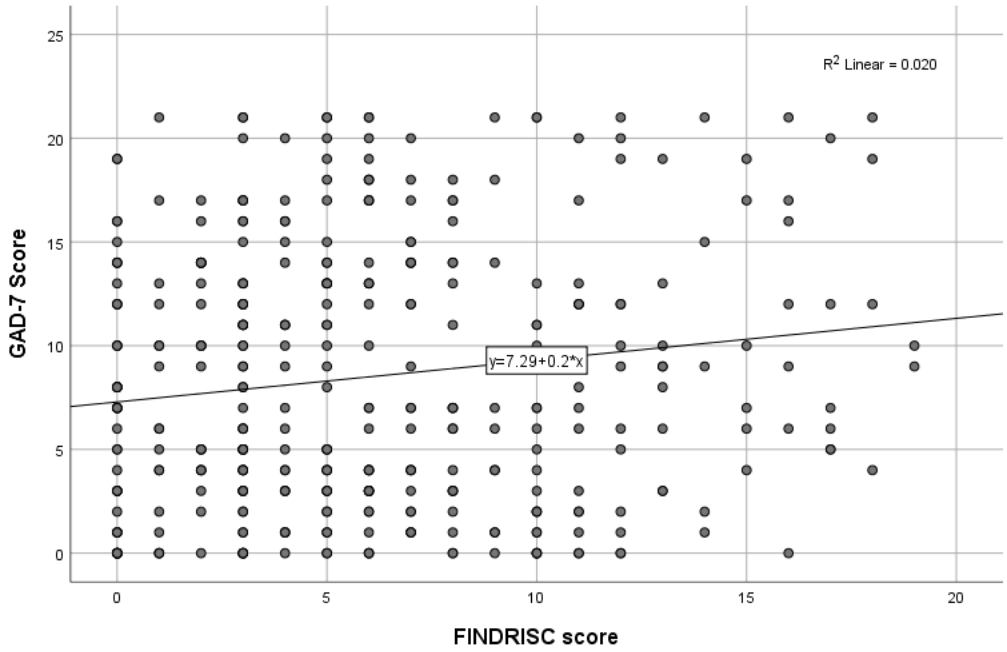

***Figure 10**: The relationship between FINDRISC score and the Generalised Anxiety Disorder (GAD-7) score results.*

***Table 15**: Association between FINDRISC scores and general health factors.*

Variable	n	Mean FINDRISC Score	95% Confidence Interval		p-value
			Lower bound	Upper bound	
Any longstanding illness or health problem? (n=375)					**0.001§**
No	296	5.27	4.78	5.76	
Yes	70	7.19	5.97	8.41	
Prefer not to say	9	8.73	6.05	11.41	
Do you take any regular medication? (n=375)					**<0.001§**
No	274	5.13	4.62	5.64	
Yes: 1-2 different medications daily	82	7.20	6.17	8.22	
Yes: 3 or more different medications daily	16	7.65	4.75	10.54	
Prefer not to say	3	8.03	1.23	14.83	
BMI Classification (n=374)					**<0.001****
Waist-to-height ratio classification (n=372)					**<0.001****
Level of anxiety (GAD-7 score categories) (n=375)					**0.018****

** Spearman's Rank correlation coefficient test; § Kruskal-Wallis H test

4.5.4. Behavioural factors

Behavioural risk factors for diabetes were assessed by asking about the smoking and alcohol consumption patterns, the level of physical activity, and the adherence to the Mediterranean diet. Table 16 and Table 17 compare the differences between male and female respondents. The results indicated that around 70% of students did not smoke, whereas around 8% were regular smokers. A higher proportion of female students indicated that they smoked occasionally or regularly compared to males, however the results were not statistically significant. On the other hand, significant differences were observed for the alcohol drinking patterns, with 30% of females reporting concerning

drinking behaviours compared to 20% of males (Table 16). No statistical differences between the genders were however observed when the mean AUDIT-C score was compared, although males had a slightly higher mean score than females (Table 17). Around 44% of respondents reported a moderate level of exercise, whereas 30% carried out low levels of physical activity. There were no gender differences, however males tended to carry out more high level of exercise compared to female students. Assessment of the adherence to the Mediterranean diet indicated that more than half of participants were classified as medium adherers, with only 2.7% being high adherers. Females were significantly more likely to consume a Mediterranean diet than males (p=0.017), as a comparably higher proportion of female students were medium adherers to the Mediterranean diet than male students, while the number of low and high adherers were approximately equal between both sexes (Table 16). Assessment of the Mediterranean diet score distribution between male and female students indicated a normal distribution, with a higher peak for females when compared to males (Figure 11), and a higher mean score for females (7.63) compared to males (6.95) when comparing the mean score by sex (Table 17).

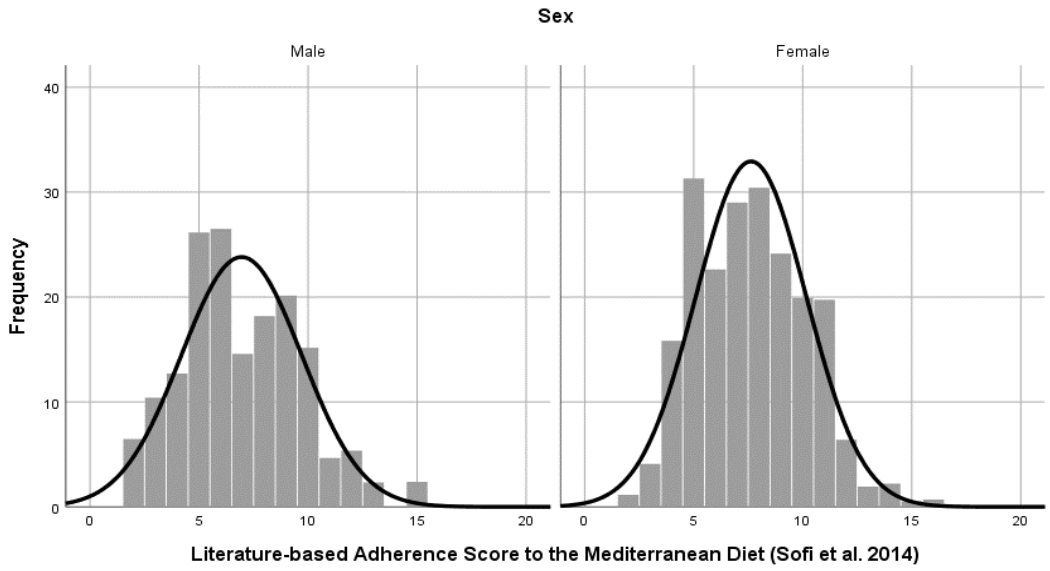

Figure 11: *Distribution of the Adherence Score to the Mediterranean diet by sex.*

***Table 16**: Behavioural factors related to risk of diabetes by sex of participants (1).*

Variable	Gender				% from total	p-value
	Males		Females			
	n	column %	n	column %		
Smoking status (n=375)						0.166*
Non-smoker	124	75.2%	140	66.8%	70.5%	
Ex-smoker	16	9.8%	19	9.1%	9.4%	
Occasional smoker	14	8.3%	32	15.2%	12.2%	
Regular smoker	11	6.8%	19	8.9%	7.9%	
Alcohol consumption (AUDIT-C categories) (n=375)						**<0.001***
No concern	132	80.1%	131	62.4%	70.2%	
Concern	33	19.9%	79	37.6%	29.8%	
Level of physical activity (IPAQ-SF categories) (n=372)						0.224*
Low	47	29.1%	66	31.4%	30.4%	
Moderate	66	40.9%	97	46.3%	43.9%	
High	49	30.0%	47	22.3%	25.7%	
Adherence to Mediterranean diet (n=375)						**0.018***
Low Adherers	82	49.8%	75	35.7%	41.9%	
Medium Adherers	78	47.3%	130	61.7%	55.4%	
High Adherers	5	2.9%	5	2.6%	2.7%	

*Pearson's chi-squared test

***Table 17**: Behavioural factors related to risk of diabetes by sex of participants (2).*

Variable	N	Mean score	95% Confidence Interval		p-value
			Lower bound	Upper bound	
Alcohol consumption (AUDIT-C score) (n=375)					0.95¶
Males	165	2.23	1.97	2.48	
Females	210	2.16	1.95	2.38	
Adherence to Mediterranean diet score (n=375)					**0.014††**
Males	165	6.95	6.52	7.37	
Females	210	7.63	7.28	7.98	

¶ Mann-Whitney test; ††Independent Samples t-test

The mean FINDRISC score was analysed against the behavioural factors to assess for relation with the risk of diabetes. The results are shown in Table 18.

Students who smoked regularly had a higher mean FINDRISC score than students who were non-smokers, ex-smokers, or who smoked occasionally, however the differences were not statistically significant. The alcohol consumption patterns were similarly not significant, with students drinking concerning amounts of alcohol having a similar mean FINDRISC score to those with no concerning drinking patterns. Similarly, no correlation was observed when the AUDIT-C score was analysed against the FINDRISC score (Table 18). On the other hand, the level of physical activity and the eating habits were significantly associated with the risk of diabetes. Students having low levels of physical activity had a higher mean FINDRISC score than students with higher levels of exercise, while higher adherence to the Mediterranean diet was significantly associated with a lower FINDRISC score, indicating a lower risk for developing diabetes (Table 18, Figure 12).

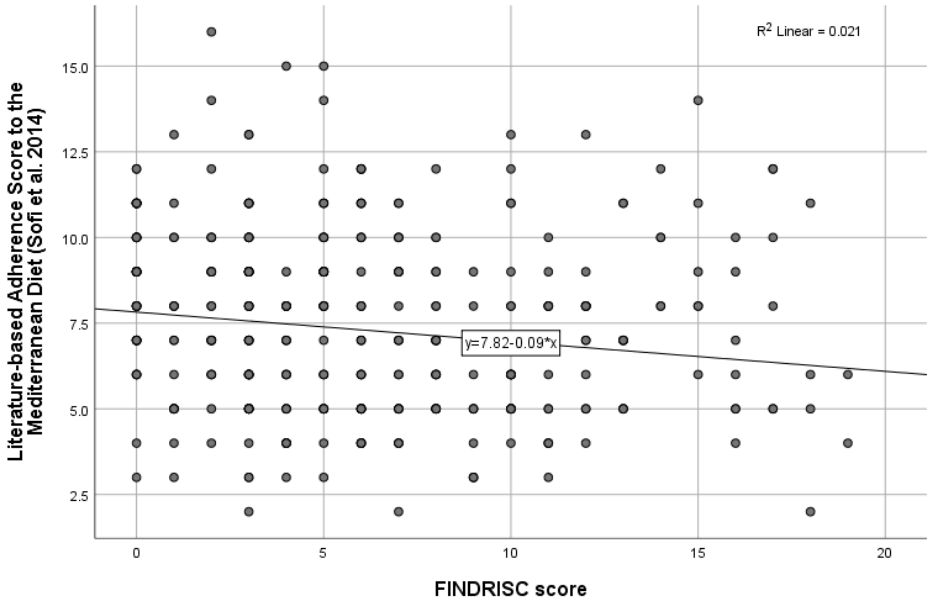

***Figure 12**: The relationship between FINDRISC score and the Literature-based Adherence score to the Mediterranean diet.*

***Table 18**: Association between FINDRISC score results and behavioural characteristics.*

Variable	n	Mean FINDRISC Score	95% Confidence Interval		p-value
			Lower bound	Upper bound	
Smoking status (n=373)					0.38§
Non-smoker	264	5.70	5.14	6.25	
Ex-smoker	35	5.36	3.71	7.01	
Occasional smoker	46	5.40	4.23	6.58	
Regular smoker	30	6.78	5.16	8.41	
Alcohol consumption (AUDIT-C categories) (n=375)					0.63†
No concern	263	5.79	5.23	6.35	
Concern	112	5.54	4.75	6.34	
Alcohol consumption (AUDIT-C score) (n=375)					0.501*
Level of physical activity (IPAQ-SF categories) (n=371)					**<0.001§**
Low	113	7.38	6.53	8.22	
Moderate	163	5.66	5.01	6.31	
High	95	3.98	3.12	4.84	
Adherence to Mediterranean diet (n=375)					**0.001***

* Spearman's Rank correlation coefficient test; † Mann-Whitney test; § Kruskal-Wallis H test

4.5.5. Genetic and environmental factors

Genetic factors were assessed by considering the first- and second-degree family history of diabetes, whereas the presence of anyone overweight or obese living in the same household was used as a proxy for environmental factors that could increase the diabetes risk. The latter was used as it is expected that persons living in the same household are exposed to similar environmental risks that affect health, irrespective of the genetic predisposition (WHO Regional Office for Europe, 2009). In the case of type 2 diabetes, factors such as ambient air pollution, the walkability of the living environment, the type

and amount of food available, and proximity to roadways (Dendup et al., 2018) were found to up the risk, particularly in those with a genetic predisposition.

As can be observed in Table 19, around 16% of students reported a first-degree family history of diabetes, while approximately 50% reported a second-degree link. There were no significant differences between the two sexes in both cases. Similarly, around 50% of students reported living with someone who was overweight or obese, with no significant difference observed between male and female students.

***Table 19**: Genetic and environmental factors related to risk of diabetes by sex of participants.*

Variable	Gender				% from total	p-value
	Males		Females			
	N	column %	n	column %		
1st degree family history of diabetes (n=375)						0.054*
No	145	87.7%	169	80.4%	83.6%	
Yes	20	12.3%	41	19.6%	16.4%	
2nd degree family history of diabetes (n=375)						0.085*
No	91	55.3%	97	46.0%	50.1%	
Yes	74	44.7%	113	54.0%	49.9%	
Anyone in same residence overweight or obese? (n=374)						0.098†
No	80	48.2%	116	55.4%	52.2%	
Yes	85	51.8%	90	42.9%	46.8%	
Prefer not to say	0	0.0%	3	1.7%	0.9%	

*Pearson's chi-squared test; †Fisher's exact test.

Analysis of the mean FINDRISC score with these factors showed a significant association in all cases. Students with a first-degree family history of diabetes had a mean FINDRISC score of 11.92, which was comparatively higher than the mean score of 8.20 for those with a second-degree family history of diabetes. Students reporting living with someone

who was overweight or obese and those who chose the option “Prefer not to answer” were found to have a significantly higher mean FINDRISC scores than those not living with anyone with increased weight (Table 20).

***Table 20**: Association between FINDRISC score results and genetic and environmental characteristics.*

Variable	n	Mean FINDRISC Score	95% Confidence Interval		p-value
			Lower bound	Upper bound	
1st degree family history of diabetes (n=375)					**<0.001†**
No	313	4.50	4.10	4.89	
Yes	62	11.92	10.95	12.89	
2nd degree family history of diabetes (n=375)					**<0.001†**
No	188	3.24	2.78	3.70	
Yes	187	8.20	7.59	8.81	
Anyone in same residence overweight or obese? (n=375)					**<0.001§**
No	196	4.91	4.30	5.52	
Yes	176	6.60	5.92	7.28	
Prefer not to say	3	6.59	-3.09	16.28	

† Mann-Whitney test; § Kruskal-Wallis H test

4.5.6. Summary of the univariate analysis by sex and FINDRISC score

Analysis of the findings to assess for differences between male and female students showed significant differences in the place of study, the level of educational attainment of the father and guardian, the monthly income of the main breadwinner of the household, the presence of longstanding illness and number of daily medications, the

waist-to-height ratio, levels of anxiety, alcohol consumption, and adherence to the Mediterranean diet.

Female students were more likely to attend the University of Malta, have a father with a sixth form or vocational education and a guardian with a sixth form or higher education, a monthly income of the main household breadwinner of less than €996, have a history of longstanding illness or health problem, take up to 2 medications daily on a regular basis, have excessive or less than ideal weight, increased level of mild or moderate anxiety, drinking concerning amounts of alcohol, and be medium adherers to the Mediterranean diet. On the other hand, male students were more likely to attend MCAST, more likely to have a father or guardian with a secondary level of education, a monthly income of higher than €3,300 for the main breadwinner of the household, have a healthy weight, and to report either no or else severe symptoms of anxiety.

The results of the analyses investigating the mean FINDRISC scores with different variables showed a significantly higher score in older students, those of Maltese nationality, students whose mother had a lower educational level, those living in households with low monthly earnings, students living with partners and with or without children, and those in full-time employment. Similarly, students with a chronic disease and those taking regular medication, students with higher BMI and waist-to-height ratios, higher anxiety levels, low levels of physical activity, low adherence to the Mediterranean diet, students with a family history of type 2 diabetes and students living with someone with a higher than ideal weight had a higher diabetes risk.

The protective factors associated with diabetes were younger age, a non-Maltese nationality, higher educational levels of the mother, higher household income, living with

roommates or friends, unemployment, the absence of chronic disease or regular medication intake, lower BMI and waist-to-height ratios, low levels of anxiety, high levels of physical activity and adherence to the Mediterranean diet, having no family history of diabetes and living in a household without other overweight or obese individuals.

4.6. Regression analysis

Following analysis of the different variables against the FINDRISC score, regression analysis was carried out to remove the confounding variables. A generalized linear model was used for this function as the data consisted of both continuous and categorical datasets with the dependent variable having a right skewed distribution.

Categorical and continuous variables having a statistically significant association with the FINDRISC score results were inputted manually into the model sequentially, starting with two variables having the smallest p-value and adding a new variable during each run. Variables that remained significant were kept into the model whereas those that lost significance were removed. This process was repeated until all the statistically significant variables were inputted into the model.

The final model included the age, BMI ratio, waist-to-height ratio, the first- and second-degree family history of diabetes, the living arrangement, the IPAQ-SF categories, the literature-based adherence score to the Mediterranean diet, and the GAD-7 score.

As can be observed from Table 21, the mean FINDRISC score increased by 0.068 for every unit of age, by 0.114 for every unit of the BMI, by 19.542 for every unit of the waist-to-height ratio, and by 0.054 for every unit of the GAD-7 score. On the other hand, it

decreased by 0.12 for every unit of the Adherence to the Mediterranean diet score. In the case of the family history of diabetes, the mean FINDRISC score increased by 5.104 for those with a first-degree history and by 3.325 for those with a second-degree family history when compared to the reference category. The results of the living arrangements showed a maximum increase in the mean FINDRISC score by 3.960 for those living with their friends or roommates versus by 2.082 for those living alone, whereas those carrying out low levels of physical activity had an increase in the FINDRISC score of 1.03 and 0.294 for those carrying out moderate levels of activity.

Figures 13 - 16 depict the mean FINDRISC scores with the 95% Confidence Intervals for each category of each categorical data variable as corrected for the other variables.

***Table 21**: Output of the Generalized Linear Model results.*

Variable	B	95% Wald Confidence Interval		p-value
		Lower	Upper	
Age (years)	0.068	0.036	0.1	<0.001
Body Mass Index (kg/m^2)	0.114	0.056	0.171	<0.001
Waist to Height ratio	19.542	15.211	23.873	<0.001
First degree FH of diabetes				
Yes	5.104	4.523	5.685	<0.001
No	REF			
Second degree FH of diabetes				
Yes	3.325	2.893	3.756	<0.001
No	REF			
Living Arrangements				0.007
Live with family (parents or grandparents, and / or siblings)	2.752	0.371	5.133	0.024
Live with partner and / or children	2.799	0.386	5.212	0.023
Live with friends or roommates	3.960	1.416	6.503	0.002
Live alone	2.082	-0.395	4.559	0.099
Other	REF			

IPAQ-SF Categories				0.001
Low	1.03	0.456	1.603	<0.001
Medium	0.294	-0.226	0.814	0.267
High	REF			
Literature-based Adherence Score to the Mediterranean Diet (Sofi et al. 2014)	-0.12	-0.2	-0.039	0.003
GAD-7 Score	0.054	0.02	0.089	0.002

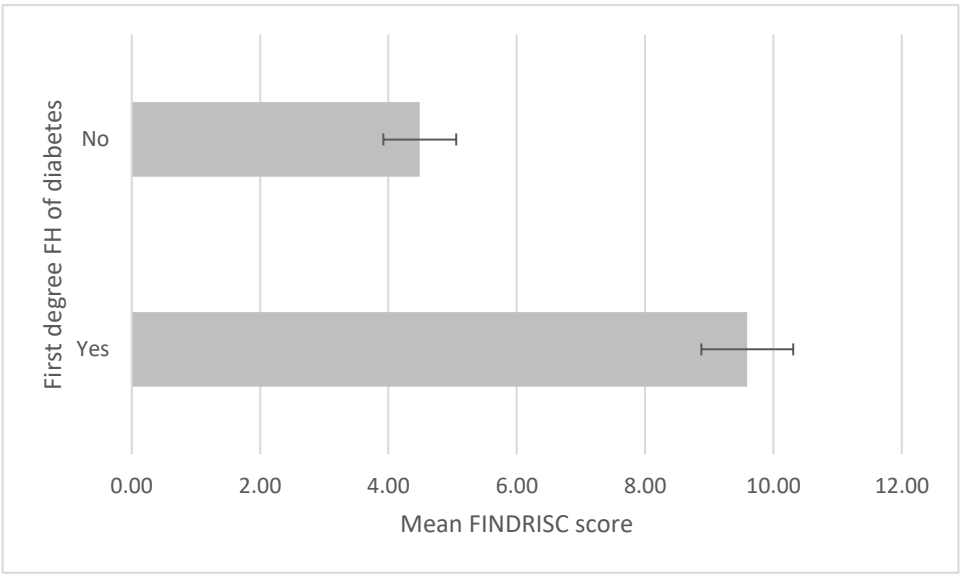

***Figure 13**: Adjusted mean FINDRISC score for the 1st degree family history. Reference category "No".*

Covariates appearing in the model are fixed at the following values: Age=25.74; Body Mass Index (BMI)=24.3356772; Waist to Height ratio=.479532984332572; Literature-based Adherence Score to the Mediterranean Diet (Sofi et al. 2014)=7.40; GAD-7 Score=8.60

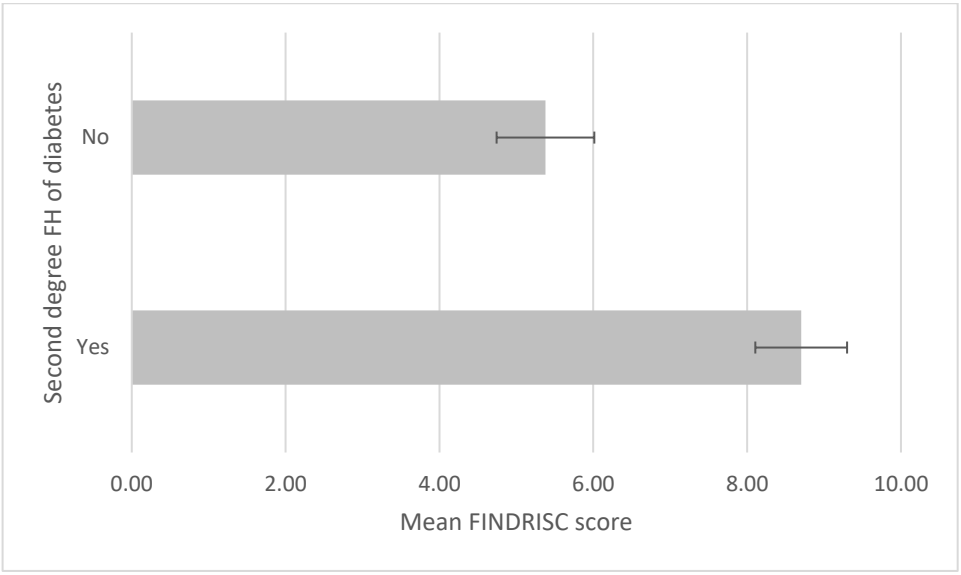

***Figure 14**: Adjusted mean FINDRISC score for the 2nd degree family history. Reference category "No".*

Covariates appearing in the model are fixed at the following values: Age=25.74; Body Mass Index (BMI)=24.3356772; Waist to Height ratio=.479532984332572; Literature-based Adherence Score to the Mediterranean Diet (Sofi et al. 2014)=7.40; GAD-7 Score=8.60

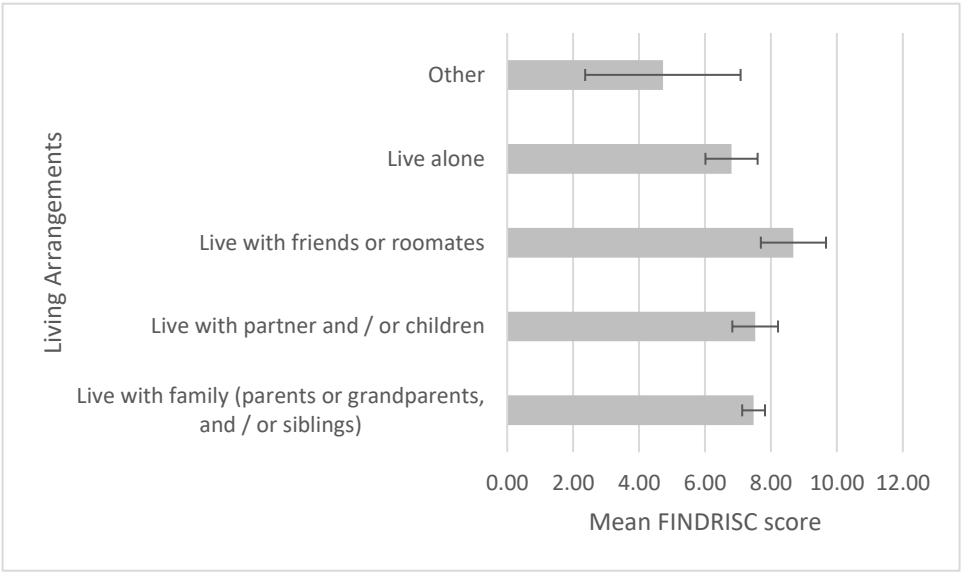

***Figure 15**: Adjusted mean FINDRISC score for the living arrangements. Reference category "Others".*

Covariates appearing in the model are fixed at the following values: Age=25.74; Body Mass Index (BMI)=24.3356772; Waist to Height ratio=.479532984332572; Literature-based Adherence Score to the Mediterranean Diet (Sofi et al. 2014)=7.40; GAD-7 Score=8.60

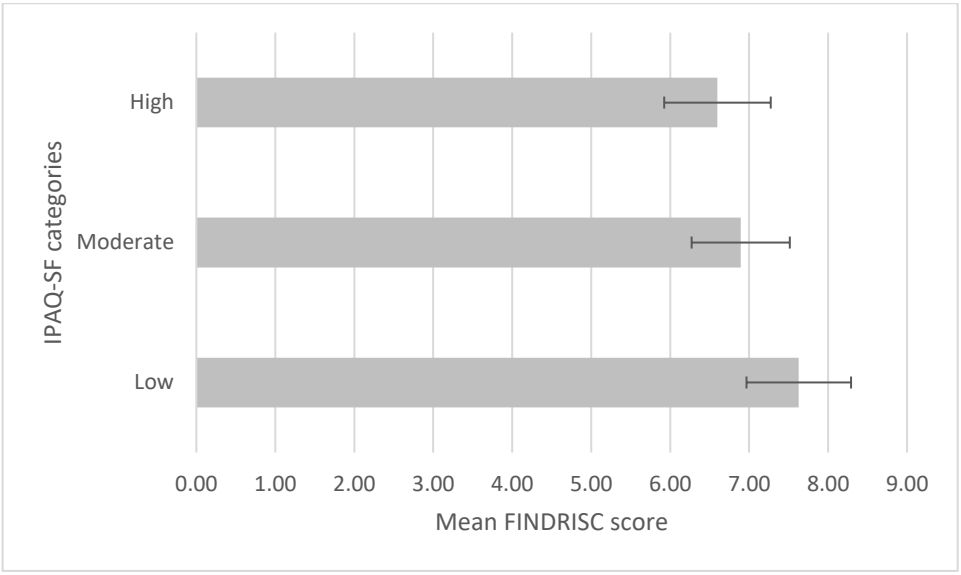

***Figure 16**: Adjusted mean FINDRISC score for the IPAQ-SF categories. Reference category "High".*

Covariates appearing in the model are fixed at the following values: Age=25.74; Body Mass Index (BMI)=24.3356772; Waist to Height ratio=.479532984332572; Literature-based Adherence Score to the Mediterranean Diet (Sofi et al. 2014)=7.40; GAD-7 Score=8.60

4.7. Conclusions of the results obtained

The following is a summary of the results of this study:

- Most students have a low risk for type 2 diabetes; however, 6.1% were found to have a moderate risk, and 5.1% had a high risk of diabetes according to the FINDRISC score categories.

- Most respondents were female and students in their first year of study.

- Demographic and socio-economic factors that were found to be linked to the risk of diabetes by univariate analysis include the age, nationality, maternal educational level, the living arrangements, income, and the employment status. Older students, those of Maltese nationality, low maternal educational level, students living with a partner and with or without children, those with a low

household income, and students employed full-time were found to have a higher risk of diabetes.

- Around one third of the respondents had excessive weight according to the BMI and waist-to-height ratio categories.

- Around two-thirds of students reported some degree of anxiety, with females being more affected than male respondents.

- Male and female students showed similar smoking and alcohol consumption patterns.

- Around one third of students have low levels of physical activity.

- Students having a family history of type 2 diabetes and those living with someone who was overweight or obese reported a high FINDRISC score.

- An increasing age, high BMI and waist-to-height ratios, the presence of a family history of diabetes, living with a partner and children, having low level of physical activity and low adherence to the Mediterranean diet, and having increased levels of anxiety were associated with a high FINDRISC score after removing confounding factors.

Chapter 5: Discussion

5.1. Introduction

This chapter will discuss the results of the analyses in the context of the existing literature. The first section focused on the prevalence of diabetes risk, whereas the subsequent sections explored the other variables related to diabetes risk in the local student population.

The strengths and limitations of this study are discussed at the end.

5.2. The prevalence of diabetes risk

To the best of our knowledge, this is the first study that investigated the risk of type 2 diabetes amongst students in tertiary education in Malta, and therefore local data could not be used for comparisons. Review of the international literature indicated that the prevalence of diabetes risk in the study sample had a similar distribution to equivalent student populations, with most students falling within the low or very low risk categories (Al-Shudifat et al., 2017; Bagbila et al., 2019; Colak, 2015; Jurca-Simina et al., 2019; Kes & Can Cicek, 2021; Morawiec et al., 2013; Özpancar et al., 2019; Sapkota et al., 2020). Similar to the results of this study, studies using the FINDRISC score carried out in Turkey, Jordan, and Romania found that around 70% of the student population fell within the

very low and low risk categories, with the remaining 30% being classified mostly in the moderate and high risk groups, and only a very small minority having a very high risk of developing diabetes (Al-Shudifat et al., 2017; Colak, 2015; Jurca-Simina et al., 2019; Kes & Can Cicek, 2021). On the other hand, a Polish study found higher rates of students in the lower risk categories as 85% were classified in the very low or low risk groups (Morawiec et al., 2013). Studies carried out in Kuwait and India, where the prevalence of diabetes is very high, reported much higher prevalence of diabetes risk amongst students (Ali, 2016a; Vardhan et al., 2012) with quoted figures ranging between 40% (Ashok et al., 2010; Sindhu et al., 2015; Vardhan et al., 2012) and 60% (Ali, 2016a) of students in the moderate, high, and very high risk groups.

The varying rates of risk obtained in international studies can be attributed to different methods used to quantify diabetes risk and different sample sizes. Other factors that could influence the results are context-specific, such as variations in demographic attributes, cultural factors, affluence, and available health resources particular to the country (Lin et al., 2020). Nevertheless, these observations provide an indication that the presence of risk factors for diabetes in a relatively young cohort of a population reflect roughly the prevalence of disease in that whole population and can be used as a predictor of the trajectory of diabetes if no action is taken (Bergmann et al., 2007; Janghorbani et al., 2013). In this case, even though students attending tertiary education are in their majority still young and relatively healthy, a sizeable proportion still had significant risk for diabetes, and if these are not addressed, they risk progressing to full-blown disease.

5.3. Demographic characteristics

5.3.1. Age

The age distribution of this study's participants reflected that of the population of students in tertiary education as reported by the NSO, where around 60% of students were aged between 18 and 24 years with smaller numbers in older age groups (National Statistics Office, 2021). Similar skewed distributions were also observed in international studies, with most students falling within the younger age brackets and a smaller proportion being older (Granillo et al., 2016; Lima et al., 2014; Morawiec et al., 2013; Skøt et al., 2018).

The association found in this study between age and risk of diabetes was similarly observed in studies that also investigated this effect (Aris et al., 2020; Granillo et al., 2016; Lima et al., 2014; Xu et al., 2016). This was an expected finding as older age is a known independent risk factor for diabetes, with age-related insulin resistance being associated with changes in body fat volume and distribution, muscle loss, and increased sedentary lifestyle that occur more commonly in older persons (Chang & Halter, 2003; Kalyani et al., 2014). The strong association found in the current study could also be attributed to the large age-range of the participants. Comparatively, studies limiting participants to a narrow age range did not find statistical association (Özpancar et al., 2019; Skøt et al., 2018), as this might not allow differences in risk to show.

5.3.2. Sex

The proportion of female participants in this study was higher than as reported for the total student population, which for the 2019-2020 academic year stood at around 57% of the total (National Statistics Office, 2021). The gender ratio for participants in this study reflected the general trends observed in studies carried out amongst undergraduate student populations (Dickinson et al., 2012; M. M. Singh et al., 2019; Skøt et al., 2018; Smith et al., 2012; Younes et al., 2019). Dickinson *et al*. observed that female students and students in their first year of study were more likely to participate in research (Dickinson et al., 2012), with Smith *et al*. attributing the gender differences to the diverse attitudes and values amongst male and female students towards the online environment (Smith et al., 2012).

Sex is a non-modifiable risk factor for diabetes, with review of literature concerning diabetes risk amongst students indicating that overall, male students scored higher than women (Abdallah et al., 2020; Al-Shudifat et al., 2017; Hao et al., 2014; Kes & Can Cicek, 2021; Morawiec et al., 2013; Sapkota et al., 2020). Conversely, a study carried out in the US found a higher prevalence of risk in women which however did not remain significant following regression analysis (Zhang et al., 2014). The current study found a slightly higher mean FINDRISC score for women which however was not significant. This could be attributed to the smaller number of men participating leading to skewed results, and to the increased number of risk factors in women that could have upped the score, such as higher BMI or waist-to-height ratio scores and lower levels of physical activity amongst women.

5.3.3. Nationality

The proportion of Maltese to non-Maltese respondents in this study reflected the patterns reported by the NSO, where 89.7% of students in the academic year 2019 – 2020 were registered Maltese nationals with EU citizens making up 3.4% of the student population and non-EU students 6.9% of the total (National Statistics Office, 2021). The higher male to female ratio in the non-Maltese respondents reflected the trends observed in the foreign resident population, with males outnumbering females particularly for non-EU nationals (National Statistics Office, 2022). However, unlike the statistics published by the NSO, there were more EU citizens who answered the survey than non-EU students. These differences could be attributed to the relatively small proportion of non-Maltese students who participated, where small numbers can cause large proportional differences to emerge.

The results of the univariate analysis showed a significantly higher risk of diabetes amongst students with a Maltese nationality. The high prevalence of obesity in the Maltese population (Cauchi et al., 2015; Cuschieri, Vassallo, Calleja, Pace, et al., 2016; OECD/European Observatory on Health Systems and Policies, 2021; World Health Organization, 2022a) could be one of the major factors contributing to this observation. Moreover, Pace *et al*. found an increased genetic risk amongst the Maltese population resulting from a high prevalence of selected risk alleles for diabetes (Pace et al., 2013). Socio-economic factors, such as consumption of bigger meal portions for Maltese students living with their parents compared to non-Maltese students, who are more likely to be living on their own or with friends (Borg & Cefai, 2014) could also contribute to these observations.

5.3.4. Region of residence

This study did not find any significant difference between the students' gender and the place of residence, indicating an approximately equal gender distribution. A significant difference was however observed when analysing the region of residence with the FINDRISC score. Students residing in the Northern region had a significantly lower mean score than other regions, whereas those residing in the Western region had the highest mean score. These findings indicate variation in the health status of students residing in different areas, given that the FINDRISC score is computed by taking into consideration different risk factors for diabetes (Lindström et al., 2003). This is an interesting finding, given that large differences in health determinants are not as expected in a small island state. However, studies carried out over several years have found regional differences in health and social outcomes of the Maltese population. A descriptive review carried out in 1990 reported demographic and socio-economic regional differences leading to social inequities (Agius, 1990), while a more recent study found health inequities with regards to obesity and impaired fasting glucose, with Gozitan residents scoring higher on both counts compared to their Maltese counterparts (Cuschieri et al., 2022).

One of the factors that could have contributed to the observations in the current study is the demographic distribution in terms of nationality, as according to the 2021 census, the Northern region houses the largest proportion of foreign residents at 33.3%, whereas the Western region has the lowest percentage at 8.8% (National Statistics Office, 2022). These figures reflect the results obtained with regards to risk of diabetes and nationality, with an increased risk of diabetes amongst Maltese students and a higher risk for those residing in the Western region.

5.4. Educational and socio-economic characteristics

5.4.1. Tertiary education characteristics

The statistics provided by the University of Malta and MCAST for the purpose of carrying out weighting indicated that the University student population had more females and an older demographic overall whereas MCAST had a higher male to female ratio and a lower average age. This information was also provided within the institutions' annual reports (Balzan, 2021; University of Malta, 2020), and reflected the demographic constitution of respondents who took part in this study.

These demographic differences between the University and MCAST were described and explained in a report published jointly by the National Commission for the Promotion of Equality in Malta and equivalent institutions in Latvia and Cyprus in 2006. This report analysed the shift in demographics in terms of sex amongst tertiary education students, noting the increase in number of female students in most courses except in technical courses, where the proportion of males was higher (National Commission for the Promotion of Equality - Malta et al., 2006). Technical courses in Malta are in their majority provided by MCAST (MCAST, 2021), thus explaining the results obtained.

Analysis of the risk of diabetes with the year and place of study did not result in any significant differences, indicating that students at all levels in both educational institutions were possibly exposed to comparable risks and would likely benefit from similar interventions targeting students in tertiary education. Moreover, given that the

study population was students enrolled in tertiary education, any effect related to educational level of participants was assumed to be equal for the whole sample.

5.4.2. Parental education

A report examining the socioeconomic background of European students, including those studying in Malta, found that Maltese students have one of the highest rates of parental low educational attainment, with most parents or guardians of students obtaining up to a maximum of post-secondary, non-tertiary education, equivalent to level 4 of the International Standard Classification of Education (ISCED) (EUROSTAT, 2022; Hauschildt et al., 2021). This tallies well with the results obtained, where most respondents confirmed that their parents or guardians attended up to secondary schooling.

Different studies reported on the effect of parental education on the health status of students. A longitudinal study carried out in adolescents and young adults in higher education in the USA indicated that students with parents having tertiary education were more likely to be physically active, have low levels of sedentary behaviour, and overall lower risks for type 2 diabetes, whereas those with parents having more basic educational levels had more risk factors, including being less active, spending more time sitting down, and consuming unhealthy diets (Lee, 2014). Similarly, a randomised control trial carried out in Jordan to investigate the effectiveness of a 12-week, educational intervention for weight loss in school children found that maternal education was associated with increased weight loss in children, whereas no association was found with paternal education. This was attributed to the traditional role of the mother in taking care of the children while the father was the traditional breadwinner (Bani Salameh et al.,

2017). The current study found a similar association as only maternal education was linked to diabetes risk, possibly pointing towards persistence of the traditional role of the mother in providing care and sustenance for her family with limited equivalent input from the father.

5.4.3. Living arrangements

Students in tertiary education commonly reside away from their families in shared or student accommodation with their peers or on their own (Hauschildt et al., 2021; Olatona et al., 2018). However, due to the short distances and cultural factors, students in Malta mostly still live with their parents. In the report comparing the social and economic characteristics of students in Europe, Hauschildt *et al*. found that more than 60% of students residing in Malta were still living with their parents, while around 20% live with their partner or children and the rest live in other type of accommodation, echoing the results obtained in this study. Comparable observations were also found in a Brazilian study, where around 70% of students lived with their parents and only 2.9% lived on their own (Lima et al., 2014). In their study on the general health of students in Malta, Cefai and Camilleri (2009) reported that most students who live on their own or with other peers were mostly non-Maltese students and Gozitans (Cefai & Camilleri, 2009).

This study found that students living with their friends or with roommates and with their family had a significantly lower risk of diabetes than students living with a partner or children when carrying out univariate analysis. Likewise, a study investigating the effect of living arrangement on eating patterns found that students living with their parents

consumed healthier food with a higher intake of vegetables and fruit that can protect against diabetes than those living in shared accommodation (El Ansari et al., 2012).

The relationship observed between the living arrangements and risk of diabetes in this study could be attributed to factors other than the socio-economic impact of the living arrangement. This is because students having a partner or children tend to be generally older, whereas students living with roommates are more likely to be younger, and non-Maltese (Cefai & Camilleri, 2009). As was previously observed, older students had a higher risk of developing diabetes due to age, whereas non-Maltese students had a lower prevalence of diabetes risk than the local population. For this reason, one could argue that the positive link between living arrangements and diabetes risk factors could be due to confounding factors.

5.4.4. Household income

Similar to the results obtained from the current study, Hauschildt *et al*. reported that most students in Malta are from middle-income households. This observation was common for most European countries with 47% of students rating their households' income as average (Hauschildt et al., 2021). Similar observations were also reported in other international literature, with a Brazilian study (Lima et al., 2014) and a study carried out in Malaysia (Hasbullah et al., 2021) quoting between 40% to 50% rate of students from middle-income households.

The income is one of the factors used to assess the socio-economic status of individuals, which in turn is considered an independent risk factor for type 2 diabetes (Kyrou et al., 2020). Similar to the results of the current study, an inverse relation between income and

risk of diabetes has been reported in the literature, with lower income being associated with the presence of risk factors for type 2 diabetes and also a higher incidence of disease (Dinca-Panaitescu et al., 2011; Kyrou et al., 2020; Lysy et al., 2013; Marley & Metzger, 2015; Zhang et al., 2014).

For example, a Canadian health survey found a four-fold increased prevalence of diabetes in lower-income groups compared to the group in the highest income bracket (Dinca-Panaitescu et al., 2011), whilst a cross-sectional survey that used the FINDRISC score to assess the risk of diabetes found a higher mean score with lower household income (Zhang et al., 2014). A population-based study that investigated the association between income and incidence of diabetes found that younger people and females were affected disproportionately when compared to older and male participants (Lysy et al., 2013). These findings give weight to the effect that socio-economic status has on health, particularly for vulnerable persons such as youth and those of the female gender, and reflecting the results obtained in this study.

5.4.5. Employment status

This study found that around half of participants had either full or part time working commitments in addition to their studies, similar to what was documented by Hauschildt *et al*. in their report on Maltese students where 55% of students in higher and tertiary education in Malta worked. This percentage was slightly lower than the average for European countries, where around 60% of students are workers. The Czech Republic, Iceland, and Norway reported the biggest share of student workers with more than 85%,

whereas less than half of students in Portugal and Georgia worked (Hauschildt et al., 2021).

The literature concerning risk of diabetes according to student employment was limited, however several studies assessed the general health of working students with regards to factors that could impact health and are themselves risk factors for diabetes. A longitudinal study carried out over a 2-month period among college students found that student workers were at a higher risk of psychological health issues, with physical health not significantly affected. These results were attributed to increased psychological distress experienced by students who juggle work and education at the same time. Physical health was less affected potentially due to a short time lag between the data capture periods, and also as physical health in young adults was more stable and a longer time frame was required to detect changes (Park & Sprung, 2013). Arias-De la Torre *et al*. reported similar findings, attributing these observations to financial pressures as young adult students gain independence from their family, and also finding that female student workers were at a higher risk than males (Arias-De la Torre et al., 2019). Another study indicated that work commitment limited the time available for students to participate in extracurricular activities and potentially exposing students to work-related injuries and psychological distress (Zierold et al., 2005).

These findings from the international literature indicate a higher risk of negative health outcomes for working students as compared to those unemployed, corroborating the results obtained in the current study. However, the effect of confounding factors should also be considered. In this case, unemployed students were more likely to be younger than those who work (Hauschildt et al., 2021), and as was seen previously age is a significant risk factor for type 2 diabetes.

5.5. Genetic and environmental factors

The findings of this study linking a higher risk for diabetes with the presence of family history of diabetes and living within the same household as someone with excessive weight were concordant with the findings of similar studies in the literature.

Hasbullah *et al*. explored the link between those sharing accommodation and the risk of diabetes, finding similar results to the findings of the current study. In their study, the authors point to the fact that individuals sharing accommodation are exposed to similar environmental and behavioural risk factors implicated in type 2 diabetes, such as for example by having and developing similar habits with regards to physical activity, food consumption, smoking exposure, and alcohol consumption. These environmental exposures can pose a separate, independent risk for diabetes, which can contribute to the disease in addition to the genetic risk inherent in first and second-degree relatives (Hasbullah et al., 2021). As Franks (2012) explains, the aetiology of type 2 diabetes is the result of complex interaction between genetic and environmental factors, with the exact extent to which each of these exert their effect being unknown. The genetic component can be estimated by using conventional qualitative genetic analysis and adopted twin pair design studies; however, both of these methodologies are subject to other confounding factors such as intrauterine environmental factors. Despite this, estimates can be used to give an idea of the extent to which genetic and environmental influences affect risk and prevalence of diabetes (Franks, 2012). Results from the Danish Twin Registry indicated that genetic factors were responsible for around 26% of risk, whereas environmental

factors contributed to 41% of risk in twins, with the remaining variance being attributed to shared environmental factors and modelling errors (Poulsen et al., 1999).

The genetic influence of type 2 diabetes was observed by the results of studies investigating the link with diabetes risk and having a family history of diabetes, with all studies reviewed finding strong correlation between the two factors (Amuta et al., 2016; Ashok et al., 2010; Colak, 2015; Hasbullah et al., 2021; Kolahdooz et al., 2019; Monedero et al., 2008; Patil & Gothankar, 2016; Spurr et al., 2020; Utami et al., 2019). Similar to the results of this study, Colak found that 9.1% of their study sample reported a first-degree family history, with a higher number overall reporting a second-degree history of diabetes (Colak, 2015). Comparative studies have also indicated a higher than baseline diabetes occurrence in those with a family history and in certain ethnic groups (Bellou et al., 2018; Pierce et al., 1995; Prasad & Groop, 2015; TODAY Study Group, 2013; Vaag et al., 2014; World Health Organization, 2021). Pierce *et al*. reported that participants with a family history had a two to four-fold increased risk of diabetes than those without (Pierce et al., 1995). Vaag *et al*. reported a 40% lifetime risk of diabetes when one of the parents had the disease that increased to 70% when both parents were diabetic (Vaag et al., 2014). The genetic component of diabetes was investigated in ethnic studies, where African Americans, South Americans, Indians, Chinese and Japanese were found to have an increased risk even in subjects who were not obese (Carulli et al., 2005; International Diabetes Federation, 2019; Yamakawa-Kobayashi et al., 2012). These observations were attributed to the "thrifty gene" hypothesis, referring to the presence of multiple genetic polymorphisms that confer genetic advantage, but that increase the risk of insulin resistance and diabetes when living in affluent countries with no lack of food (Carulli et al., 2005). Variations in different genes have been implicated, however the exact

mechanisms and pathways are still not well known (Bellou et al., 2018; Carulli et al., 2005; TODAY Study Group, 2013), and an interplay between combinations of genetic variations and epigenetic factors are thought to work together to produce the diabetes phenotype (Bellou et al., 2018; Prasad & Groop, 2015; TODAY Study Group, 2013).

5.6. Behavioural factors

5.6.1. Smoking

Studies carried out amongst students attending the University of Malta and MCAST over the years reported a comparable rate of non-smoking students to the results obtained in the current study. Cauchi and Mamo reported a rate of 72.8% amongst health care students (Cauchi & Mamo, 2012), Pizzuto et al. found that 68.5% of medical students were non-smokers (Pizzuto et al., 2020), whereas a study covering students at both MCAST and University reported a non-smoking rate of approximately 60% (A. F. Fenech, 2012). The rate of occasional smokers was higher than that for those who smoked regularly in all studies reviewed (Cauchi & Mamo, 2012; A. F. Fenech, 2012; Pizzuto et al., 2020), although the exact proportions differed slightly and could be attributed to differences in student demographics, sampling methods, and sample sizes.

Similar to what was reported in this study, the studies reviewed did not report any significant differences amongst male and females students (Cauchi & Mamo, 2012; Pizzuto et al., 2020). Conversely, official statistics for Malta typically show a higher rate of

smoking in male adults (24%) and adolescents (14%) than for female adults (17%) and adolescents (8%), with the average smoking rates for adults being similar to the EU average and lower for the younger population (OECD/European Observatory on Health Systems and Policies, 2021). The results obtained in the current study were closer to the rates reported for adult males for both genders, pointing towards a higher rate of students who smoked compared to the general population, and in particular, higher rates for female students compared to females in the general population. Similar observations were also reported in a Polish study (Morawiec et al., 2013) and also in the other local studies carried out (Bonnici et al., 2020; Cauchi & Mamo, 2012; A. F. Fenech, 2012; Pizzuto et al., 2020). This observation is concerning especially considering the difficulty to stop smoking once started (Cauchi & Mamo, 2012; Rippe, 2018) and also the various ill-health effects related to smoking (Pan et al., 2015; Rippe, 2018).

In their study, Pizzuto et al. attempted to examine the reasons for why students smoked, finding that students used smoking as a coping mechanism and to deal with stress. A Polish study documented similar findings, with peer pressure also found to contribute (Morawiec et al., 2013). Pizzuto *et al*. also found that around a third of smokers started smoking after starting university, with the rate of smoking students in their last year of studies being higher than for those in their first year. Moreover, students who smoked socially and occasionally were likely to increase the amount smoked when surrounded by friends or with more stress (Pizzuto et al., 2020)

This study found a higher mean FINDRISC score for regular smokers, however, similar to a cross-sectional study carried out in amongst students in Lebanon (Abdallah et al., 2020), these findings were not statistically significant. Admittedly, studies carried out within the student population were scarce, however studies investigating the risk that smoking has

on type 2 diabetes were more comprehensive in the general population, with prospective cohort studies consistently finding an increase in diabetes incidence among smokers and ex-smokers (Luo et al., 2013; Mehta et al., 2020; Rimm et al., 1995; Spijkerman et al., 2014; Yeh et al., 2010). Mehta *et al*. found that smoking contributed 9% of the diabetes incidence in men and 14% of the incidence in women (Mehta et al., 2020), stressing the importance of smoking cessation and reducing smoking prevalence especially amongst the young. The lack of association between smoking and risk of diabetes found in the current study could be explained by the fact that the metabolic health effects of smoking typically require a long exposure period, and given that most students are still young, any metabolic effects on health have not yet emerged (Inoue-Choi et al., 2018; West, 2017).

5.6.2. Alcohol consumption

Alcohol consumption amongst students is fairly common both in Malta (Bonnici et al., 2020; Cefai & Camilleri, 2009) and other countries (Morawiec et al., 2013; Pertseva et al., 2021; Porto-Arias et al., 2017; Sapkota et al., 2020).

The study carried out by Cefai and Camilleri showed that only 10% of students admitted to never consuming alcohol; however 13% binge drink and 11% drink on a regular basis while the rest drink occasionally or socially (Cefai & Camilleri, 2009). Comparatively, a study comparing the lifestyle habits of students before and during the COVID-19 pandemic found that the pandemic may have led to a significant increase in alcohol consumption amongst students, including an increase of 8.7% in binge drinking (Bonnici et al., 2020). This observation could explain the high rates of concerning alcohol consumption reported by the participants, particularly amongst female students.

Males traditionally had more problematic drinking behaviours than females, with a 2011 study reporting a slightly higher prevalence of alcohol consumption in males which however was not statistically different from the prevalence amongst female students (Cefai & Camilleri, 2009). Interestingly however, the latest ESPAD survey of 2019 showed a higher proportion of girls who reported being intoxicated, consumed alcohol in an entertainment venue, and during the last drinking occasion (Arpa & Borg, 2020). Similar to these observations, the current study found a much higher prevalence of problematic drinking amongst female students, with twice as many females than males reporting excessive drinking when considering the AUDIT-C categories. This observation could reflect the much higher proportion of female respondents, especially as when the mean AUDIT-C score for males and female students was considered, males had a slightly higher score overall that however was not statistically different from the mean score of females.

This study did not find any significant differences in the mean FINDRISC scores of students with concerning drinking behaviour and amongst those without. One of the studies reviewed that investigated this link similarly did not find any difference in diabetes risk between students who drank occasionally or none at all (Sapkota et al., 2020). Due to the limited literature investigating the link between diabetes risk in students and alcohol consumption, studies carried out amongst the general population were reviewed. A Danish prospective cohort study with more than 70,000 participants assessed alcohol drinking patterns with incidence of diabetes, finding that those who drank alcohol three to four times weekly had a lower risk for diabetes whereas those who drank either less or more had a higher risk. This effect applied for both men and women when considering 14 drinks per week for men and 9 weekly drinks for women, and demonstrated the protective effect of moderate amounts of alcohol in terms of diabetes risk (Holst et al.,

2017). Similar observations were noted in two meta-analyses that found a U-shaped association (Baliunas et al., 2009; Huang et al., 2017), with Huang *et al*. reporting a 20% reduction in diabetes risk with moderate alcohol consumption (Huang et al., 2017). Bahadoran et al. attributed the protective effect of alcohol to the presence of polyphenols that are naturally present in red wine, and that have a role in regulating blood glucose (Bahadoran et al., 2013). Another prospective cohort study found that the type of alcohol consumed had a bearing on diabetes risk, with beer and spirits upping the risk, whereas wine providing a protective effect particularly for women. The detrimental effect of excessive alcohol consumption on risk of diabetes, irrespective of the type of alcohol consumed, should however be considered, particularly in young adults (Cullmann et al., 2012). These findings stress the importance of promoting a responsible drinking culture amongst students, particularly for women considering the recent trends with regards to drinking patterns.

5.6.3. Physical activity

The results of this study found concerning low level of exercise amongst students, similar to studies that were carried out amongst Maltese students at all levels of education including primary (A. Fenech et al., 2020), secondary (Decelis et al., 2014a), and at post-secondary levels (Attard & Vassallo, 2015; Cumbo et al., 2019). A study carried out at MCAST similarly indicated that only 31% of students achieve the levels of physical activity recommended by WHO (Cumbo et al., 2019). The identified barriers that were quoted by students included lack of adequate facilities and lack of time and motivation (Attard & Vassallo, 2015; Silva et al., 2022).

Similarly low levels of exercise were evident amongst the general Maltese population, with the latest statistics showing a decline in physical activity for adolescents with lower levels amongst girls compared to 2014, and insufficient levels of exercise in at least a third of adults (Altobelli et al., 2020; Gauci et al., 2018; OECD/European Observatory on Health Systems and Policies, 2021). Additionally, Altobelli *et al*. (2020) reported that Malta had the highest rate of physical inactivity amongst European countries, with 45% of the population being inactive (Altobelli et al., 2020). The studies reviewed found a significant difference between genders (Altobelli et al., 2020; Lima et al., 2014) which was however not reflected in the current study probably due to the higher number of female respondents.

This study found a significant inverse association between the levels of exercise and risk of diabetes which persisted after removing the effects of confounding factors. These results were comparable to the results of a Malaysian study (Aris et al., 2020) and a Turkish study (Colak, 2015) that investigated the association between physical activity levels using IPAQ-SF tool and risk of diabetes using the FINDRISC score. Similar observations were reported in studies carried out amongst the general population, with a systematic review and meta-analysis finding stronger evidence of reduced risk of diabetes with low-intensity rather than high levels of physical activity (Aune et al., 2015). The detrimental effect of sedentary behaviour was reported in another study which found a 112% relative increased risk of diabetes in persons who reported watching TV for prolonged periods as opposed to those reporting shorter times (E. G. Wilmot et al., 2012).

5.6.4. Dietary habits

Assessment of the dietary habits of students in the current study resulted in comparable results to a small study carried out at the University of Malta that also used the literature-based adherence to the Mediterranean diet score developed by Sofi *et al*. Treki and Jones found that most students were medium adherers to the Mediterranean diet, with the score following a normal distribution among the sample population, similar to what was obtained in this study. Moreover, female students had a slightly higher mean score compared to males, indicating a higher adherence; however, unlike the results of this study, the gender differences in the study by Treki and Jones were not significant. The latter finding could be attributed to the small sample used that could have impacted the outcomes of the study (Treki & Jones, 2021).

Although this study did not assess the intake of a healthy diet per se but rather the adherence to a Mediterranean diet, the results tallied with a study published in 2011 that assessed the dietary habits of students attending the University of Malta. The authors reported that female students were more likely to follow healthy eating patterns, while the majority of students preferred carbohydrate-rich condiments and a diet low in dietary fibre with few fruit and vegetables (Cefai & Camilleri, 2011). The international literature reported similar results, with students preferring carbohydrate-rich food and carbonated drinks rather than fruit and vegetables (Al-Awwad et al., 2021; Beaudry et al., 2019; Hirshberg et al., 2011; Olatona et al., 2018; Tok et al., 2018). These observations do not augur to adherence to a Mediterranean diet, which is typically characterised by a high intake of dietary fibre and low proportions of refined carbohydrates (Sofi et al., 2014).

This study found a positive association between increased adherence to the Mediterranean diet and a reduction in risk of diabetes that remained even after removing the confounding factors. Similarly, cohort studies investigating the effect of consumption

of a Mediterranean diet on developing diabetes showed comparable results (Martínez-González et al., 2008; Mozaffarian et al., 2007; Romaguera, 2011). A systematic review and meta-analysis of studies calculated that the Mediterranean diet could reduce the risk of diabetes by up to 19% (Schwingshackl et al., 2015), while Georgoulis *et al*. found evidence of benefit when consuming a Mediterranean diet for the management of those with pre-existing diabetes (Georgoulis et al., 2014). Other health benefits were also implicated, with a meta-analysis reporting a reduction of 8% in overall mortality together with 10% reduction in risk of cardiovascular disease and a 4% reduced risk of neoplasms with increased adherence to this type of diet (Sofi et al., 2014). Although the exact mechanisms involved are not known, the antioxidant and anti-inflammatory properties of the Mediterranean diet and its effect in reducing insulin sensitivity and improving the gut microbiota are thought to contribute (Milenkovic et al., 2021).

5.7. General health status factors

5.7.1. Coexisting health issues and regular medications

The study by Cefai and Camilleri provided a picture of the general health of the students attending the University of Malta more than 10 years ago. The proportion of students suffering from some health ailment was higher than the results obtained in the current study, with 65% of students reporting health issues. This figure however included acute health conditions such as respiratory illnesses and back pain that the students reported

having within the year preceding the survey. When assessing the number of medications taken, the results were concordant to those of the current study, with approximately 40% of students taking some medication and 5% taking three or more different medications on a regular basis. As per results obtained in our study, the proportion of female students affected was higher than that of males (Cefai & Camilleri, 2009).

Studies investigating gender differences with regards to self-reported health typically find worse outcomes in female participants (Boerma et al., 2016; Jatrana, 2021; Merrill et al., 1997; Shi et al., 2021). Boerma *et al*. carried out survey data analysis from 59 countries to investigate the gender gap in self-reported health outcomes, finding worse results amongst women with all health indicators, at all ages, and in all regions, with a wider gap between the sexes for chronic conditions. Younger women and women from high-income countries were less affected, however they still had worse health outcomes than the equivalent male cohort (Boerma et al., 2016). Both Boerma *et al*. and Jatrana (2021) implicated gender differences in the biological make-up and exposures to socio-economic determinants of health for these observed variations.

This study found that the presence of long-standing illness or health problem and regular medication intake were associated with a higher mean FINDRISC score that indicated a higher risk of diabetes. Studies investigating this link amongst students were scarce, however studies carried out amongst the general population similarly indicated a higher prevalence of multimorbidity with type 2 diabetes when compared to the non-diabetic population (Bernabe-Ortiz et al., 2018; Teljeur et al., 2013). Bernabe-Ortiz *et al*. found that around a third of diabetics had at least another chronic condition, 14.1% reported two, and around 5% had three or more other comorbidities (Bernabe-Ortiz et al., 2018). High blood pressure, dyslipidaemia, cardiovascular disease, and obesity were the

commonest comorbidities reported (Bernabe-Ortiz et al., 2018; Teljeur et al., 2013). In addition, a prospective cohort study investigating the occurrence of multiple comorbidities found that the presence of one chronic condition increased the risk of having another, possibly due to accelerated ageing associated with the primary condition. The authors also noted a shorter time gap for the development of a subsequent condition, however preventive interventions can halt or delay their development (Shang et al., 2020). Timely and effective interventions that included early detection, adequate management, and support for those affected, were very important to prevent the onset of other comorbidities and further worsening of the quality of life (Shang et al., 2020; Teljeur et al., 2013).

5.7.2. Weight issues

The proportion of participants who were classified as being overweight or obese in this study were higher than the results of a self-report study published in 2009, where a quarter of University of Malta students assessed their weight as being excessive (Cefai & Camilleri, 2009). These observations support the trends observed in the general Maltese population wherein the rates of overweight and obesity in all ages were on the increase (Cuschieri, Vassallo, Calleja, Camilleri, et al., 2016; OECD/European Observatory on Health Systems and Policies, 2021; World Health Organization, 2022a). Similarly high rates of excessive weight amongst students were obtained for studies carried out in tertiary education institutions in Southern Europe or around the Mediterranean region. For example, a Jordanian study reported that 23.2% of participants had excessive weight (Al-

Shudifat et al., 2017), while a Romanian study reported an overweight and obesity rate of 39.6% (Jurca-Simina et al., 2019).

Assessment of the mean BMI and waist-to-height ratio scores for male and female participants in this study showed slightly higher scores for males in both cases, which however were not significantly different from those of female respondents. The international literature similarly indicated higher rates of overweight and obesity in male students (Al-Shudifat et al., 2017; Colak, 2015; Kes & Can Cicek, 2021; Meijnikman et al., 2018; Porto-Arias et al., 2017), whereas the latest published EHIS report for Malta also reported increased prevalence of excessive weight amongst men (Gauci et al., 2018). The lack of significant differences observed in the current study could reflect a higher prevalence of risk factors for obesity in female students. Conversely, the findings could also be the result of bias due to the larger number of female respondents and the subjectivity of data collection that could have influenced the results (Maruf et al., 2012).

Similar to the results obtained in the current studies, the prevalent risk of diabetes amongst tertiary education students was strongly associated with excessive weight, even when other diabetes risk scores, such as the Canadian and Indian risk scores for example, were used (Al-Shudifat et al., 2017; Ali, 2016a; Ashok et al., 2010; Jurca-Simina et al., 2019; Kolahdooz et al., 2019). Studies carried out amongst the general population also produced similar results. For example, Gupta *et al*. (2020) investigated the effect of excessive weight on the risk of diabetes, finding that in addition to excessive weight on its own, a change in weight when this leads to a high BMI also ups the risk of diabetes and the risk of being pre-diabetic or diabetic. Individuals with a normal weight initially were similarly affected, albeit having a lower risk that those starting with excessive weight.

Gender differences were also observed with males having an overall higher risk than females (Gupta & Bansal, 2020).

Of relevance to the local context, a study carried out in the US found that overweight and obesity at younger ages was associated with a higher lifetime risk of type 2 diabetes than for people who had an increase in weight when older. According to the authors, the risk for diabetes for men increased from 7.6% to 70.3% for obese 18-year-olds and from 12.2% to 74.4% for the equivalent female cohort. The authors reported that the effect of BMI on risk of diabetes was less with increasing age, stressing the importance of managing excessive weight in younger ages to prevent diabetes in later years (Narayan et al., 2007). These observations provide further evidence for implementing actions that promote a healthy weight amongst students to prevent metabolic health complications later in life.

5.7.3. Anxiety

The results obtained in this study indicate a higher prevalence of anxiety in the study sample when compared to the prevalence of anxiety in the general population. The latest published EHIS reported a lifetime prevalence of anxiety of 7.9% while the 12-month prevalence was 5.3% (Gauci et al., 2018). Similarly, a cross-sectional study carried out to investigate the general health status of students at the University of Malta found that 16.4% of participants self-reported feeling anxious (Cefai & Camilleri, 2009). A more recent study reported that Maltese students were amongst the most stressed in Europe with mental health issues causing significant impairments (Hauschildt et al., 2021).

The differences in levels of anxiety registered in the various studies may be attributed to diverse respondent populations. In the case of EHIS, the data was sourced from the general population whereas the current study was carried out amongst students in tertiary education. On the other hand, the sampling size and techniques may have influenced the results of the studies carried out amongst students. Another important factor to consider is the COVID-19 pandemic that may have contributed to the increased level of anxiety amongst select groups of the population (Aristovnik et al., 2020; Chen & Lucock, 2022). The WHO reported that within the first year of the pandemic, there was a registered 25% increase in the levels of anxiety and depression worldwide due to a number of stressors such as social isolation, upheaval of the usual lifestyle, and financial difficulties (World Health Organization, 2022b). Similar trends were registered in Malta, as calls made to a mental health helpline increased drastically during the pandemic (J. Scerri et al., 2021), while a number of studies found that around 70% of Maltese youths experienced anxiety as a result of the pandemic (Richmond Foundation, 2022) with students being particularly affected (Cuschieri, 2021). In fact, a study carried out to investigate the effects of the COVID-19 pandemic on students at the University of Malta found that 70% of respondents reported feeling anxious and nervous while 60% reported symptoms of depression. In all cases, female students were affected at a higher rate (Bonnici et al., 2020). Interestingly, these figures were much higher than the results of a study carried out in 2009 (Cefai & Camilleri, 2009).

This study found a positive association between risk of diabetes and anxiety levels which remained even after removing the confounding factors. This corroborated with evidence from the literature investigating the effects of psychological disorders on development of type 2 diabetes, with a meta-analysis that used more than 200 unique studies from 32

systematic reviews finding that diabetes was a common occurrence in persons suffering from psychiatric issues. In particular, persons having anxiety were found to have a 14% prevalence of diabetes (Lindekilde et al., 2022). Moreover, a prospective cohort study involving more than 1,600 persons measuring the incidence of type 2 diabetes amongst the general population found a two-fold increased incidence rate of diabetes amongst those with a high GAD-7 score (Atasoy et al., 2021). Another prospective study from Taiwan with more than 700,000 participants found that the prevalence of diabetes in persons with anxiety disorders was around twice that for the general population, with all age groups being affected (Chien & Lin, 2016).

Studies investigating this effect amongst tertiary education students were scarce, however the abnormally high rates of anxiety amongst students (Bonnici et al., 2020; Borg & Cefai, 2014; Cefai & Camilleri, 2009; Cuschieri, 2021) coupled with the presence of risk factors for type 2 diabetes, such as high overweight and obesity rates, physical activity and sedentary behaviour patterns, inadequate nutrition, and excessive alcohol consumption amongst others (Attard & Vassallo, 2015; Bonnici et al., 2020; Cauchi & Mamo, 2012; Cefai & Camilleri, 2011; Cumbo et al., 2019; Decelis et al., 2014b; A. F. Fenech, 2012; Santonastaso et al., 2006), should prompt action to counteract modifiable factors, including anxiety.

5.8. The strengths and limitations of the study

This study had several strengths. Validated tools that allowed comparison with the results of studies carried out both locally and internationally were used, and where

possible, tools that had already been used amongst the local population were selected. Additionally, the study population could be readily defined with relative accuracy in terms of demographic characteristics, as basic demographic information was requested and readily made available by the selected institutions. This also helped with the application of weighting which was applied as a corrective technique to adjust for the proportionality of under- and over-represented groups, reduce the effect of bias, and improve the quality of the findings (Haddad et al., 2022; Lavrakas, 2008). Moreover, Generalized Linear Models were applied as a regression technique to remove the effect of confounding factors and identify the factors that increased the diabetes risk in the study population.

The survey was distributed using online means. This method removed geographical barriers and ensured that the questionnaire was available to all students registered at the selected institutions, irrespective of their presence on campus. This was particularly significant as the data collection was carried out at a time when social distancing and online learning were prioritized in response to the COVID-19 pandemic, and a number of students were following lectures exclusively online (Balzan, 2021; Kunsill Studenti Universitarji, 2020). Additionally, there was consistency in the distribution method used, with a personalised email with a link to the survey sent to students enrolled at both the University and MCAST. This reduced confounding bias emanating from the distribution method. Online data collection also reduced duplication of work errors related to data inputting, handling, analysis, and reporting, while the completed surveys were available for review in real-time (Andrade, 2020; Oliveri et al., 2021; S. Singh & Sagar, 2021). Besides this, respondents could reply to the survey at their convenience on their own schedule (Oliveri et al., 2021; S. Singh & Sagar, 2021; Tanner, 2018), while interviewer

bias was removed as the participants were not influenced by the presence of another person (Van Mol, 2016).

There were a number of limitations that could have influenced the interpretation of the findings. One of the main limitations was the response rate. Online surveys amongst adult students typically have low response rates, with the literature quoting lack of personal engagement, lack of interest, survey fatigue, and privacy concerns as the commonest reasons for non-participation (Menon & Muraleedharan, 2020; S. Singh & Sagar, 2021; Van Mol, 2016). As a result, results may be skewed given that participants and non-respondents may have different characteristics which cannot be described, therefore impacting the external validity and generalisability of the survey outcomes (Blumenberg & Barros, 2018; Van Mol, 2016).

Other limitations concerned the method of distribution used. Questionnaires were distributed to the email address list kept by the Academic Registrars, and therefore the distribution relied on accurate data inputting and updated lists. Data accuracy errors, such as wrongly inputted email addresses, could have led to some students not receiving the questionnaire or the questionnaire being sent to someone by mistake. Moreover, not all those receiving the email may see or read the contents due to other priorities or commitments they may have at the time. Additionally, unless an identification tool is used, the researcher could not know if a responder has answered the questionnaire more than once, or else if a person other than the intended recipient responded (S. Singh & Sagar, 2021). The method used for distribution also did not allow for random sampling, as the options were limited to sending the link to all registered students rather than to a random sample of students. In this case, a larger sample could not be used, and non-

respondents could not be characterized whilst those who responded may be biased in some way.

Selection bias was another limitation that could have caused skewed results, especially when the survey was accessible only to those who meet certain criteria, such as access to the online platform, those who may be interested enough to answer the questionnaire, and those who were sufficiently computer-literate (Andrade, 2020; Haddad et al., 2022; Menon & Muraleedharan, 2020; S. Singh & Sagar, 2021; Tanner, 2018). Given that students in tertiary education are required and expected to use the institution email for updates and communication regarding their course, computer literacy was not deemed to be a limiting factor.

This study relied on self-report to collect information, potentially introducing recall and information bias. The latter could have limited the reliability of responses, particularly where body measurements were required as in such cases there was no guarantee of the accuracy of the values inputted. Recall bias could be introduced in cases where participants were required to remember past information. Moreover, as the researcher was not physically present respondents could not ask for clarifications in case of difficulty (Tanner, 2018). This was mitigated by providing an email address where respondents could contact the researcher directly if needed.

The effect of confounding factors that were not investigated could also lead to biased results, and in some cases suggesting an association between factors when in reality this does not exist (Jager et al., 2008). For example, a high GAD-7 score may be obtained because of a temporary acute event rather than being the norm for a person, whereas a low IPAQ-SF score may be secondary to a physical injury that limits mobility temporarily

in a person who otherwise would exercise regularly. Similarly, the socio-economic impact on risk of diabetes is affected by many other factors that were not investigated or that were investigated indirectly, such as housing and exposure to pollutants for example. Health promotion campaigns carried out around the data collection period, such as for example mental health campaigns targeting young adults and students, may have influenced the responses received regarding anxiety. The COVID-19 pandemic led to a greater awareness of mental health needs of different sections of the population, and particular attention was given to the needs of youth and marginalised groups (Richmond Foundation, 2022). Therefore, the heightened awareness about mental health may have led to the high reported prevalence of anxiety observed in this study.

This study only considered students attending the University of Malta and MCAST, which are the largest tertiary education institutions in Malta. However, this could have introduced selection bias as students attending other tertiary education centres were excluded, potentially leading to over- or under-representation of some groups who may be more likely to enrol in one centre rather than another. Additionally, this study chose a cross-sectional methodology which involves investigating the exposure and outcome simultaneously to study the relationship between several factors. As a result, causality could not be determined, and further research is required to investigate this effect (Kesmodel, 2018).

As a result of these limitations, the outcomes of this study may not be fully representative of the study population. Further research carried out using a randomized sample with efforts to increase the response rate could help provide better representative results. A face-to-face approach and the inclusion of objective measures for calculating body

measurements, rather than online and self-report methods, could also improve the outcomes and accuracy of the results.

5.9. Conclusions

This study provided a picture of the current demographic, socio-economic, general health and behavioural characteristics of the students enrolled in tertiary education in Malta despite the number of limitations. Several interesting observations emerging from this study can be further expanded in future research.

Chapter 6: Conclusions and Recommendations

6.1. Conclusions

The aim of this study was to assess the prevalence of type 2 diabetes risk in students enrolled in tertiary education. This was carried out by using a diabetes risk score to quantify the risk and investigate the association with different risk factors.

The results provided a cross-sectional overview of the demographic, socio-economic, lifestyle, general health status, and the genetic and environmental exposure risk of the respondents. The majority were young adults aged between 18 and 24 years, female, of Maltese nationality and in their first year of study. The demographic and socio-economic overview also indicated that a small proportion of students were older, and some were from a socially disadvantaged background from low-income households and having low parental educational levels. The majority were in good health, however around a third reported having excessive weight, drank concerning amounts of alcohol, and had low levels of physical activity. Around one fifth smoked on a regular or occasional basis, and more than 40% had low adherence to the Mediterranean diet. Most concerningly, around two thirds reported having some degree of anxiety. As background risk, around 16% of students had a first-degree family history of diabetes whereas around half had a second-degree family history. Half of respondents also reported living in the same household with someone having excessive weight.

With regards to diabetes risk, most students were in the low or slightly elevated risk categories, however 6.1% of the respondents had a moderate risk and 5.1% had a high risk. The risk factors that were associated with an increased risk were older age, a high body-mass index and waist-to-height ratio, having a family history of diabetes, living with friends or roommates, having low levels of physical activity, having a diet with a low adherence to the Mediterranean diet, and having high anxiety levels. Other factors that increased the risk of diabetes and were found to be significant only with univariate analysis included having a Maltese nationality, having a mother with a low educational level, living in a household with low monthly income, students in full-time employment, having a chronic disease and taking regular medication, and living in the same household as someone with excessive weight. The limitations of the study need to be taken into consideration when interpreting the results, particularly when it comes to confounding factors and issues related to the methodology employed in carrying out the study.

The outcomes of this study should be considered within the context of the study population, who were all students in tertiary education. Education is an important determinant of health that is inherently linked with health and wellbeing, with high educational levels being associated with improved life expectancy, healthy lifestyles, and lower morbidity and mortality (Parker et al., 2020; The Lancet Public Health, 2020; Wu et al., 2020). While there is little that can be done for background risk and non-modifiable risk factors, it was expected that educated participants had a lower prevalence of modifiable risk factors that would translate into the expected improved health outcomes. Conversely, the prevalence of risk factors such as smoking, alcohol consumption, and anxiety levels were found to be higher in students while other factors such as level of physical activity, type of diet, and overweight and obesity, were comparable to the

general population. These observations indicate that having a high educational level on its own is not enough, and measures that facilitate choosing a healthy lifestyle are needed. Any measures implemented should tackle the problem holistically. Educational campaigns should be carried out on a regular basis and targeted towards students. Moreover, any policy implemented by the educational institutions and country-wide legislative measures should take into consideration the health of students and ensure a health-inducing environment. Measures should be able to impact most students; however, minorities and socially disadvantaged groups should not be neglected to prevent health and social inequities that can themselves worsen health outcomes.

In conclusion, this study managed to reach the aim and objectives of this study by quantifying the diabetes risk and identifying the factors that increase this risk in the local student population. These findings can be used to guide recommendations for measures that can be implemented to improve the health of students and reduce the risk for diabetes later in life. The following section presents these recommendations for policy and the educational sector and for future research in the area.

6.2. Recommendations

6.2.1. Recommendations for policy

- Incorporate a health-in-all-policies approach when drawing up policies and strategies in any sector that affect students directly or indirectly. This can be facilitated by collaboration with the Advisory Council on Healthy Lifestyles to

promote an inter-ministerial and inter-sectoral approach on issues related to the social determinants of health and ensure that these are considered.

- Future revision of existing health policies incorporated into the new Prevention Framework should tackle prevention aspects of health that are particular to students and suggest actions directed at this cohort.
- The future diabetes strategy should include a section to tackle risk factors in high-risk populations, with particular attention given to students.
- Advocate for legislative actions promoting healthy lifestyles, such as restricting the availability of unhealthy food options and the sale of alcohol and tobacco within a certain distance from educational campuses, and incentives to increase physical activity in students for example.

6.2.2. Recommendations for the educational sector

- Measures promoting a healthy lifestyle in an educational setting should be started from the early years of education, including kindergarten and primary school. This can improve the health outcomes of students later in life and during adulthood.
- Most of the students enrolled in tertiary education are young adults who are passing through a transitional stage of their life to become independent adults. Thus, tertiary education institutions should strive to create a health-promoting environment that facilitates the uptake and maintaining of healthy habits throughout life. Health promoting activities that target older students and students coming from a disadvantaged background should also be given due importance.

- Health and social inequities need to be taken into consideration when implementing measures. This can be applied by ensuring equitable access to services and providing support to students, such as childcare facilities and flexibility of learning options (such as online or hybrid options) for example, so that all students can achieve better study-work-life balance.

Recommendations regarding general health of students:

- Increase cooperation with the Health Promotion and Disease Prevention Directorate and health student associations to organize activities promoting health and educating the student population.
- Facilitate and promote physical activity by offering showering and changing facilities and providing financial incentives or discounts for access to facilities where students can exercise, such as gyms, pool, tennis courts, et cetera.
- Increase accessibility to healthy food options on campus.
- Build on the services currently provided by the Health Clinics on campus, focusing particularly on the specific needs of students including those who are older, and promotion of the services offered to increased awareness and referrals. Tailored clinics focusing on weight loss, smoking cessation, and alcohol rehabilitation on campus can increase awareness and improve access to students. These Health Clinics can also act as a bridge between students and the health sector by providing information about services available and directing or referring students as needed.
- Optional modules or courses that focus on health, such as healthy eating, physical activity, and self-care for example, can be tailor-made and subsidized for students.

These courses should be promoted, and incentives given to encourage students to attend.

Recommendations regarding Mental Health:

- Expand services targeting mental health on campus, such as access to psychological support, support groups, and explore the implementation of peer support systems whereby students who required help for anxiety can support others passing through similar experiences.
- Provide training and educational sessions for staff regarding early identification and appropriate referral pathways for common health problems in students, including mental health issues and addiction problems for example.

6.2.3. Recommendations for future research

- Consider including students in younger age groups, such as those in secondary and post-secondary education up to 18 years of age, and students attending other tertiary education institutions, in similar research.
- Use objective measures for data collection, particularly for weight, height, and waist circumference measurements, and include options for carrying out blood tests to improve the sensitivity of tests for detection of undiagnosed pre-diabetes and diabetes.
- Similar studies can provide trends that can be used to monitor progress or otherwise in interventions that were implemented in this sector to target diabetes risk factors.

- Qualitative research to help planning and implementation of health promoting activities that are student-centric and that fulfil the specific needs of students, particularly those vulnerable and those from a disadvantaged background.
- Carrying out an exercise to quantify the burden of risk factors for diabetes and the financial implications in the student population and comparing this to the general population.
- Economic evaluation of using a risk score to guide screening and interventions to prevent the onset of pre-diabetes and diabetes in students with a high diabetes baseline risk.

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Appendices

Appendix 1: Conditional permission from the University of Malta Academic Registrar.

L-Università ta' Malta

Office of the Registrar
University of Malta
Msida MSD 2080, Malta

Tel: +356 2340 2385/6
registrar@um.edu.mt

www.um.edu.mt

17 June 2021

Dr Tania Cardona

Dear Dr Cardona

I refer to your request for permission to contact students to participate in your study which you will be carrying out for the dissertation which you will be submitting in partial fulfilment for the degree of Master of Science in Public Health.

The Office of the Registrar finds no objection to your request, subject to the approval of the Faculty Research Ethics Committee.

Yours sincerely

Colin Borg
Registrar

Appendix 2: Ethical approval from the University of Malta.

L-Università ta' Malta

Faculty of Medicine & Surgery

University of Malta
Msida MSD 2080, Malta

Tel: +356 2340 [illegible]
[illegible]

www.um.edu.mt/ms

Ref No FREC/MDS_2022_002

2 November 2021

Dr Tania Cardona

[redacted]

Dear Dr Cardona,

With reference to your application submitted to the Faculty Research Ethics Committee in connection with your research entitled:

Risk of type 2 diabetes in young adults attending the main tertiary education institutions in Malta

The Faculty Research Ethics Committee is granting ethical approval for the above-mentioned application reviewed on 26 October 2021

Yours sincerely,

Professor Anthony Serracino Inglott
Chairman
Faculty Research Ethics Committee

Appendix 3: Ethical approval from MCAST

MCAST

Dear Ms Tania Cardona,

Reference is made to your research proposal number E08_2021 titled "Risk of Type 2 Diabetes in Young Adults Attending the Main Tertiary Education Institutions in Malta." and dated 16th June 2021.

This is to confirm that your proposal has been accepted by the MCAST Ethics Committee, you are thus free to proceed with your research under the described ethical criteria.

Best regards,

Alex

Dr. Ing. Alex Rizzo FIET, FCMI, FCIWEM
Deputy Principal, Research & Innovation
Malta College of Arts, Science & Technology
Tel: 00356 7941 7176
Email: alex.rizzo@mcast.edu.mt
Web: www.mcast.edu.mt
Date: 18th June 2021

Appendix 4: The questionnaire sent to the participants.

Lifestyle assessment of students attending tertiary educational institutions in Malta

This questionnaire should take approximately 10 minutes of your time. If you have already answered this questionnaire, thank you!

Dear Participant,

I would like to invite you to take part in my study investigating the general lifestyle of students attending tertiary educational institutions in Malta to assess for risk factors of type 2 diabetes.

The study will explore the lifestyle habits, level of physical exercise, type of diet consumed, and risk for anxiety in students. Basic information about the demographics will also be collected to be able to assess the risk in context to demography and compare to other similar studies.

The information will be collected via an anonymous and confidential self-completed questionnaire in a way that cannot be retraced back to you, and any data collected will be treated with the utmost confidentiality and will be processed in accordance to the General Data Protection Regulation. No personal, identifying data will be collected for this study. All information collected will be used solely for purposes related directly to this study and will be destroyed in a secure manner once the study is completed.

Your participation is on a voluntary basis, with the option to opt out at any point if you feel uncomfortable continuing. Refusal to participate will not affect your rights or the medical care that you receive.

Under the General Data Protection Regulation (GDPR) and national legislation that implements and further specifies the relevant provisions of said Regulation, you have the right to obtain access to, rectify, and where applicable ask for the data concerning you to be erased.

If you would like to ask for further information or clarification, or if you have any queries about this study, you are more than welcome to contact me on tania.cardona.19@um.edu.mt.

Thank you for your help!

*Required

1. I understand the above information and agree to participate in the survey *

   Mark only one oval.

   - Yes
   - No

Demography

This section will collect general information about yourself. No identifying information will be collected.

2. 1. What is your year of birth? *

   Please write only the year when you were born in the format YYYY.

3. 2. What is your sex? *

Please choose your biological sex. The answer will be used to compute the score for one of the questions below.

Mark only one oval.

- Male
- Female
- Other: _____

4. 3. What is your region of residence in Malta? *

Mark only one oval.

- Southern Harbour District: (Birgu, Bormla, Fgura, Floriana, Isla, Kalkara, Luqa, Marsa, Paola, Santa Luċija, Tarxien, Valletta, Xgħajra, Żabbar)
- Northern Harbour District: (Birkirkara, Il-Gżira, Il-Hamrun, L-Imsida, Pembroke, Ta' Pietà, Ħal Qormi, San Ġiljan, San Ġwann, Santa Venera, Ta' Xbiex, Is-Swieqi, Ta' Xbiex)
- South Eastern District: (Birżebbuġa, Ħal Għaxaq, Il-Kalkara, Ħal Kirkop, Marsaskala, Marsaxlokk, L-Imqabba, Il-Qrendi, Ħal Safi, Iż-Żejtun, Iż-Żurrieq)
- Western District: (Ħal Attard, Ħal Balzan, Ħad-Dingli, L-Iklin, Ħal Lija, L-Imdina, L-Imtarfa, Ir-Rabat, Is-Siġġiewi, Ħaż-Żebbuġ)
- Northern District: (Ħal Għargħur, Il-Mellieħa, L-Imġarr, Il-Mosta, In-Naxxar, San Pawl Il-Baħar)
- Gozo and Comino District: (Il-Fontana, Għajnsielem, L-Għarb, L-Għasri, Ta' Kerċem, Il-Munxar, In-Nadur, Il-Qala, San Lawrenz, Ta' Sannat, Ix-Xagħra, Ix-Xewkija, Ir-Rabat (Victoria), Iż-Żebbuġ)

5. 4. What is your nationality? *

Mark only one oval.

- Maltese
- European
- Other (Non-European)

6. 5. Which educational institution do you attend? *

Mark only one oval.

- MCAST
- University of Malta
- Other: _____

7. 6. In which year of your current course are you currently in? *

Please write in only the year, eg. "2"

_____

8. 7. Is this the final year of your course? *

Mark only one oval.

- Yes
- No

9. 8. How are your living arrangements? *

Mark only one oval.

- I live with my family (parents / siblings)
- I live alone
- I live with my friends / roommates
- I live with my partner / spouse
- I live with my partner / spouse and children
- I live with my children (no partner / spouse)
- Other: _____

10. 9. What is the level of education of your parents? *

Mark only one oval per row.

	Not applicable	No formal education	Until primary education	Until secondary education	Sixth form	Vocational training	Tertiary education	I don't know
Mother								
Father								
Other / Legal guardian								

11. 10. Are you currently employed? *

Mark only one oval.

- Yes - Full-time
- Yes - Part-time
- No

12. 11. What is the monthly income of the main breadwinner in your household, approximately?

Consider the income of the person who contributes the most in your household (that is who lives in the same residence) ONLY.

Mark only one oval.

- Below €996
- Between €996 and €1,565
- Between €1,566 and €2,907
- Between €2,208 and €3,300
- Above €3,300
- Do not know

Lifestyle habits and general health

This section will collect information about your lifestyle in general.

13. 12. Do you smoke? *

Mark only one oval.

- Never
- I am an ex-smoker (I do not currently smoke)
- I am an occasional smoker (I smoke a cigarette once in a while, but not everyday)
- I smoke regularly

14. 13.1. How often do you have a drink containing alcohol? *

Mark only one oval.

- Never
- Monthly or less
- 2-3 times a month
- 2-3 times a week
- 4 or more times a week

15. 13.2 How many standard drinks containing alcohol do you have on a typical day? *

Mark only one oval.

- 1 or 2, or none
- 3 or 4
- 5 or 6
- 7 to 9
- 10 or more

16. 13.3 How often do you have six or more drinks on one occasion? *

Mark only one oval.

- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

17. 14. Do you have any longstanding illness or longstanding health problem? *

By longstanding I mean illness or health problems which have lasted or are expected to last for six months or more

Mark only one oval.

- Yes
- No
- Prefer not to say

18. 14.1. If you answered yes to the question above: What illness or long-standing health problem do you suffer from?

This question is optional.

19. 15. Do you take any regular medication? *

Mark only one oval.

- No
- Yes: 1-2 different medications daily
- Yes: 3 or more different medications daily
- Prefer not to say

20. 16. Is there anyone who lives with you who is overweight or obese? *

Mark only one oval.

- Yes
- No
- Prefer not to say

Risk of developing type 2 diabetes

This section will provide a rough estimate for the risk of diabetes.

21. 17. What is your weight in kilograms (kg)? *

Please write only the number, eg. 60

22. 18. What is your height in meters (m)? *

Please write only the number, eg. 1.70

23. 19. What is your waist circumference in centimeters (cm)? *

Check the circumference of your waist at the level of your navel (belly button).

24. 20. Are you physically active for more than 30 minutes every day? *

Mark only one oval.

- Yes
- No

25. 21. How often do you eat vegetables and fruit? *

Mark only one oval.

- Every day
- Not every day

26. 22. Have you ever taken any medication for high blood pressure on a regular basis? *

Mark only one oval.

- Yes
- No

27. 23. Have you ever been found to have high blood glucose (e.g. in a health examination, during an illness, during pregnancy? *

Mark only one oval.

- Yes
- No

28. 24. Has your grandparent, aunt, uncle, or first cousin been diagnosed with diabetes (type 1 or 2)? *

Mark only one oval.

- Yes
- No

29. 25. Has your parent, brother, sister, or own child been diagnosed with diabetes (type 1 or 2)? *

Mark only one oval.

- Yes
- No

Physical Activity

This section will collect information about your level of exercise in general.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

30. 26. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling? *

Please write the number of days only, eg "2". If you did not do any vigorous physical activities, write "None" or "n/a"

31. 27. How much time did you usually spend doing vigorous physical activities on one of those days? *

Please write the number of hours or minutes that you spent doing vigorous activity. If you did not do any vigorous physical activity or don't know, write "n/a" or "Do not know"

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

32. 28. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, * bicycling at a regular pace, or doubles tennis? Do not include walking.
Please write the number of days only, eg "2". If you did not do any moderate physical activities, write "None" or "n/a"

33. 29. How much time did you usually spend doing moderate physical activities on one of those days? *
Please write the number of hours or minutes that you spent doing moderate activity. If you did not do any moderate physical activity or don't know, write "n/a" or "Do not know"

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

34. 30. During the last 7 days, on how many days did you walk for at least 10 minutes at a time? *
Please write the number of days only, eg "2". If you did not do any walking activity, write "None" or "n/a"

35. 31. How much time did you usually spend walking on one of those days? *
Please write the number of hours or minutes that you spent doing walking activities. If you did not do any walking activityor don't know, write "N/A" or "Do not know"

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work,at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

36. 32. During the last 7 days, how much time did you spend sitting on a week day? *
Please write the number of hours or minutes that you spent sitting down on a week day. If you don't know or are not sure,write "Not sure" or "Do not know"

Nutrition

This section will collect information about the type of diet that you usually follow.

37. 33.1 How many portions per DAY of the following do you usually consume? *

Mark only one oval per row.

	Less than 1 portion per day	Between 1 to 1.5 portions per day	More than 1.5 portions per day
Fruits(1 portion = 150g)			
Cereals (1 portion = 130g)			
Meat and meat products (1 portion = 60g)			
Dairy products (1 portion = 180g)			

38. 33.2 How many portions per DAY of the following do you usually consume? *

Mark only one oval per row.

	Less than 1 portion per day	Between 1 to 2.5 portions per day	More than 2.5 portions per day
Vegetables (1 portion = 100g)			

39. 33.3 How many portions per WEEK of the following do you usually consume? *

Mark only one oval per row.

	Less than 1 portion per week	Between 1 to 2 portions per week	More than 2 portions per week
Legumes (1 portion = 70g)			

40. 33.4 How many portions per WEEK of the following do you usually consume? *

Mark only one oval per row.

	Less than 1 portion per week	Between 1 to 2.5 portions per week	More than 2.5 portions per week
Fish (1 portion = 100g)			

41. 33.5 How many units alcohol per DAY do you usually consume? *

Mark only one oval.

- Less than 1 unit per day
- Between 1 and 2 units per day
- More than 2 units per day

42. 33.6 How much Olive Oil do you usually consume? *

Mark only one oval.

- Occasional use (use sparingly or rarely, or never)
- Frequent use (use approximately weekly, but not everyday)
- Regular use (every day, or nearly every day)

Mental Health

This is the last section of the survey.

43. 34.1 Over the last 2 weeks, how often have you been bothered by the following problems? *

Mark only one oval per row.

	Not at all	Several days	Over half the days	Nearly every day
Feeling nervous, anxious, on or edge				
Not being able to stop or control worrying				
Worrying too much about different things				
Trouble relaxing				
Being so restless that it is hard to sit still				
Becoming easily annoyed or irritable				
Feeling afraid as if something awful might happen				

44. 34.2 If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people? *

Mark only one oval.

- Not applicable
- Not difficult at all
- Somewhat difficult
- Very difficult
- Extremely difficult

Thank you! This is the end of the questionnaire ;)

Thank you for your time and patience in answering this survey. Your help is very much appreciated. Please press the "Submit" button to submit your answers.

If you have any queries and would like to get in contact to clarify anything about this questionnaire, you can e-mail me at tania.cordova.06@um.edu.mt.

Thank you.

This is the end of the questionnaire.

Appendix 5: Information about type 2 diabetes and sources of help

Information section - What is type 2 diabetes?

Diabetes mellitus refers to a group of diseases that affect how blood sugar (glucose) is used by the body. There is more than one type of diabetes, with the different types referring to what is causing the high level of sugar in the body. If not treated, consistently high levels of blood glucose can cause damage to different organs leading to complications later in life.

The commonest type of diabetes is type 2. Type 2 diabetes is caused by a combination of factors, with genetic factors (that is, diseases that are passed down the family tree), environmental factors (such as pollution and urbanisation), and lifestyle factors (such as consumption of a diet rich in carbohydrates and sugar, lack of exercise, spending a lot of time sitting down and carrying out little exercise, being overweight or obese, smoking, and drinking alcohol for example), all contributing to increase the risk of developing this disease. Although it is not possible to change the genetic make-up of a person or alter the environmental factors, people can reduce their risk of developing type 2 diabetes by modifying those factors that can be changed by improving their daily lifestyle habits.

Type 2 diabetes is usually a disease of older people; however, those lifestyle factors that increase the risk of developing this disease are very difficult to change once people grow older. It is therefore important to start practicing a healthy lifestyle when young. Apart from helping to reduce the risk of developing type 2 diabetes, a healthy lifestyle can also help reduce the risk of other diseases, such as heart disease, liver and kidney disease, diseases related to the nervous system and diseases related to the bones and joints amongst others.

So, what can you do to help reduce your risk of developing type 2 diabetes?

Some of the things that can help are the following:

- Eat a healthy diet rich in vegetables and fruit, high in fibre, and low in refined sugar,
- Avoid spending a lot of time sitting down,
- Exercise at least 30 minutes a day,
- Stop smoking, or if you do not smoke, do not start. Avoid also second-hand smoking as much as is possible,
- Limit your alcohol intake,
- Seek professional help if you are suffering from excess anxiety or feel depressed,
- Speak to your family doctor or a general practitioner regarding the need for health check-ups.

The Health Promotion and Disease Prevention Directorate provides services related to adopting a healthy lifestyle, which include smoking cessation services and healthy eating amongst others. You can check the Ministry for Health website on https://health.gov.mt for further information or call on 23266000 during office hours to request a service.

You can also discuss any health issues with your family doctor or a general practitioner at the health centre.