The association between alcohol intake and obesity in a sample of the Irish adult population

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List of abbreviations and acronyms

AUDIT-C	Alcohol Use Disorder Identification Test - Consumption
AOR	Adjusted odds ratio
BMI	Body mass index
BF %	Percentage of body fat
CAPI	Computer-aided personal interview
HC	Hip circumference
ISSDA	Irish Social Science Data Archive
Kcal	Kilocalories
KJ	Kilojoule
NIAAA	National Institute on Alcohol Abuse and Alcoholism
OR	Odds ratio
RCPI	Royal College of Physicians of Ireland
SD	Standard deviation
SAMHSA	Substance Abuse and Mental Health Service Administration
ST	Skinfold thickness
UCD	University College Dublin
US	United Status
UK	United Kingdom
WHtR	Waist-to-height ratio
WHO	World Health Organization
WC	Waist circumference
WHR	Waist-to-hip ratio

Abstract

Background: The prevalence of obesity is increasing worldwide. Alcohol has been studied as a possible risk factor for obesity, but the evidence is discordant. This study examined the association between alcohol consumption and obesity in an Irish population.

Methodology: A cross-sectional study using secondary data from the Healthy Ireland Survey 2017 was conducted. Descriptive and comparative data were analysed to identify associations of alcohol-related variables with waist circumference (WC) and body mass index (BMI). Regression analysis was performed to examine associations between harmful alcohol consumption (AUDIT-C score≥ 5) and obesity indicators. Adjustments for sociodemographic variables, health-related factors, and other alcohol-related variables were applied.

Result: A total of 7,486 participants participated in this survey (response rate=60.4%). Most of the participants (86%) were alcohol drinkers, with the majority drinking less than 3 times per week (77.5%); 49.1% were considered harmful drinkers. After controlling for possible confounders, positive associations of harmful alcohol consumption with WC (β=1.978, 95% CI: 0.996, 2.960) and BMI (OR=1.247, 95% CI: 1.058, 1.471) were observed. Further controlling for alcohol consumption frequency and binge drinking made this association nonsignificant. Unlike less frequent binge drinking, daily binge drinking was positively associated with WC.

Conclusion: Harmful alcohol consumption was associated with obesity (high BMI, large WC) after controlling for possible confounders; however, this association became nonsignificant after controlling for other alcohol-related variables. Frequent binge drinkers were more likely to have a large WC. Further longitudinal studies to examine the exact association between alcohol consumption and obesity are warranted.

Keywords: Obesity, harmful alcohol drinking, binge drinking, waist circumference, BMI

Chapter 1: Introduction

1.1. Background

Obesity is considered an endemic problem worldwide. Its prevalence has tripled over the last few decades, with 13% of adults considered obese and 39% considered overweight (World Health Organization, 2021). Obesity is related to the development of various chronic illnesses, including diabetes mellitus, cardiovascular diseases, and certain types of cancers. The underlying cause of obesity is multifactorial and includes genetic and environmental factors, and attempting to understand the direct cause of obesity is difficult due to the interactions of different predisposing factors. The prevalence of obesity varies significantly among countries, with some countries showing an alarming increase in the number of cases, e.g., many countries in Southeast Asia (World Population Review 2021). According to the World Population Review 2021, the lowest prevalence of obesity worldwide was observed in Vietnam, at 2.1%, while the highest proportion was observed in Nauru, at 61% (World Population Review, 2021). In Ireland, 25.3% of the population is obese (World Population Review, 2021). Various factors have contributed to the discrepancy in obesity prevalence rates among countries, including diet, environmental and cultural factors, and the implementation of programs that increase awareness about healthy lifestyles.

Alcohol consumption has been examined in different epidemiological studies as a possible risk factor for the development of obesity. In addition to its association with many behavioural and mental problems, alcohol consumption is thought to be associated with the development of obesity (World Health Organization 2018). Both alcohol consumption and obesity are considered public health problems in Ireland. According to the Healthy Ireland Survey 2017, 6 out of 10 people were either obese or overweight (23% were obese and 37% were overweight) (Ipsos MRBI,2017). Additionally, the proportion of individuals who consumed alcohol was 76%, of whom 39% were considered binge drinkers (≥ 6 standard units of alcohol per occasion) (Ipsos MRBI,2017). The results of studies on the association between alcohol consumption and obesity are discordant and inconclusive. Some studies have shown an inverse association between alcohol consumption and obesity (Tolstrup et al., 2005; Dumesnil et al., 2013; Lean et al., 2018; Rohrer et al., 2005). Wannamethee et al., 2005, on the other hand, found a positive association between alcohol consumption and obesity. However, this association was not observed in other studies (Park et al, 2017). Different types of alcoholic beverages have been studied with regard to obesity, and the results are conflicting (Duncan et al., 1995, Slattery et al, 1992; Schutze et al. 2009, Wannamethee et al. 2005 Rosmond & Bengtsson, 1999). Further details will be discussed in the literature review in Chapter 2. The inconsistency in the evidence of the association between alcohol consumption and obesity could be attributed to many factors, including different methodologies, different types of confounders, different alcohol exposure measurements (quantity, frequency, or both), and different outcomes of interest (BMI, WC, waist-to-hip ratio [WHR], waist-to-height ratio [WHtR], or percent body fat [%BF]).

To the best of our knowledge, no single study has examined the association between alcohol consumption and obesity in Ireland, despite the high prevalence of both overweight and obesity in the country. This study will explore the association between alcohol consumption (specifically harmful alcohol consumption) and obesity in the Irish population using Healthy Ireland Survey 2017 data.

1.2. Overview of the study method

The current study analysed secondary data from wave 3 of the Healthy Ireland Survey 2017. Access to these data was requested from and permitted by the Irish Social Science, Data Archive (ISSDA). A request for exemption from ethical approval was submitted, and a letter of approval was obtained from the Research Ethics Committee of the School of Public Health, Physiotherapy and Sport Science, University College Dublin. The data of the parent study was collected using probability sampling. The survey was conducted in peoples' homes via face-to-face interviews with the aid of computer-assisted personal interviewing (CAPI). Anthropometric measurements were performed by trained staff. Verbal consent was obtained from all adult participants, and written consent was obtained from the parents/caregivers of participants aged less than 18 years. An analytical cross-sectional design was chosen for the current study. Of the 134 variables included in the parent survey, 27 variables were chosen for the current study. These variables included sociodemographic data, health-related data, alcohol-related data, and anthropometric measurement data. Further details on the methodology are discussed in Chapter 3.

The dependent variables used in this study were body mass index (BMI, kg/m^2) and waist circumference (WC, cm). WC was considered a continuous variable, while BMI was considered a binary variable (BMI ≥ 25 kg/m^2, BMI < 25 kg/m^2). The Alcohol Use Disorders Identification Test - Consumption (AUDIT-C) score, which was used to assess harmful alcohol consumption, was considered an independent variable. The participants who obtained a score of 5 or more points on the AUDIT-C questionnaire were considered harmful drinkers. Other alcohol-related factors studied were frequency of alcohol drinking (≥ 3 times per week versus < 3 times per week) and frequency of binge drinking (≥ 1 time per week versus < 1 time per week); binge drinking was defined as the consumption of six standard units of alcohol per occasion for both genders. The confounding factors that were considered in this study were sociodemographic factors (age, gender, marital status, educational status, employment status, urban vs. rural residency, full medical cards, and private medical cards) and health-related factors (general condition, long-term illness, smoking status, frequency of fruit consumption, and active travel as a mode of transportation).

Descriptive data were obtained for sociodemographic factors, health-related factors, alcohol-related factors and anthropometric measurements. Univariate analyses were performed to compare the associations of alcohol-related factors, sociodemographic factors, and health-related factors with obesity indicators (WC and BMI) using an appropriate statistical test. Multivariable analysis was then performed to examine the associations between harmful alcohol consumption and obesity indicators while controlling for possible confounders. The Windows-based statistical package SPSS (version 24) was used for analysis. A two-tailed t test was used, and a p value of <0.05 was used to define statistical significance.

1.3. Overview of the results

A total of 7,486 individuals participated in this survey, with a response rate of 60.4%. More than two-thirds of the study population was overweight or obese

(40.6% and 30.0%, respectively). Approximately 9 of 10 participants (86.5%) were alcohol drinkers, of whom 22.5% consumed alcohol three or more times per week. Among those who completed the AUDIT-C questionnaire, nearly half obtained a score of 5 or above (49.1%). Details of the results are presented in Chapter 4.

In the univariate analyses, all sociodemographic variables and most of the health-related variables were significantly associated with obesity indicators (BMI and WC) ($p < 0.05$). Obesity (BMI ≥ 30 kg/m^2) was most prevalent among the group aged 45-64 years (34.0%), females (56.4%), married participants (50.8%), participants living in urban areas (58.7%), employed participants (50.6%) and participants with a moderate education level (35.7%). WC was largest in the group aged 65 + years and older, males, those with a low educational level, and retired participants. Obesity and overweight were also prevalent among participants with a good/very good medical condition, participants without long-term illness, nonsmokers, and those who did not use active transportation. On the other hand, WC was larger in participants with a fair/poor general condition, participants with long-term illness, nonsmokers, and those who did not use active transportation than in their counterparts. Further details of the univariate analyses of sociodemographic and health-related factors and obesity indicators are presented in Chapter 4, Table 4.4, and Table 4.5.

Regarding alcohol-related variables, obesity was most prevalent in those who consumed alcohol (78.5%, $p <0.001$). Frequent drinkers (≥ 3 times per week) were less likely to be overweight (22.9%) or obese (23.9%) than occasional drinkers; however, the difference was not statistically significant ($p=0.103$). Obesity was also prevalent in less frequent binge drinkers (< 1 time per week) (64.1%, $p<0.001$) and those who scored 5 or more on the AUDIT-C questionnaire (48.2%; <0.001). On the other hand, WC was significantly larger in frequent drinkers (93.98 ± 14.35 cm; $p<0.001$), frequent binge drinkers (95.66 ± 14.16 cm; $p<0.001$), and those who scored 5 or more on the AUDIT-C questionnaire (93.4 ± 13.86 cm; $p<0.001$) than in their counterparts (Table 4.5).

Both logistic and linear multivariable regression analyses were carried out using different models; variables with a p value <0.05 were retained for subsequent analysis until a fully adjusted model was reached. After adjustment for sociodemographic and health-related factors, harmful alcohol drinkers had a significantly larger WC (β=1.98, 95% CI: 1.00, 2.960) and higher BMI (OR=1.25, 95% CI: 1.06, 1.47) than nonharmful alcohol drinkers. However, in the fully adjusted model, after controlling for binge drinking and the frequency of alcohol consumption, harmful alcohol consumption was no longer associated with a larger WC. Frequent binge drinkers (≥ 1 time per week) had a significantly larger WC (β= 2.03, 95% CI 0.089, 3.17) than less frequent binge drinkers. An inverse association between alcohol consumption frequency and obesity was observed, but it was not statistically significant.

1.4 Discussion:

The current study showed positive associations between harmful alcohol consumption and obesity indicators (BMI and WC) in model 3. After further controlling for the frequency of alcohol consumption and binge drinking, no significant association between harmful alcohol consumption and WC was found (Table 4.6, model 4). Binge drinking was also found to be positively associated with mean WC. Similarly, other studies showed positive associations between binge drinking and obesity (Arif and Rohrer, 2005; Park et al., 2017). The frequency of alcohol consumption was inversely associated with WC in this sample of the study population, but the association was not statistically significant. To the best of our knowledge, this is the first study to examine the association between alcohol consumption and obesity in an Irish population. Additionally, this study used the AUDIT-C tool to examine the association between harmful alcohol consumption and obesity. The biggest limitation of the current study is the cross-sectional study design; as a result, causation between harmful alcohol consumption and obesity cannot be inferred. Further details on data interpretation and a discussion of this study are presented in Chapter 5.

The mechanism by which alcohol consumption induces obesity is not fully understood. Some studies have suggested that alcohol increases hunger by inhibiting certain hormones, such as leptin (Yeomans, 2010). Additionally, the energy obtained from alcohol was found to have an additive effect on energy obtained from other dietary sources. Alcohol can enhance fat storage by suppressing fat oxidation. Moreover, alcohol can have a catabolic effect on muscle through its effect on sex hormones and growth hormones. Certain genes have been shown to influence the association between alcohol intake and obesity (Liao et al., 2016; Yokoyama et al, 2013), but the exact mechanism is not well defined. Overall, further studies are needed to explore the exact mechanism by which alcohol affects obesity.

Different factors have influenced the conflicting evidence of the association between alcohol intake and obesity. Such factors include variations in the prevalence of both obesity and alcohol consumption among countries, different adjustments for confounders, and different methodologies used in different epidemiological studies. Furthermore, the types of measurements used to examine alcohol consumption are different across studies and may lead to underestimation of actual alcohol consumption (Bellis et al., 2009).

Many conclusions can be derived from this study. First, most of the obesity management protocols and guidelines do not address the effect of alcohol on obesity, probably due to conflicting evidence of this association (National Institute for Health and Care Excellence, 2021). Nevertheless, these guidelines need to be regularly updated to address the possible association between alcohol intake and obesity, especially binge drinking and harmful alcohol consumption. The message regarding the association between alcohol intake and obesity shared by health care workers should be consistent and updated regularly. Future action plans and policies that address obesity management and prevention should highlight the “possible” effect of alcohol intake on obesity and establish recommendations on how to reduce the associated burden. Furthermore, it is important to increase public awareness about the possible effect of alcohol on obesity, as this might help individuals manage their alcohol consumption. Last, more research is needed to fully understand the possible mechanism by which alcohol consumption affects obesity.

1.5. Conclusion

This is the first study to explore the association between alcohol consumption and obesity in an Irish population using Healthy Ireland Survey 2017 data. Harmful alcohol consumption was positively and significantly associated with BMI and WC after controlling for sociodemographic and health-related factors. However, controlling for other alcohol-related variables made this association nonsignificant. Furthermore, frequent binge drinking was found to be positively associated with WC. No significant association between the frequency of alcohol consumption and obesity was observed. Further longitudinal studies are needed to explore the association in detail.

Chapter 2

Background and literature review

2.1 Background

Obesity is defined as an "abnormal or excessive fat accumulation that may impair health" (World Health Organization, 2021). The prevalence of obesity has tripled worldwide since 1975. In 2016, 39% of the worldwide adult population was overweight (BMI 25.0-29.9 kg/m^2), while 13% of the adult population was obese (BMI ≥ 30.0 kg/m^2) (World Health Organization, 2021). There are wide variations in obesity prevalence rates among countries; the lowest prevalence is 2.1% in Vietnam, where malnourishment is highly prevalent, and the highest prevalence is 61% in Nauru (World Population Review 2021). In Ireland, 23% of the adult population was obese, and 39% was overweight in 2017 (Ipsos MRBI,2017). This figure increased in 2021, with 25.3% of the population being considered obese (World Population Review 2021).

Obesity is associated with the development of many chronic medical illnesses, including cardiovascular diseases and different types of cancers. The possible underlying causes of obesity are complex and multifactorial. The interaction between different factors, including genetic, environmental, and societal factors, makes obesity a complex problem that requires a multisectoral, multilevel approach to reduce its burden. A behavioural factor that has been studied extensively and has gained substantial interest in the past few decades is alcohol consumption (Centers for Disease Control and Prevention 2021). Alcohol consumption has been linked to adverse health consequences, especially when consumed in excess (Ritchi and Roser 2018). Alcohol consumption imposes behavioural and mental burdens, and it has also been associated with the development of a wide range of noncommunicable diseases, including obesity and fatty liver disease (World Health

Organization 2018). The patterns of alcohol consumption among countries vary greatly and are influenced by multiple factors. The highest level of alcohol consumption was observed in Belarus, at 14.4 litters per person/year, which was 1.5 times higher than that in the United States (US). Ireland ranked sixth among the top countries for alcohol consumption, at 11.44 litters per person per year (American Addiction Centers 2021) (Figure 2.2). According to the Healthy Ireland Survey, 2017, 76% of the Irish population consumed alcohol, 54% consumed alcohol at least once a week, and 39% engaged in binge drinking (Ipsos MRBI, 2017). Beer consumption accounted for nearly half (47.0%) of all alcohol consumption in Ireland, followed by wine and spirit consumption, at 28.0% and 18.8%, respectively (World Population Review 2021) (Figure 2.2).

Many factors can affect the level and pattern of alcohol consumption at individual and societal levels. These include demographic factors, economic factors, cultural and religious factors, alcohol availability, and the presence of legislation and policies that regulate societal alcohol consumption. No single factor can fully explain the amount of alcohol consumed by an individual, but the presence of more vulnerability factors increases the likelihood that an individual will exhibit a harmful alcohol consumption pattern (World Health Organization, 2018). Several studies have analysed the effect of alcohol consumption on obesity, but the results were inconclusive. Since alcohol consumption and obesity are both public health concerns, a deeper understanding of their possible association is warranted. This literature review will explore the association between alcohol consumption and obesity.

2.1.1. Possible mechanisms by which alcohol causes obesity

The exact underlying mechanism by which alcohol consumption causes obesity is not fully understood. Among all macronutrients, alcohol is the second-highest source of energy, as each gram of ethanol provides almost 29 kJ (7 kcal) of energy (Yeomans et al, 2003). The energy obtained from alcohol was found to have an additive effect on energy obtained from other nonalcoholic sources, which subsequently led to weight gain (Yeomans, 2010). Some studies have shown that alcohol acts by increasing hunger (Yeomans et al, 1999; Caton et al., 2004; Colditz et al.1991); however, other studies have shown no significant association (Raben et al., 2003; Caton et al., 2006,2007). Moreover, alcohol is a suppressant of fat oxidation and subsequently favours lipid storage (Gianoulaki, 1998; Prentic, 1995). It also acts as a precursor for fat synthesis (Suter et al 1992). Furthermore, alcohol intake enhances cortisol secretion, which subsequently affects the distribution pattern of fat in the body (Bjorntor, 2001). Certain types of alcoholic beverages, such as beer, have higher amounts of carbohydrates per unit of alcohol than others and thereby contribute to an increased risk of obesity. Moreover, alcohol consumption has a catabolic effect on muscle tissue through its effects on sex hormones and growth hormones. This leads to fat deposition in visceral organs and muscles, which further leads to the development of various noncommunicable diseases, including obesity and diabetes mellitus (Suter et al, 1992). Finally, individuals who engage in binge drinking usually have other impulsive behaviours that could contribute to weight gain; thus, it is important to assess both personal and environmental factors that influence the behaviour of binge drinking in individuals (Fischer &Smith, 2008).

Mild to moderate alcohol consumption, on the other hand, was shown to protect against weight gain, especially in women, according to epidemiological data (Yeomans et al, 2003). Several studies have examined the possible mechanism by which alcohol consumption can reduce the risk of obesity; however, the exact mechanism is still unclear. One possible mechanism is the activation of a microsomal ethanol oxidizing system that can stimulate thermogenesis, which in turn can lead to weight loss. Additionally, nonbinge, regular alcohol consumption may act as an appetite suppressant and thus help in reducing weight (Yeomans et al, 2003). Overall, further investigations are needed to determine the possible underlying mechanism and further resolve the paradox behind the relationship between alcohol consumption and body weight.

2.1.2. Measurement of obesity

Epidemiological studies have used different indirect adiposity indicators to analyse the association between alcohol consumption and obesity. These indicators include BMI, WC, waist-to-hip ratio (WHR), and skinfold thickness (ST) (Rothman, 2008). The most commonly used indirect measure of adiposity is BMI, as it is easy to calculate and inexpensive. The World Health Organization (WHO) defines obesity as BMI equal to or more than 30 kg/m^2 (World Health Organization 2021). Table 2.1 represents the WHO classification of BMI, which is calculated as weight over height squared (kg/m^2). However, BMI is a crude measure of adiposity and does not consider nonfat mass, such as bone and muscle mass; thus, it can be misleading in certain groups, e.g., athletes and elderly individuals (Rothman, 2008). Moreover, the BMI indicator does not consider age, gender or ethnic background, which makes it challenging to use as an independent measure representative of adiposity. Many times, BMI measurement can lead to the misclassification of individuals with excess body fat but a normal BMI (Rothman, 2008). Frankenfield et al., 2001 found that 30% of men and 46% of women who had a BMI < 30 kg/m^2 were misclassified as nonobese (Frankenfield et al, 2001). WC and the WHR, on the other hand, are considered suitable indicators to examine obesity morphology. Using more than one indirect indicator might provide a better overview of adiposity. However, the use of different measures to assess adiposity indicators and alcohol intake contributes to conflicting results regarding the alcohol-obesity relationship.

Table 2.1: Body Mass Index (BMI) classification*

Classification	**BMI (kg/m^2)**	**Risk of comorbidity**
Underweight	<18.50	Low
Normal weight	18.50-24.99	Average
Overweight	25.00-29.99	Increased
Obesity class I	30.00-34.99	Moderate
Obesity class II	35.00-39.99	Severe
Obesity class III	≥ 40.00	Very severe

*Reproduced from the WHO 2000

2.1.3. Measurement of alcohol consumption

Measuring alcohol consumption is challenging, as no single standard definition exists across countries. The WHO has defined binge drinking as the consumption of at least six standard drinks on one occasion, and this is the same definition applied in Ireland (Alcohol Action Ireland, 2021). The current recommendation for low-risk drinking in Ireland is less than 17 standard drinks (10 grams of pure alcohol) for men (< 11 standard drinks for women) per week, with a recommendation to spread consumption throughout the week and allow for 2-3 free drinks per week. (Health service executive, 2021). On the other hand, the National Institute on Alcohol Abuse and Alcoholism (NIAAA) defines binge drinking as the consumption of 5 or more drinks for males or 4 or more drinks for females within two hours. The Substance Abuse and Mental Health Service Administration (SAMHSA) extended the definition to the consumption of a similar amount (5 or more drinks for males, 4 or more drinks for females) within two hours or at the same time on at least 1 day in the past month. For males, heavy drinking is defined as the consumption of “more than 4 drinks in any day or more than 15 drinks a week”, while for females, it is defined as the consumption of “more than 3 drinks on any day or more than 7 drinks in a week” (National Institute on Alcohol Abuse and Alcoholism, 2021).

When addressing alcohol consumption for epidemiological and research purposes, it is important to address the following factors: alcohol consumption status, the average volume of alcohol consumed, the frequency of consumption, the volume consumed during heavy episodic drinking, the beverage-specific quantity and frequency, and the context under which alcohol is consumed (Nugawela et al., 2016). Dawson, 2021, suggested measuring alcohol consumption in terms of quantity/frequency (QF), graduated frequency (GF), or both (Dawson, 2021). However, not all these factors have been analysed in previous examinations of the association between alcohol intake and obesity, and on many occasions, some terms , such as heavy drinking and binge drinking, have been used interchangeably, which has caused inconsistencies in the collected data. Additionally, some studies used standard drink volumes that differed from one country to another, while others used actual drink volume. Moreover, different studies have used different reference periods for measuring alcohol intake (e.g., within the last year, last month, or last week, or last drink), and this in turn can further affect the overall result (Dawson, 2021).

Alcohol consumption can be measured using self-reporting, telephone interviews, or personal interviews, although the last method is the best option for gathering accurate data. At the population scale, the most common method for the collection of alcohol data is a self-report questionnaire. Despite its common application, the self-report method might not be an accurate method for the evaluation of alcohol consumption, as it is prone to different types of bias and misinterpretation. Bellis et al. found that self-reported alcohol consumption accounts for only 40-60% of total alcohol sales and thus underestimates alcohol intake (Bellis et al., 2009). This might be attributed to the fact that these surveys exclude subgroups of populations among whom the prevalence of alcohol intake is high, such as homeless individuals, those in the armed forces, people living in institutions, and students (Rehm 1998).

2.2. Literature search strategies

To gather all relevant literature, the PubMed, CINHAL, and Medline databases were searched for publications on the association of alcohol consumption with obesity. The keywords used in the primary search were "ethanol", "alcohol drinking", "wine", "beer", "whisky", "obesity", "overweight", "body mass index", "BMI", "waist circumference", and "'WC". Medical Subject Heading (MeSH) terms and Boolean operators (AND, OR) were used to narrow the search for relevant literature. The search was restricted to articles published between January 1990 and December 2020. The inclusion criteria for potentially relevant studies were subjects aged 18 years and older, publication in English, and a cross-sectional design. The exclusion criteria were subjects aged less than 18 years, the inclusion of subjects who were pregnant or breastfeeding , unpublished articles, and publication in a language other than English. The references of the included studies were also searched for relevant articles. A total of 546 articles resulted from this search. After reviewing the titles and abstracts, 513 articles were excluded (Figure 2.1). Additionally, 15 studies were found to be duplicates and were thus removed. Full-text reviews were performed for the remaining 32 articles, and 16 articles were found to be relevant. A summary of the literature review process is shown in Table 2.2.

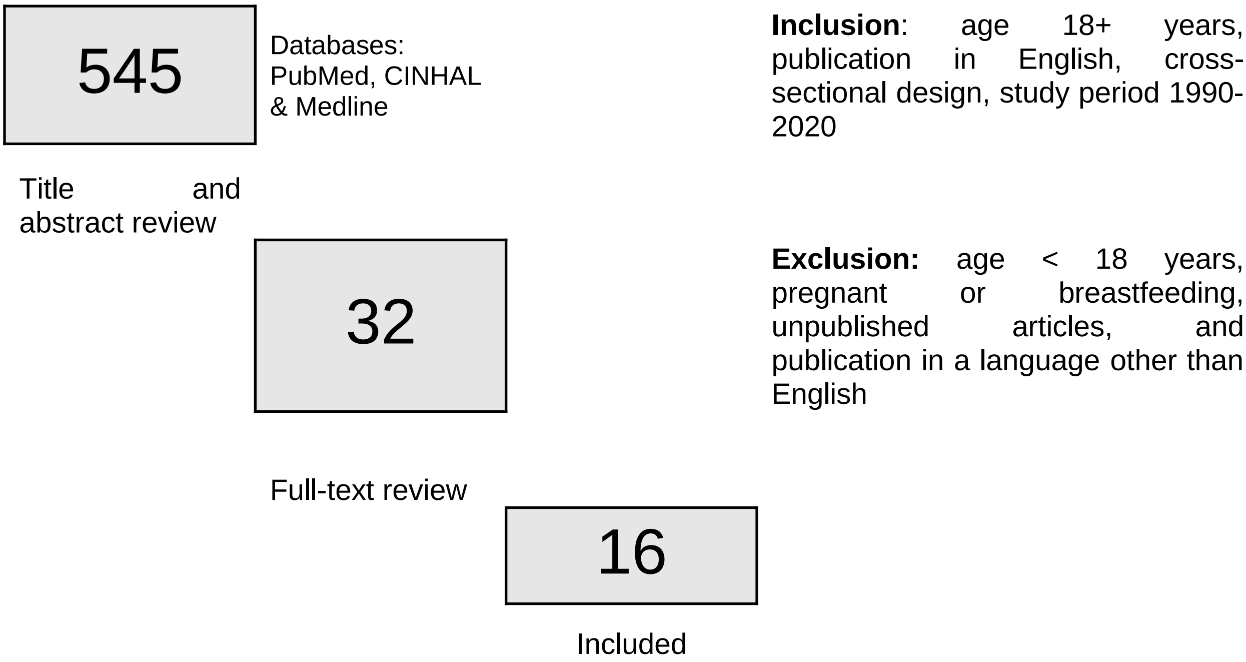

Figure 2.1 Alcohol consumption and obesity, literature review search strategies

2.3. Literature review

No consensus regarding the association between alcohol intake and obesity has been achieved (Suter et al. 1997). Evidence of a positive association (Wannamethee et al. 2005; Shelton and Knott 2013; Vadstrup et al., 2003), inverse association (Lean et al 2018; Tolstrup et al 2005), and no association is discordant (Eisen et al 1993). Light to moderate alcohol consumption was shown to be protective against weight gain (SAayon-Orea et al, 2007). This contradiction in evidence could be attributed to the various methodologies used, different adjustments for confounders, different baseline alcoholic beverage intake values, different nutritional habits of the population, variable alcohol consumption measurements (frequency versus quantity), and different types of obesity indicators measured. The following sections will address the literature review for the association of obesity with alcohol consumption based on the search performed for this study.

2.3.1. Frequency and pattern of alcohol consumption and obesity

2.3.1.1. Inverse association between frequency of alcohol consumption and obesity

Evidence of the association between the frequency of alcohol consumption and obesity is discordant. Dumesnil et al., 2013, examined the association between alcohol consumption per occasion and obesity in French middle-aged men (50-59 years) using a self-report questionnaire (n=7,855). Daily drinking was reported by 75% of the study population. After adjustment for possible confounders, the results showed inverse associations between the frequency of alcohol consumption and adiposity indicators (both BMI and WC) independent of total alcohol consumed (P<0.0001); those who consumed alcohol occasionally (1-2 days/week) had higher odds of obesity than those who consumed alcohol more frequently (3-5 days/week) or daily drinkers. The finding was similar for both wine and beer consumption. Additionally, there was a significant interaction between the total amount of alcohol consumed and the frequency of alcohol intake (p= 0.0003), which can explain the conflicting results between studies (Dumesnil et al., 2013). Tolstrup et al, 2005, found inverse associations between the frequency of alcohol consumption and obesity indicators (both BMI and WC) in a Danish population, irrespective of gender or total alcohol intake. A cross-sectional, nationally representative Scottish study was performed in adults of both genders aged 18 years and older (n=20008) using personal interviews. The prevalence of obesity in this study was slightly higher in females than in males (25% and 23.5%, respectively). A total of 90.6% of the population cohort consumed alcohol. After adjustment for possible confounders, the frequency of alcohol consumption was found to be inversely associated with obesity, as daily drinkers had a lower BMI and WC than less frequent drinkers in both genders (Lean et al 2018), similar to other study findings (Breslow 1997-2001).

Another study was conducted in the US by Rohrer et al., who analysed a purposive sample of adult patients attending three community clinics (n=747). Sixty-five percent of the participants were either overweight or obese. After adjustment for confounders, the result showed an inverse association between alcohol consumption frequency and obesity, as those who consumed 3 or more alcoholic drinks per month had lower odds of obesity than nondrinkers (OR=0.49, P=0.037) (Rohrer et al., 2005). The biggest limitations of the study were the use of self-reported weight/height measurements and the purposive sampling method. Arif and Rohrer examined the association between alcohol consumption (drinkers versus nondrinkers) and obesity (BMI) in nonsmoking US participants (n=8236). The results showed that more than half of the study population was either overweight or obese (31.4% and 21.9%, respectively). The overall prevalence of current drinking in this study was 46%, with the number of male current drinkers being twice that of female current drinkers (63% vs. 35%, respectively, p <0.001). After adjustment for possible confounders, the odds of obesity were 0.73-fold lower among current drinkers (AOR= 0.73; 95% CI: 0.55-0.97) than among nondrinkers (Arif and Rohrer 2005). No association between alcohol consumption and overweight was observed in the study. However, it did not consider dietary factors, type of alcohol consumed, and the context under which alcohol was consumed. Additionally, focusing on nonsmokers makes the results less generalizable.

2.3.1.2. Positive association between frequency of alcohol consumption and obesity

Positive associations between alcohol consumption patterns and obesity were observed in different studies. A large population-based study conducted in both Scotland and England examined the associations of alcohol consumption with obesity indicators (BMI, WHR) using a seven-day recall method. The results showed a bell-shaped curve for the association between the frequency of alcohol consumption (times per month) and obesity, i.e., there was no difference between those who drank frequently and those who never drank. There was a positive linear relationship between the volume of alcohol consumed and obesity in this study; those who never drank had the lowest BMI. Additionally, the quantity of alcohol consumed was found to have had a positive confounding effect on the association between the frequency of alcohol consumption and obesity (O'Donovan et al, 2018). This may explain the conflicting results in other studies upon examination of such associations. However, this study did not consider the type of alcohol consumed. Wannamethee et al. 2005 carried out a study in elderly men (aged 60-79 years, n=3327) in the United Kingdom (UK), and the results showed that moderate or heavy drinkers (21 or more drinks/week) had higher adiposity levels (WC, WHR, BMI, %BF) than those who consumed less than one drink/week, irrespective of the type of alcohol and pattern of consumption. Another study showed a positive association between the quantity and frequency of alcohol consumption (Breslow& Smothers, 1997-2001).

Studies that address the association of alcohol consumption with obesity stratified by occupation are limited. A descriptive study analysed self-reported alcohol consumption among Australian farmers (n=1792) and its relation to obesity (BMI, WC). The prevalence of short-term high-risk alcohol consumption (> 6 standard drinks (SDs) for men, >4 SDs for women on a single occasion) was markedly high in this study sample (56.9% in adult males, 27.5% in adult females) compared to the national level (20.5% in adult males, 16.9% in adult females). Additionally, in participants with psychological distress, positive associations between high-risk alcohol consumption and abdominal obesity (WC) and general obesity (BMI) were observed (Brumby et al.,2013). Similar studies have shown that high-risk, harmful drinking is more prevalent in rural areas than in urban areas (Cooper-Stanbury & Nagris 2009). Other studies highlight the positive association between alcohol consumption and depressive symptoms that could lead to adverse, yet modifiable, behavioural risk factors, including increased alcohol consumption and abnormal dietary habits, that subsequently lead to obesity (Strine et al., 2001, Ahluwalia et al., 2004).

2.3.1.3. No association between frequency of alcohol consumption and obesity

Evidence presented in some studies has indicated no association between the frequency of alcohol consumption and obesity. In the current literature review, only one study reported no association between the frequency of alcohol intake and obesity. Park et al., 2017, examined the effect of alcohol consumption on abdominal obesity in normal-weight middle-aged (40-69 years) Korean adults (n=11289). The prevalence of abdominal obesity in this study was similar between males and females (7.9% and 7.6%, respectively). The results showed that the frequency of alcohol consumption had no significant association with abdominal obesity in normal-weight adults (Park et al. 2017). Similarly, Gruchow et al., 1985, Jones et al., 1982, concluded that there was no significant association between the frequency of alcohol consumption and obesity.

2.3.1.4. Binge drinking and obesity

The amount of alcohol consumed per occasion, specifically binge consumption, was also studied with regard to its relationship with obesity indicators, with an overall positive association. Park et al., 2017, found that male participants who engaged in daily binge drinking (≥ 7 drinks per occasion for males, ≥ 5 drinks per occasion for females) had a higher odds of abdominal obesity (OR=2.10, 95% CI: 1.21, 3.63) than less frequent binge drinkers. However, this association was nonsignificant in female participants. Arif and Rohrer, 2005, showed a dose–response relationship between binge drinking and obesity, with participants of both genders who engaged in binge drinking (5 or more drinks per occasion) having an odds of obesity 1.77-fold higher than that of nonbinge drinkers (OR=1.77; 95% CI: 1.18, 2.65). Rohrer et al., 2005, examined the association between alcohol consumption and obesity in adult patients attending three community clinics in the US (n=793) and found that the frequency of binge drinking (> 5 drinks per occasion for males, >4 drinks per occasion for females) was not associated with obesity. This result could be attributed to the small number of binge drinkers in this study (only 43 participants). The possible explanation by which binge drinking could lead to obesity is not clear, but some studies suggest that binge drinkers also exhibit other impulsive behaviours that might contribute to their weight gain (Fischer &Smith, 2008).

2.3.2. Total alcohol consumption and obesity

Total alcohol consumption as an indicator in the examination of the association between alcohol consumption and obesity has been studied extensively, with an overall positive association (Ferreira et al 2008; Schro¨der et al 2007; Tolstrup et al., 2005; Lean et al 2018). A study was performed in a Spanish adult population comprising both genders to explore the association of alcohol consumption with abdominal obesity (WC, n= 3054) using a self-reported food frequency questionnaire. The mean alcohol consumption value was higher in males than in females, at 18.1 ± 20.7 g/d and 5.3 ± 10.4 g/d, respectively, and both genders predominantly consumed wine. There was a significant association between abdominal obesity and energy underreporting (p =0.001). After controlling for age, smoking status, educational level, diet quality, leisure-time physical activity level, and energy underreporting, males consuming more than 30 grams of alcohol per day had higher odds of abdominal obesity (OR=1.80, 95% CI: 1.05, 3.09) than those consuming less than 10 grams per day. However, this association was nonsignificant in females, possibly because only a small proportion of women (2.3%) drank more than 30 grams of alcohol per day. Additionally, those who consumed more than 30 grams of alcohol exceeded the recommended energy consumption (OR= 1.97, 95% CI: 1.32, 2.93) (Schro¨der et al 2007). A similar finding was observed in a British study in elderly men (60-79 years, n= 3327); those who consumed more than 21 units of alcohol per day had significantly higher rates of abdominal obesity (WC, WHR) and general obesity (BMI, %BF) than nondrinkers and light drinkers, irrespective of the type of alcohol or time of alcohol consumption (Wannamethee et al., 2005). Lean et al., 2018, found that heavy drinkers (21-28 units per week) had a significantly higher BMI and larger WC than light drinkers (1-7 units per week). However, the study showed no significant correlation between the type of alcoholic beverage and obesity. Another study was performed in France using six-day, 24-hour dietary records to examine the association between total alcohol intake (grams/day) and obesity (WHR, BMI) in adults of both genders (n=2323). After adjustment for possible confounders, a J-shaped relationship was found between total alcohol intake and WHR; those who drank less than 100 grams per day had a lower WHR than nondrinkers or heavy drinkers ($p < 0.05$). However, only men demonstrated a J-shaped association between total alcohol intake and BMI ($p < 0.05$) (Lukasiewicz et al, 2005).

Another study was conducted among male blood donors aged 20-59 years in Brazil (n=1235) to examine the association between total alcohol consumption and abdominal obesity (WC, WHR) using a self-report questionnaire. Beer consumption was highly prevalent in this study, as 90% of participants who consumed alcohol consumed beer. The results showed positive associations between total alcohol intake and WHR and WC (p=0.01 and p=0.03, respectively) after controlling for age, smoking status, physical activity level, and percent body fat (Ferreira et al 2008). However, many confounders were not addressed in this study, including dietary factors, marital status, and educational status.

Tolstrup and colleagues examined total alcohol intake in relation to obesity (BMI, WC) in a sample of the Danish population (n=49877). The results showed that total alcohol consumption (drink/week) was positively associated with both BMI and WC in both genders. However, it was inversely associated with hip circumference in males, but in females, this association existed at only the highest level of alcohol intake (Tolstrup et al., 2005). Similarly, O'Donovan et al., 2018, found a positive linear relationship between the volume of alcohol consumed and obesity; those who never drank alcohol had the lowest BMI. Moreover, participants of both genders with high alcohol consumption per occasion (≥ 7 per occasion for men and ≥ 10 per occasion for women) were more likely to be obese than less frequent drinkers, even after controlling for the frequency of alcohol consumption. Moreover, Arif and Rohrer, 2005, concluded that heavy drinkers (≥ 4 drinks/day) had higher odds of overweight (OR 1.30, 95% CI: 1.00, 1.68) and obesity (OR=1.46, 95% CI: 0.98, 2.17) than non-/former drinkers. Moreover, light to moderate drinkers (< 5 drinks per week) had lower odds of obesity (OR 0.62, 95% CI: 0.46, 0.82) than non-/former drinkers (Arif and Rohrer 2005). Wakabayashi examined the influence of age on the relationship between alcohol consumption and obesity (WC, WHR) in Japanese males aged 20-70 years old (n=36121). The results showed that young participants with light and moderate alcohol consumption (< 44 g/day) had a significantly smaller WC and a lower WHR than nondrinkers (<0.01). On the other hand, values in the 3rd quartile showed a significant association with only light drinking (<22 g/day) (Wakabayasi et al, 2010, 2011).

Overall, some studies showed that alcohol consumption volume acts as a positive confounder of the association of alcohol consumption frequency and obesity (O'Donovan et al 2018) and might explain the inconsistencies among the results of different studies.

2.3.3. Type of alcoholic beverage and obesity

Results of the association between the type of alcoholic beverage and obesity are also controversial. Some studies showed positive associations of obesity with the consumption of beer (Duncan et al., 1995, Slattery et al, 1992; Schutze et al. 2009; Wannamethee et al. 2005; Ferreira et al, 2008), wine (Slattery et al, 1992;), spirits (Wannamethee et al. 2005) and all types of alcoholic beverages (Wannamethee et al. 2005). Others showed an inverse relationship (Rosmond & Bengtsson, 1999). This may be attributed to several individual and societal factors that confound or interact with the association between alcohol consumption and obesity, along with methodological factors that can alter the results obtained.

A study that was conducted among young and middle-aged Brazilian males (20-59 years, n=7,855) showed that beer consumption was positively associated with a larger WC ($\beta=0.026$, $p=0.02$) and higher WHR ($\beta=0.0002$, $p=0.02$), while spirit consumption was positively associated with only WC ($\beta=0.244$, $p=0.04$) after controlling for possible confounders. However, wine consumption was not associated with either WC or the WHR in this study sample. The results might be subject to confounding by the preference and availability of certain beverages, as 90% of participants in this study were beer drinkers (Ferreira et al., 2008). Another study in the US, where beer consumption is prevalent (48%) compared to other types of alcoholic beverages (14% wine, 38% liquor), showed that the frequency of nonwine alcohol consumption (specifically > 6 drinks/week) was positively associated with a large WHR (OR=1.4, 95% CI: 1.1, 1.7), which might support the common notion of a "beer belly". On the other hand, wine consumption was negatively associated with a large WHR (OR=0.45, 95% CI: 0.21, 0.95). (Duncan et al., 1995). These results were in contrast with those of another study in the US that showed that liquor, wine, and beer consumption all had a positive association with a large WHR (Slattery et al, 1992).

Another study in France analysed associations of the consumption of different types of alcoholic beverages with obesity (WHR, BMI). Wine was the most common type of alcoholic beverage consumed. The study showed that the median alcohol consumption value in males was almost four times higher than that in females (19.9 grams/day and 4.8 grams/day, respectively). Spirit consumption was positively associated with both BMI and WHR in both genders. Participants who drank less than 100 grams of wine per day had a higher BMI and WHR than nondrinkers and heavy drinkers. No significant relationship was found between beer consumption and BMI/WHR (Lukasiewicz et al, 2005). However, the absence of an association does not mean the absence of a relationship, as beer consumption is uncommon in France.

Age could also affect the association between alcohol consumption and obesity. In a study performed among senior UK participants (60-79 years), the results showed that the consumption of beer, wine, spirits, and mixed drinks were all positively associated with BMI, although the greatest effect was shown with beer (>3 drinks/week) (Wannamethee et al. 2005). Wakabayashi and colleagues examined the associations of alcohol consumption (quantity, frequency) with obesity indicators (WC, WHR) and found an inverse association between alcohol consumption and obesity ($p<0.01$), with a more prominent association in the younger age group than in the older age group (Wakabayasi et al, 2010, 2011).

Gender has also been found to influence the association between alcohol consumption and obesity, and alcoholic beverage preference and availability have major effects on the type of alcohol consumed. Bobak et al. examined the association between beer consumption and obesity (BMI, WHR) among adult Czech participants (age 25-64 years old, n=1989) using 24-hour dietary recall. The results showed that the average weekly intake values of beer in men and women were 3.1 litres and 0.3 litres, respectively. The effect of beer was different in both genders, with a weakly positive association with the WHR in men and a weakly negative association with the WHR in women. Additionally, beer intake had an inverse association with BMI in only women (Boback et al, 2003).

2.3.4. Time of alcohol consumption and obesity

Context and time of alcohol consumption could also affect the pattern and volume of alcohol intake. However, limited studies have examined associations between the time of alcohol consumption and central and general obesity. A large cross-sectional study examining associations of the time and frequency of alcohol consumption with obesity indicators (WHR, WC, BMI, and % BF) using a self-report questionnaire was performed in the UK. All four adiposity indicators significantly increased with increasing alcohol intake, though the effect was remarkable for central obesity indicators (WC and WHR), and this effect remained irrespective of the time of alcohol intake. No specific interaction was found for the time of alcohol consumption ("with" versus "before/after" meals) when examining the association between alcohol consumption and obesity (Wannamethee et al. 2005). However, the context under which alcohol is consumed has not been studied adequately; thus, further research is needed to explore a possible association of the time of alcohol consumption and the context under which an individual drinks alcohol with obesity.

2.3.5. Alcohol consumption and obesity twin study

A limited number of studies have looked at the interactions between genetic and environmental factors that predispose individuals to obesity. A population-based cross-sectional study was conducted in 6121 male twins aged 18-79 years in China using a self-report questionnaire. The study showed that alcohol consumption was positively associated with BMI after controlling for sociodemographic and lifestyle factors. However, when controlling for shared factors in the within-pair analysis (for both monozygotic and dizygotic twin pairs), current alcohol consumption had no significant influence on BMI. This might indicate that familial factors play a role in the development of obesity. There was a statistically significant interaction between alcohol consumption and the presence of certain genes on BMI (95% CI: -0.215, -0.058), i.e., regular alcohol drinking downregulated the effect of genetics on BMI. On the other hand, it might increase environmental-related variance in obesity (Liao et al., 2016). Similar findings of alcohol-gene interactions were reported in female-twin study, in which the association between alcohol intake and central obesity was limited to those participants who were genetically susceptible to obesity (Greenfield et al., 2003). Moreover, a study conducted in African American participants showed that alcohol consumption acted as a positive effect modifier in those with a certain allele: (PPARGC1A) rs4619879 (Edward et al., 2012). More studies on alcohol-gene interactions need to be carried out to better understand the possible mechanism for such interactions.

2.3.6. Limitations of the literature review

The current literature review has several strengths. Most of these studies had large sample sizes, and some of them enrolled nationally representative samples (Park et al., 2017; Wakabayashi et al., 2010, 2011; O'Donovan et al., 2018); thus, the results are more likely to be generalizable. The literature review included studies from different countries with different backgrounds and different alcohol intake patterns. All studies except two (Rohrer et al., 2005; Liao et al., 2016) had anthropometric measurements performed by trained staff.

There are several limitations to this literature review. It examined only cross-sectional studies; thus, it was difficult to infer causation between alcohol consumption and obesity or confirm evidence of the temporal sequence of events. Additionally, cross-sectional studies are prone to recall bias and selection bias that might affect the accuracy of the data obtained. Most of the studies analysed secondary data that might not include all the confounding variables. Furthermore, all studies except three (Lean et al., 2018; O 'Donovan et al.,2018; Ferreira et al., 2008) used self-report questionnaires, which generally underestimate the amount or frequency of alcohol consumed (Bellis et al., 2009). Self-report questionnaires have disadvantages in terms of response bias, intentional/unintentional misinterpretation of questions, or missing data for vital questions. Different measurements were used to explore alcohol consumption; some studies used short-recall methods (Park et al., 2017; Wannamethee et al., 2005; Ferreira et al.,2008), while others used long-recall methods (Tolstrup et al., 2005). Studies using different cut-off limits for alcohol-related variables and obesity indicators were included in the current literature review, which makes comparisons challenging. Many of these studies did not consider baseline alcohol consumption, cultural differences, time of consumption, contexts under which alcohol was consumed, sleep patterns, diet, and physical activity levels, as many of these studies used secondary data to study the association. The reference groups used in the analysis also differed among studies. Finally, the current literature review might have also missed important studies that were not identified up during the search process.

2.3.7. Gaps in knowledge

Current evidence of the association of alcohol consumption and obesity is controversial. In Ireland, according to the Healthy Ireland Survey, 2017, 60% of the Irish population is obese or overweight. Additionally, the prevalence of alcohol consumption in the population is significantly high, with three-quarters of the population (76%) considered drinkers and 39% reporting binge drinking (more than 6 standard units of alcohol) (Ipsos MRBI,2017). Both obesity and alcohol consumption are public health concerns in Ireland and need immediate attention, especially given the high prevalence. To the author's knowledge, no study has examined the association between alcohol consumption and obesity in the Irish population. Moreover, none of the studies discussed in this literature review addressed the effect of harmful drinking using the AUDIT-C and its relationship with obesity. The current thesis aims to further explore the association between alcohol consumption and obesity in a sample of the Irish population.

2.3.7. Conclusion

This literature review included 16 cross-sectional studies that examined the association between alcohol consumption and obesity, with discordant results. Many studies showed a positive association between alcohol consumption and obesity, while others showed a negative association. The mixed result can be attributed to many factors, including differences in baseline alcohol consumption in the study populations, alcohol consumption variables, obesity indicators, methodologies, and adjustments for confounders. The development of more standardized tools to aid in the examination of the association between alcohol consumption and obesity is warranted.

2.4. Aim(s) and objectives

2.4.1. Research question

What are the associations of sociodemographic and health-related factors, including alcohol-related factors, with obesity, and is there an association between alcohol consumption and obesity in the Irish population who participated in wave 3 of the Healthy Ireland Survey 2017?

2.4.2. Specific aim(s)

1. To explore the association between alcohol consumption and obesity in the Irish adult population.

2. To explore the associations of sociodemographic factors and health-related factors, including alcohol-related factors, with obesity.

2.4.3. Objectives

1. To determine the prevalence and pattern of alcohol consumption, including harmful alcohol consumption, in this Irish population sample.
2. To explore the associations of sociodemographic factors and health-related factors with obesity indicators using WC and BMI.
3. To explore the associations of alcohol consumption with obesity indicators using WC and BMI.
4. To explore whether harmful alcohol consumption is significantly associated with obesity using multivariable regression analysis.

Table 2.2 Literature review of cross-sectional study that analyse the association between alcohol consumption and obesity (n=16)

Ref Author/ Year	Aim	Country (n)	Study population	Source of data, measurement	Alcohol measurement (Type)	Anthropometric measurement (Type)	Adjustment	Results summary
Park et al. 2017	To examine the association between alcohol consumption and WC.	Korea N=11289)	Adults aged 40-60 years with a normal BMI	Korean National Health and Nutrition Examination survey (KNHANES) from 3 waves (2008 to 2013)	-Self-reported -Quantity per occasion, consumption frequency, and binge frequency using single-day recall	-Measured (WC) -WC ≥90 cm for males and ≥85 cm for females	Age, sex, BMI, smoking, physical activity, education, income, energy intake	-High alcohol consumption on one occasion was associated with an increased risk of a large WC - Daily binge drinking was associated with a large WC -Frequency of alcohol consumption was not associated with a large WC in those with normal weight
Wakabayashi et al 2010, 2011	To investigate the effect of age on the relationship between alcohol intake and obesity in Japanese men.	Japan (n=36121)	Male workers aged 20-70 years	Local population database. Questionnaire provided at workplace examination clinics in Yamagata Prefecture.	-Measured in the clinic -Quantity (g/day), frequency and type of alcohol -Drinkers defined as “daily drinkers” - Heavy drinkers (≥44 g/day)	-Measured (BMI, WC, WHR) -WC ≥85 cm for both genders, WHR ≥0.05	Age, smoking	-An inverse association between alcohol consumption and BMI was observed, with a stronger association in the younger group than in the older group -An inverse alcohol consumption and WC and WHR association in only the young age group was observed -BMI was lower in light/moderate drinkers (<22 g/day) than in nondrinkers.
Wannamethee et al. 2005	To examine the association between pattern and frequency of alcohol intake with obesity in elderly men.	UK (n=3327)	Men aged 60-79 years with no PMH of DM, MI, or stroke	British Regional Heart Study (1999-2000)	-Self-reported using seven-day dietary recall -Quantity, pattern, and type of alcohol consumption	-Measured (WC, WHR BMI, %BF)	Age, smoking, physical activity, CVD, total fat, nonalcoholic calories	-All obesity indicators increased with increasing alcohol intake -The consumption of >21 units/week of alcohol was positively associated with BMI, WC, WHR &%BF in men irrespective of the time of alcohol consumption -An association with beer and spirits was evident
Arif and Rohrer 2005	To examine the association between alcohol consumption and obesity in nonsmoking US adults.	US (n=8236)	Nonsmoking, nonpregnant women aged 18 years and older in the US	Third National Health and Nutrition Examination survey (1988 to 1994)	-Self-reported -Quantity, frequency, and type of alcohol consumed -Binge drinking defined as ≥ 5 drinks/occasion	-Measured (BMI)	Age, sex, marital status, race, ethnicity, poverty to income ratio, education level, urban/rural residency, leisure-time physical activity	-Current drinkers had lower odds of obesity than nondrinkers -A dose-response relationship between binge drinking and overweight/obesity was observed -An inverse association between moderate alcohol consumption and obesity was observed
Liao et al 2016	To examine the association of alcohol consumption and smoking with	China (n=6121)	Male twins aged 18-79 years with no previous CVD and no T2DM	Chinese National Twin Registry	-Self-reported -Drinking status (current verses formal/no drinking)	-Self-reported (BMI)	Age, region, zygosity, marital status, education level, alcohol	-Alcohol was positively associated with BMI in the whole sample of twins -There was no significant difference in BMI between former alcohol drinker and nondrinkers

	obesity and whether these factors can modify the genetic variance in BMI.		(2011-2012)		-No data on quantity or frequency of alcohol intake		consumption status, physical activity level	-In the gene-BMI association, alcohol acted as negative effect modifier -Smoking was negatively associated with BMI, independent of genetic influences.
Schro¨der et al 2007	To explore the association between alcohol consumption and abdominal obesity in both genders.	Spain (n=3054)	Purposive sample of Spanish adults (18+) with average energy intake in Girona	REGICOR study and a population-based survey questionnaire, Girona, 1999-2000.	-Self-reported using the FFQ. -Total alcohol intake (units/day) and type of alcohol	-Measured (WC)	Age, smoking, leisure-time physical activity, education level, diet quality, energy underreporting	-The average consumption of alcohol in a day was 3 times higher in men than women (18.11 ± 20.7 g/d vs. 5.3 ± 10.4 g/ d, respectively). -A positive association between total alcohol consumption and abdominal obesity in only men irrespective of energy underreporting was observed
Rohrer et al 2005	To examine the association between alcohol consumption and self-reported obesity in primary care patients visiting a community medical clinic.	US (n=793)	Convenience sample of adult patients aged 18+ years who were nonpregnant (response rate 54%)	Self-report questionnaires administered in three clinics serving low-income patients	-Self-reported -Frequency (days/month) and intensity (frequency of binging/month) - Binge drinking was defined as ≥ 5 drinks/occasion)	-Self-reported (BMI)	Age, access to a location for walking, concern about food, days with impaired activity of daily living	-Frequent drinking (> 3 days/month) was inversely associated with obesity -Frequency of binge drinking was not associated with obesity
O'Donovan et al 2018	To examine the association between alcohol consumption and obesity.	Scotland and England (n=106182)	Convenience sample of adult patients aged 18 + years of both genders	England and Scottish health surveys from different years	Personal interview (self-report questionnaire was optional.) -Both quantity and frequency data were collected using 7-day recall	-Measured (BMI, WHR) -Abdominal obesity: WHR >0.9 for men, > 0.85 for women	Age, sex, smoking, physical activity, long-term illness, psychological distress, socioeconomic status	-The association between alcohol consumption frequency and obesity (BMI) was "bell shaped" -Abstinence was associated with an increased risk of obesity among women -Drinking volume positively confounded the alcohol consumption frequency and BMI relationship
Brumby et al. 2013	To examine the association between alcohol consumption patterns and physical/mental health in farmers.	Australia (n=1792)	Adult farmers aged 18-74 years of both genders with no PMH, no pregnancy and no lactation	Sustainable farm family (SFF) programme, 2003 to 2009	-Self-reported -Short-term risk level was calculated (defined as > 6 SD for men, >4 SD for women on any single occasion)	-Measured (BMI, %BF, WC)	No adjustment (descriptive data)	-An increased prevalence of short-term, high-risk alcohol consumption among Australian farmers was observed, with males more affected than females (56.9% for males, 27.9% females) -A positive association between high-risk alcohol consumption and general/abdominal obesity in participants with psychological distress was observed
Lukasiewicz et al. 2005	To examine the associations between type and	France (n=2323)	Adults of both genders aged 35-60 years	SU.VI.MAX study	-Self-reported -Total alcohol intake (g/d), and	-Measured (BMI, WHR)	Age, smoking, physical activity, total energy	-A J-shaped association between total alcohol intake and WHR in both sexes was observed

	frequency of alcohol intake and BMI (WHR) in adults.				type of alcoholic beverage using six-day, 24-hour dietary recall		intake, education level, type of alcoholic beverage	-A J-shaped association between total alcohol intake and BMI was observed in only men -Positive associations between spirit consumption and BMI/WHR in both genders was observed - Participants who consumed wine <100 g/d had a lower WHR and BMI than nondrinkers and heavy drinkers -No associations between beer consumption and BMI/WHR were observed
- Lean et al 2018	To investigate the association between alcohol frequency/quantit y and body composition in	Scotland (20008)	Adults of both genders aged 18 + years who were nonpregnant	Nationally representative Scottish Health Surveys (1995-2010)	-Personal interview -Quantity (g/week) and frequency	-Measured (WC, BMI)	Age, smoking physical activity, DC income, economic status	-The frequency of alcohol consumption was inversely associated with BMI and WC in both genders -The amount of alcohol consumed was positively associated with BMI and WC, with most of the associations observed in patients aged >30years.
Schütze et al 2009	To examine gender-specific differences in the association between alcohol consumption and WC.	Germany (n=20625)	Participants aged 35-65 years who had available data on beer consumption	Nested study of the EPIC-Potsdam Study (1994-1998)	-Self-reported -Quantity (ml/d) of beer consumption	-Measured (WC)	Age, smoking frequency, education level, alcohol consumption (g), type of alcohol, total nonbeer-energy intake	-A positive association between beer consumption and WC in men was observed, but this association was not observed in females
Tolstrup et al 2005	To study the association between quantity and frequency of alcohol intake and obesity.	Denmark (n=49877)	Adults aged 50-65 years of both genders	Nested study of the Diet, Cancer, and Health Study (1993-1997)	-Self-reported -Quantity (drink/week) and frequency using 1-year recall	-Measured (BMI, WC, HC) -Large WC ≥102 cm for men, ≥88 cm for women -Large HC (≥ 100 cm) for both genders	Age, drinking frequency, diet, smoking, education level, physical activity	-A positive association between total alcohol consumed and obesity (WC, BMI) and an inverse association with HC in both genders were observed -Inverse associations between frequency of alcohol intake and BMI/WC in both genders independent of the total amount consumed were observed
Bobak et al. 2003	To examine the associations between beer consumption and WHC and BMI.	Czech Republic (n=1989)	Random sample of adults aged 25-64 years (response rate 76%)	Random sample from 6 Czech registries	-Self-reported -Frequency of alcohol consumption using 24-hour dietary recall on several occasions	-Measured (WHR, BMI)	Age, cigarettes/ day, physical activity, total cholesterol, education level	-Beer intake had a weak positive association with WHR in males and a weak inverse association in females -Bear intake had weak inverse association with BMI in women but not in men -Smoking acted as effect modifier between beer intake and WHR in men
Dumesnil et al 2013	To examine the association between alcohol frequency and	France (n=7855)	French adult males aged 50-59 years	Three French centres, 1991-1993	-Self-reported -Frequency (ml/wk) and pattern of	-Measured (BMI, WC)	Age, smoking status, physical activity, education level,	-75% of the participants consumed alcohol every day -The frequency of alcohol intake was inversely associated with BMI and WC for

	BMI in adult males.				consumption		alcohol intake	given total alcohol intake, with no difference between wine and beer consumption
Ferreira et al 2008	To examine the association between alcohol consumption and body fat.	Brazil (n=1235)	Male blood donors aged 20-59 years	Blood donors from Cuiabá, Aug 1999-Jan 2000	-Personal interview -Quantity and type of alcohol using 7-day recall	-Measured (WC, WHR)	Age, smoking physical activity, %BF	-Total alcohol consumption and beer consumption were positively associated with WC and the WHR -Spirit consumption was positively associated with alcohol consumption

BMI: body mass index, WC: waist circumference, HC: hip circumference, WHR: waist-to-hip ratio, WHtR: waist-to-height ratio, %BP: % body fat, SD: standard drink, DC: deprivation category, EPIC: SU.VI. MAX_

Chapter 3:

Research Method

3.1. Study population

The population in this study comprised those aged 15 years and older who had participated in wave 3 of the Healthy Ireland Survey 2017. This survey was part of the Healthy Ireland framework 2013-2025 that aims to improve overall wellbeing and reduce inequality within the population in the Republic of Ireland. It provides information that aids in the assessment and monitoring of different policy initiatives within the framework in a way that enables Ireland to meet international requirements. A request to access secondary data of the Healthy Ireland Survey 2017 was sent to the ISSDA, which is based in UCD, and permission was obtained shortly thereafter. The data were anonymized to protect participant confidentiality. Only the main researcher was permitted to access the dataset. The letter of request is attached in Appendix 2.

3.2. Study sample and sampling strategy

The survey was conducted face-to-face by trained interviewers. All interviews were performed at participants' homes using computer-assisted personal interviewing (CAPI). Topics included in the third wave of the Healthy Ireland Survey were smoking status, alcohol consumption, active travel, attitude towards breastfeeding, use of antibiotics, diet and nutrition, sexual health, general health, and health service utilization (Ipsos MRBI, 2017). Physical measurements (which included weight (kg), height (cm), and WC (cm)) were measured by trained staff. The survey along with the CAPI script underwent extensive testing and validation before being administered to a large population base.

The sample was selected using a probability-based methodology. To ensure the sample was representative, two-stage probability sampling was performed with the aid of An Post Ordnance Survey Ireland geographical data, which provided accurate and standardized postal addresses. The sample was determined based on electronic division clusters (each containing less than 500 addresses) to ensure coverage of a wide geographical area. Stratification by region was performed. A total of 686 clusters were selected. The addresses of those who took part in previous waves of the Healthy Ireland Survey were excluded from the current wave. Within each cluster, 20 addresses were systematically selected, with a random start address and fixed interval skips. One household member was selected randomly by interviewers to take part in this survey. Verbal consent was obtained from participants aged 18 years and older, and the parents/guardians of participants under 18 years of age provided written consent before participation in the survey. Survey fieldwork was conducted between September 2016 and June 2017 by Ipsos MRBI. Out of 12389 eligible addresses preselected to take part in the survey, 7487 households completed the interview, with an overall response rate of 60.4%. A total of 5868 (78%) participants completed the physical measurement examination.

3.3. Study design

This was an observational, analytical, cross-sectional study in which both descriptive and analytical data were analysed. The data of this study comprised secondary data from wave 3 of the Healthy Ireland Survey 2017.

3.4. Data collection and study instrument

Out of 134 variables included in the original Healthy Ireland Survey 2017 dataset, 23 variables were included in this study. These data included demographic data, health-related data, alcohol-related data, and physical measurement data.

3.4.1. Independent variables

Independent variables included alcohol-related variables, which were obtained via a face-to-face interview. In this study, participants were classified into two categories: “drinkers” and “nondrinkers”. Drinkers were defined as those who responded “Yes” to the question “Have you ever consumed an alcoholic beverage in your lifetime?”, while nondrinkers were defined as those who responded “I have never had a drink” or only “I drank a few sips of an alcoholic beverage in the past”. In terms of the alcohol frequency question “How often did you consume alcohol in the last 12 months?”, alcohol frequency was categorized into two categories: “less than 3 drinks per week” and “three or more drinks per week”. Binge drinking was defined in this study as the consumption of six or more standard units per occasion for both genders. According to the response to the question “During the last 12 months, how often did you consume the equivalent of 6 standard drinks on one occasion?”, binge drinking was categorized as “less than one occasion of binge drinking per week” and “one or more occasion of binge drinking per week”.

The AUDIT-C tool was used to screen for hazardous/harmful alcohol consumption. Three questions included in the AUDIT-C questionnaire were as follows: “How often did you have a drink containing alcohol in the past year?”, “How many drinks containing alcohol did you have on a typical day when you were drinking in the past year?”, and “How often did you have six or more drinks on one occasion in the past year?” The results of these three questions were given scores of 0-2, 3-4, or 5 or higher. A score of 5 or higher was considered harmful drinking (Bradley et al., 2007). For the regression analysis, binary variables of harmful alcohol consumption (score 5+) and nonharmful alcohol consumption (score less than 5) were created.

3.4.2. Dependent variables

The dependent variables of interest in this study were WC and BMI, which were measured by trained staff with standard protocols. WC was considered a continuous variable and was measured in centimetres. BMI is expressed as a weight (kg) divided by height squared (m^2). BMI was further categorized into four categories: underweight (<18.50 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2) and obesity (≥ 30.0 kg/m^2). For the multivariable logistic regression analysis, a binary variable of BMI (< 25.0 kg/m^2 and ≥ 25.0 kg/m^2) was created. WC was considered a continuous variable in the multivariable linear regression analysis.

3.4.3. Sociodemographic and health-related factors

Demographic and socioeconomic data were examined to analyse their associations with obesity indicators. These data included age, gender, marital status, level of education, employment status, urban or rural residency, a full medical card and a private medical card. Age was considered a categorical variable in the original database, as follows: 15-24 years, 25-44 years, 45-64 years, and 65 years and older. For regression analysis, a binary age category was created (15 to 44 years and 45 years and older). Gender was categorized into a binary variable: male or female. Marital status was the same as that in the original dataset: single, never married; married; widowed; civil partnership; divorce; or separated. Marital status was further categorized as married (including “married” and “civil partnership”) or single (including “widowed”, “divorced”, “separated”, and “single never married”) in the current study. Employment status was categorized the same as in the original data, as follows: employed; unemployed looking for a job; unable to work; retired; or pupil/student. In this study, employment status was further categorized as employed and unemployed (which includes “unemployed looking for a job”, “unable to work”, “retired”, and “pupil/student”).

Health-related data included in this study were general health condition, long-term illness, smoking status, active transportation, and frequency of fruit consumption. General health condition was categorized into four categories in the original database: very good; good; fair; or poor. In this study, health condition was further categorized into two categories: very good/good or fair/poor. Smoking status was categorized in original study as follows: yes, daily; yes, occasionally; or no. This study further categorized smoking as yes (including “yes, daily” and “yes, occasionally”) and no. Both long-term illness and active transportation had two categories (Yes or No). Answers that were recorded as “don’t know” or data missing from the original dataset were treated as missing variables and thus excluded from the analysis.

3.5. Ethical approval

This study was based on secondary data of wave 3 of the Healthy Ireland Survey 2017. The original survey was approved by the Research Ethics Committee of the Royal College of Physicians of Ireland (RCPI) on 18 September 2014 (Appendix 1). For the current study, a request for exemption from full ethical approval was submitted to the UCD Research Ethics Committee of the School of Public Health, Physiotherapy and Sport Science, at University College Dublin. The letter of permission for exemption is attached in Appendix 3.

3.6. Statistical analysis

For descriptive data, sociodemographic variables (age, gender, marital status, education level, employment status, and full and private medical cards) and health-related data (general health condition, long-term illness, smoking status, frequency of fruit consumption, and active transportation) were considered categorical variables and are thus presented as numbers and percentages (n/%). Alcohol-related variables (alcohol consumption status, alcohol consumption frequency, binge drinking, and AUDIT-C score) were also considered categorical variables (n/%). Anthropometric measurements (BMI, WC) are presented as means (standard deviation, SDs) and medians (ranges). BMI is further presented in categories and thus expressed in numbers and percentages.

Univariate analyses were performed to examine the associations between sociodemographic data, health-related data, alcohol-related data, and obesity indicators (BMI, WC). The means of continuous variables were compared using the independent Student's t test and one-way analysis of variance (ANOVA). The difference in percentages between groups was compared using the Pearson chi-square (χ^2) test. Variables with a p value less than 0.05 in the univariate analysis were retained and included in the multivariable analysis.

Multivariable linear regression analysis was performed to analyse the association between harmful alcohol consumption and WC while controlling for possible confounders. Four different models were constructed in this regression analysis, and confounding variables (sociodemographic and health-related variables) with significant p values ($p < 0.05$) were retained and included in the subsequent model. Model 1 included all variables, while model 2 was adjusted for sociodemographic data (age, gender, marital status, education level, employment status, full medical card, and private medical card). Model 3 was adjusted for the statistically significant variables in model 2 ($p < 0.05$), along with health-related data (general health, long-term medical illness, smoking status, active travel, and fruit consumption). The fully adjusted model (model 4) included the statistically significant variables in model 3, along with alcohol-related variables (alcohol frequency and binge drinking). Binary variables of possible confounders were included in the analysis. The results are presented as linear regression coefficients (β) and 95% confidence intervals (95% CIs). Similarly, a multivariable logistic regression analysis was performed to assess the association between harmful alcohol consumption and BMI using the different models as described above in the linear regression analysis. The results are presented as adjusted odds ratios (ORs) and 95% CIs. The Windows-based SPSS statistical package (version 24) was used to perform the analysis. Two-tailed tests were used, and a p value of <0. 05 was considered statistically significant. The results are presented in chapter 4.

Chapter 4: Results

4.1. Descriptive statistics

Table 4.1 presents descriptive data of the sociodemographic factors. A total of 7486 participants participated in wave 3 of the Healthy Ireland Survey, and female participants accounted for more than half of the study population (55.3%). Middle-aged and old individuals accounted for nearly 60% of the study population (31.9% for those aged 45-64 years and 26.1% for those aged 65 years and older). Just over half of the participants were married or in a civil partnership (51.8%), and nearly two-thirds of them were living in urban areas (60.6%). Almost three-quarters of the participants had either a moderate or high educational level (36.0% for moderate education level and 35.6% for high education level). More than half of the participants were employed (56.0%). A similar proportion of participants had either a full medical card or private health insurance (41.2% and 45.3%, respectively).

Table 4.2 presents the descriptive characteristics of the health-related factors, including alcohol consumption. Most of the participants reported that their health condition was good or very good (81.6%). Only one-third of participants reported having a long-term medical illnesses (33.2%). More than three-quarters of the study population (79.4%) were nonsmokers, and a minority of participants reported using active transportation (15.4%). A total of 4787 (63.9%) participants reported consuming fruit one or more times per day. Alcohol consumption was highly prevalent in this study population, with 8 out of 10 participants reporting alcohol consumption (86.5%). However, most of them reported drinking less than three times per week (77.5%), and approximately one-third of them engaged in binge drinking at least once per week (31.5%). Of the 5601 participants who completed the AUDIT-C questionnaire, nearly half were classified as harmful drinkers (AUDIT-C score ≥ 5, 49.1%).

Table 4.3 presents the anthropometric measurements of the study population. The mean WC of the participants was 92.2 ±14.3 cm, while the mean BMI was 27.3

±5.78 kg/m^2. More than two-thirds of the participants were either overweight or obese (31.0% and 40.6%, respectively).

Table 4.1: Descriptive data of the study participants and sociodemographic factors based on Healthy Ireland Survey 2017 data				
Variable	**Valid Denominator**	**Measurement**	**Result**	
Age (Years)	**7,486**	**n (%)**		
15-24			**623**	**8.3%**
25-44			**2,517**	**33.6%**
45-64			**2,390**	**31.9%**
65 +			**1,956**	**26.1%**
Gender	**7,487**	**n (%)**		
Male			**3,349**	**44.7%**
Female			**4,138**	**55.3%**
Marital status	**4,487**	**n (%)**		
Single *			**3,606**	**58.2%**
Married**			**3,881**	**51.8%**
Urban/rural residency	**7,487**	**n (%)**		
Urban			**4,539**	**60.6%**
Rural			**2,948**	**39.4%**
Educational status	**7,487**	**n (%)**		
Low			**2,127**	**28.4%**
Medium			**2,698**	**36.0%**
High			**2,662**	**35.6%**
Employment status	**6,359**	**n (%)**		
Employed			**3,561**	**56.0%**
Unemployed			**68**	**10.8%**

			8	
Retired			1,633	25.7%
Pupil/student			477	7.5%
Full medical card	7,487	n (%)		
Yes			3,088	41.2%
No			4,399	58.8%
Private Health insurance	7,487	n (%)		
Yes			3,389	45.3%
No			4,098	54.7%

*Includes single never married, separated, divorced, widowed, ** includes civil partnership.

Table 4.2: Descriptive data of the study participants and health-related data based on Healthy Ireland Survey 2017 data				
Variable	Valid denominator	Measurement	Result	
General health condition	7,483	n (%)		
Good/Very good			6,104	81.6%
Fair/Bad			1,379	18.4%
Long-term illness	7,475	n (%)		
Yes			2,485	33.2%
No			4,990	66.8%
Smoking status	7,486	n (%)		
Yes			1,539	20.6%
No			5,947	79.4%
Mode of transportation				
Active travel	4,038	n (%)		
yes			623	15.4%
No			3,415	84.6%
Frequency of fruit consumption	7,486	n (%)		
≥ 1 time per day			4,787	63.9%
< 1 time per day			2,699	36.1%
Alcohol consumption	7,486	n (%)		
Yes			6,473	86.5%

No			1,013	13.5%
Alcohol consumption frequency	3,518	n (%)		
≥ 3 times per week			886	22.5%
<3 times per week			3,053	77.5%
Binge drinking**	3,624	n (%)		
≥1 time per week			1,140	31.5%
< 1 time per week			2,484	68.5%
AUDIT-C**	5,601	n (%)		
Score =0-2			1,324	23.6%
Score =3-4			1,526	27.2%
Score =5+			2,751	49.1%

*Transportation by foot or bicycle, ** 6+ standard units per occasion, ***Alcohol Use Disorder Identification Test - Consumption

Table 4.3: Descriptive data of the study participants' anthropometric measurements based on Healthy Ireland Survey 2017 data

Variable	Valid Denominator	Measurement	Result
Weight (kg)	5,875	Mean (SD**)	77.3(16.70)
		Median (Range)	75.8(31.0-188.0)
Height(m)	5,923	Mean (SD)	168.3(10.10)
		Median (Range)	168.0(106.0-211.0)
WC* (cm)	5,796	Mean (SD)	92.2(14.30)
		Median (Range)	91.1(40.0-174.0)
BMI (kg/m²)**	5,870	Mean (SD***)	27.3(5.78)
		Median (Range)	26.5(12.0-156.0)
Less than 24.9		n (%)	2,120(28.40%)
25.0-29.9		n (%)	2,313(31.00%)
Equal to or more than 30.0		n (%)	3,027(40.60%)

*Waist circumference, ** Body mass index, *** Standard deviation

4.2. Univariate analysis

4.2.1. Sociodemographic data and obesity indicators

Table 4.4 presents the univariate associations between sociodemographic factors and obesity indicators (WC and BMI). In the univariate analyses, all sociodemographic variables analysed in this study showed significant associations with both WC and BMI ($p < 0.05$). Mean WC measurements were highest in those aged 65 years and older (97.0 ± 14.68 cm, $p < 0.001$), males (96.5±13.16 cm, $p < 0.001$), and those who were married or in a civil partnership (93.3±13.37 cm, $p < 0.001$). Additionally, participants with low educational attainment and those living in rural areas had high mean WC measurements (95.5 ±15.39 cm, $p < 0.001$ and 92.9 ±14.35 cm, $p = 0.004$, respectively). Participants who were retired and unemployed were found to have significantly higher mean WCs than their counterparts (97.0 ± 14.46 cm; 95.4 ±15.74 cm, $p < 0.001$, respectively) (Table 4.4).

Regarding BMI, the rates of overweight (BMI 25-29.9 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) were highest among those aged 45-64 years (35.8% and 34.0%, respectively) ($p < 0.001$). Additionally, the rate of obesity was significantly higher among female participants (56.4%), while the rate of overweight was significantly higher among male participants (55.1%, $p < 0.001$). When analysing BMI according to marital status, both overweight and obesity were associated with married and civil partnership statuses, at 58.7% and 50.8%, respectively ($p < 0.001$). Moreover, obesity was significantly higher among urban participants (58.7%) and employed participants (50.6%) than among rural participants and unemployed participants. Over two-thirds of the obese population had a low or moderate educational level (34.2% and 35.7%, respectively, $p < 0.001$). Among participants with full medical cards and private health insurance, obesity was reported in less than half of the participants (48.6% and 41.0%, respectively).

4.2.2. Health-related data and obesity indicators

The univariate analysis results of the associations between health-related factors and obesity indicators (BMI, WC) are presented in Table 4.5. The results clearly demonstrate significant associations between most of the factors and both BMI and WC. The mean WC was highest among participants with a fair/poor general health condition (96.76 ± 16.73 cm, p<0.001), participants with long-term illness (95.4 ±15.5 cm, p <0.001) and nonsmokers (92.4 ± 14.37 cm, p<0.041). On the other hand, the lowest mean WC was found in individuals who ate fruit at least once per day. No significant association between active travel and mean WC was found.

Regarding BMI, low rates of overweight and obesity were reported among participants who described their health as fair/poor (15.2% and 25.5%, respectively, p < 0.001). Among those with long-term illness, overweight was reported in nearly one-third of the participants (31.7%), while obesity was reported in less than half of the participants (40.5%, p<0.001). Participants who used active travel were less likely to be obese or overweight than those who did not (15.0% and 13.1%, respectively, p<0.001). Similarly, smokers were less likely to be overweight or obese (18.4%. 21.1%, p=0.005).

4.2.3. Alcohol-related data and obesity indicators

Univariate analyses were also carried out to examine the associations between alcohol-related variables and obesity indicators (Table 4.5). The results demonstrated no significant difference in mean WC between drinkers and nondrinkers. However, those who drank more frequently (≥ 3 times per week) had a higher mean WC (94.0 ±14.35 cm, P<0.001) than those who drank less frequently. Binge drinkers who engaged in binge drinking one or more times per week were more likely to have a higher mean WC (95.7 ±14.16 cm, p<0.001) than those who engaged in binge drinking less frequently. Participants with harmful drinking patterns (AUDIT-C score ≥ 5) had the highest mean WC (93.4 ±13.86 cm, p<0.001) compared to participants with nonharmful drinking patterns.

Regarding BMI, a significant proportion of those who were overweight or obese were drinkers (84.2% and 78.5%, respectively, p<0.001). No significant relationship between the frequency of alcohol intake and BMI was found. However, obesity was reported in slightly more than one-third of those who reported binge drinking one or more times per week (35.9%, $p<0.001$). Finally, overweight and obesity were more common among those who scored 5 or higher on the AUDIT-C questionnaire (53.2% and 48.2%, respectively).

Table 4.4: Univariate association between sociodemographic factors and waist circumference (WC) and body mass index (BMI) based on Healthy Ireland Survey 2017 data

Variable	Waist circumference (cm) (n=5796)			BMI (kg/m^2) (n=5870)				
	N*	Mean (SD**)	p value	N	<25.0 n (%)	25.0-29.9 n (%)	≥30.0 n (%)	p value
Age (in years)								
15-24 years	5,796	83.1(12.54)	<0.001[b]	622	337 (15.9%)	131 (5.7%)	154 (5.1%)	<0.001[c]
25-44 years		89.6(13.35)		2,510	880 (41.5%)	765 (33.1%)	865 (28.6%)	
45-64 years		94.1(13.74)		2,374	518 (24.4%)	827 (35.8%)	1,029 (34.0%)	
65 + years		97.0(14.68)		1,953	385 (18.2%)	590 (25.5%)	978 (32.3%)	
Gender								
Male	5,796	96.5(13.16)	<0.001[a]	7,460	735 (34.7%)	1,275 (55.1%)	1,321 (43.6%)	<0.001[c]
Female		88.4(14.25)			1,385 (65.3%)	1,038 (44.9%)	1,706 (56.4%)	
Marital status								
Single***	5,796	91.0(15.24)	<0.001 [a]	7,460	1156 (54.5%)	955(41.3%)	1,488(49,2%)	<0.001[c]
Married/civil partnership		93.0(13.37)			964 (45.5%)	1,358 (58.7%)	1,539 (50.8%)	
Urban, Rural split								
Urban	5,796	91.8(14.29)	0.004[a]	7,460	1,327 (62.6%)	1,419 (61.3%)	1,776 (58.7%)	0.012[c]
Rural		92.9(14.35)			793 (37.4%)	894 (38.7%)	1,251 (41.3%)	
Educational status								
Low	5,796	95.5(15.39)	<0.001[b]	7,460	456 (21.5%)	631 (27.3%)	1,035 (34.2%)	<0.001[c]
Medium		92.3(13.89)			774 (36.5%)	830 (35.9%)	1,081 (35.7%)	
High		89.7 (13.4)			890 (42.0%)	852 (36.8%)	911 (30.1%)	
Employment status								
Employed	4,972	91.2(13.29)	<0.001[b]	6,336	1,061 (58.8%)	1,210 (60.1%)	1,276 (50.6%)	<0.001[c]
Unemployed		95.4(15.74)			158 (8.8%)	196 (9.7%)	331 (13.1%)	
Retired		97.0 (14.46)			325 (18.0%)	520 (25.8%)	783 (31.1%)	
Pupil/student		83.3(12.94)			260 (14.4%)	86 (4.3%)	130 (5.2%)	
Full medical card								
Yes	5,796	94.4 (15.48)	<0.001[a]	7,460	742 (35.0%)	874 (37.8%)	1,464 (48.4%)	<0.001[c]
No		90.8 (13.34)			1,378 (65.0%)	1,439 (62.2%)	1,563 (51.6%)	
Private Health insurance								
Yes	5,796	91.5 (13.84)	0.002[a]	7,460	1,012 (47.7%)	1,123 (48.6%)	1,240 (41.0%)	<0.001[c]
No		92.9 (14.71)			1,108 (52.3%)	1,190 (51.4%)	1,787 (59.0%)	

*Valid denominator, ** Standard deviation, *** Includes single never married, separated, divorced, widowed [a]. 2-Sample t test; [b]. ANOVA test; [c]. Pearson chi-square test; level of significance:

p<0.05

Table 4. 5: Univariate associations of health-related factors with waist circumference (WC) and body mass index (BMI) based on Healthy Ireland Survey 2017 data

Variable	Waist circumference (cm) (n=5,796)			BMI (kg/m^2) (n=5,870)				
	N*	Mean (SD**)	p value	N	< 25.0 n (%)	25.0-29.9 n (%)	≥30.0 n (%)	p value
General health condition								
Good/very good	5,792	91.4(13.65)	<0.001[a]	7,456	1,864 (88.0%)	1,960 (84.4%)	2,255(74.5%)	<0.001[c]
Fair/poor		96.816.727)			255(12%)	351(15.2%)	777(25.5%)	
Long-term illness								
Yes	5,792	95.4(15.5)	<0.001[a]	7,448	518 (24.5%)	733 (31.7%)	1,223 (40.5%)	<0.001[c]
No		90.7(13.48)			1,600 (75,5%)	1,579 (68.3%)	1,796 (59.5%)	
Smoking status								
Yes	5,795	91.5(14.13)	0.041[a]	7,459	470 (22.2%)	425 (18.4%)	638 (21.1%)	0.005[c]
No		92.4(14.37)			1,650 (77.8%)	1,888 (81.6%)	2,388 (78.9%)	
Mode of transportation								
Active travel								
Yes	3,266	89.3(13.71)	0.085 [a]	4,023	244 (18.5%)	194 (15.0%)	184 (13.1%)	<0.001[c]
No		90.4(13.45)			1,077 (81.5%)	1,102 (85.0%)	1,222 (86.9%)	
Frequency of fruit consumption								
≥ 1 time per day	5,796	91.3(13.98)	<0.001[a]	7,459	1,426 (67.3%)	1,507 (65.2%)	1,839 (60.8%)	<0.001 [c]
< 1 time per day		93.9(14.78)			694 (32.7%)	806 (34.8%)	1,187 (39.2%)	

Alcohol consumption								
Yes	**5,795**	**92.3(14.12)**	**0.500** [a]	**7,459**	**1,753(82.7%)**	**1,945(84.2%)**	**2,373(78.5%)**	**<0.001**[c]
No		**91.9(15.29)**			**367(17.3%)**	**367(15.9%)**	**652(21.5%)**	
Alcohol consumption frequency								
≥ 3 times per week	**3,141**	**94.0(14.35)**	**<0.001** [a]	**3,922**	**235(20.5%)**	**303(22.9%)**	**347(23.9%)**	**0.103**[c]
< 3 times per week		**91.3(13.57)**			**914(79.5%)**	**1,019(77.1%)**	**1,104(76.1%)**	
Binge drinking (6+ SU per occasion)								
≥ 1 time per week	**2,985**	**95.7(14.16)**	**<0.001** [a]	**3,604**	**255(24.2%)**	**408(32.8%)**	**469(35.9%)**	**<0.001** [c]
< 1 time per week		**90.8(13.34)**			**798(75.8%)**	**835(67.2%)**	**839(64.1%)**	
AUDIT-C* **								
Score = 0-2	**4,473**	**91.3(14.64)**	**<0.001** [b]	**5,578**	**410(24.8%)**	**384(21.2%)**	**527(24.9%)**	**<0.001** [c]
Score = 3-4		**89.7(13.56)**			**491(29.7%)**	**463(25.6%)**	**569(26.9%)**	
Score = 5+		**93.4(13.86)**			**751(45.5%)**	**963(53.2%)**	**1,020(48.2%)**	

Valid denominator; **Standard deviation; Alcohol Use Disorder Identification Test - Consumption; [a]. Independent 2-sample t test; [b]. ANOVA; [c].Pearson chi-square test; level of significance p<0.05**

4.3. Multivariable analysis

4.3.1. Multivariable linear regression analysis

Table 4.6 shows the multivariable linear regression analysis results, highlighting the association between harmful alcohol consumption and WC after controlling for sociodemographic and health-related factors. Four models were constructed, of which model 4 is the fully adjusted model. Variables that had nonsignificant p values ($p > 0.05$) were excluded from the subsequent model(s). The adjusted R square (R^2) value represents the percentage of variance in mean WC that can be explained by the variables in each model. The adjusted R^2 values for models 1, 2, 3, and 4 were 0.22, 0.188, 0.201, and 0.225, respectively. Fully adjusted model 4 showed that 22.5% of the variability in BMI could be explained by the variables present in that model.

After adjustment for sociodemographic factors and health-related factors in model 3, harmful alcohol consumption (AUDIT-C score of 5+) was positively associated with WC (β=1.98, 95% CI: 1.00, 2.960). Age, gender, and marital status were significantly and positively associated with WC ($p<0.001$, $p<0.001$, and $p<0.001$, respectively). The strongest association was with gender, with male participants having a WC 7.912 times larger than that in female participants (β=7.91; 95% CI: 6.94, 8.88). A higher education level had an inverse association with WC (β = -1.48, 95% CI: -2.43, -0.512) compared with the reference group. No association between long-term illness or active travel and WC was found. Employment status was significantly associated with WC, with employees having a WC 5.214 times larger than that in unemployed participants (β = 5.21, 95% CI: 3.60, 6.83). The perception of general health was found to be positively associated with WC, with those reporting their health as fair/poor having a mean WC 3.353 times higher than that in those who reported their health as good/very good (β=3.35, 95% CI: 1.4, 5.27). Smoking status was inversely associated with WC, with smokers having a mean WC 1.746 times larger than that in nonsmokers (β= -1.75, 95% CI: -2.94, -0.55). The frequency of fruit intake was also found to be inversely associated with mean WC (β= -1.62, 95%: CI: -2.59, -0.64).

In the fully adjusted model (4) and after controlling for other alcohol-related variables (alcohol consumption frequency and binge drinking), harmful drinking was no longer associated with WC (β=1.34, 95% CI: -0.79, 2.75). Binge drinking was significantly associated with WC, with those who engaged in binge drinking once or more per week having a WC 2.032 times higher than that in those who engaged in binge drinking less than once per week. (β= 2.03, 95% CI 0.089, 3.17). There was an inverse association between the frequency of alcohol consumption and mean WC, as participants with frequent alcohol consumption had a lower mean WC than those with less frequent alcohol consumption; however, the difference was not statistically significant. Age, gender, marital status, level of education, a full medical card, and smoking status remained significantly and independently associated with mean WC. General health condition was no longer associated with WC in the fully adjusted model. However, the frequency of fruit intake remained significantly and inversely associated with WC (β= -1.11, 95% C: 2.16, -0.05).

Table 4.6: Multivariable linear regression analysis of the association of alcohol intake and sociodemographic and clinical factors with waist circumference (cm) based on Healthy Ireland Survey 2017 data

Variable	Model 1	95% CI		p	Model 2	95% CI		p	Model 3	95% CI		p	Model 4*	95% CI		p
	β	Low.	Upp.		β	Low.	Upp.		β	Low.	Upp.		β	Low.	Upp.	
AUDIT-C score (Ref. < 5)**																
Score 5 +	**2.57**	**1.00**	**4.14**	**0.001**	**1.222**	**0.35**	**2.09**	**0.006**	**1.98**	**1.00**	**2.96**	**<0.001**	**1.34**	**-0.79**	**2.75**	**0.064**
Age group (Ref. < 45 years)																
45 and above	**5.53**	**4.23**	**6.83**	**<0.001**	**6.663**	**5.81**	**7.52**	**<0.001**	**4.51**	**3.51**	**5.51**	**<0.001**	**6.12**	**5.02**	**7.21**	**<0.001**
Gender (Ref. female)																
Male	**7.54**	**6.32**	**8.76**	**<0.001**	**8.294**	**7.43**	**9.16**	**<0.001**	**7.91**	**6.94**	**8.88**	**<0.001**	**7.67**	**6.59**	**8.75**	**<0.001**
Marital status (Ref. single*)**																
Married	**2.36**	**1.11**	**3.60**	**<0.001**	**1.475**	**0.61**	**2.34**	**0.001**	**2.11**	**1.12**	**3.10**	**<0.001**	**2.66**	**1.56**	**3.68**	**<0.001**
Educational status (Ref. low and moderate)7																
High	**-0.99**	**-2.24**	**0.27**	**0.122**	**-1.617**	**-2.53**	**-0.71**	**<0.001**	**-1.48**	**-2.43**	**-0.52**	**0.003**	**-1.53**	**-2.65**	**-0.41**	**0.007**
Urban/rural residency (Ref. rural)																
Urban	**-0.01**	**-1.22**	**1.20**	**0.986**	**-0.548**	**-1.38**	**0.28**	**0.197**								
Employment status (Ref. unemployed)																
Employed	**-1.87**	**-2.91**	**-0.838**	**<0.001**	**-1.254**	**-1.96**	**-0.55**	**<0.001**	**5.21**	**3.60**	**6.83**	**<0.001**	**-0.14**	**-1.30**	**1.01**	**0.806**
Full medical card (Ref: no)																
Yes	**0.89**	**-0.78**	**2.55**	**0.295**	**2.821**	**1.79**	**3.85**	**<0.001**	**1.24**	**0.01**	**2.46**	**0.047**	**1.84**	**0.54**	**3.14**	**0.006**
Private health insurance (Ref. no)																
Yes	**-0.21**	**-1.51**	**1.09**	**0.751**	**-0.318**	**-1.25**	**0.62**	**0.505**								
General health condition (Ref. good/very good)																
Fair/poor	**2.35**	**-0.14**	**4.84**	**0.064**					**3.35**	**1.44**	**5.27**	**0.001**	**1.63**	**-0.01**	**3.27**	**0.052**
Past medical history (Ref. no)																
Yes	**1.37**	**-0.20**	**2.93**	**0.087**					**0.91**	**-0.30**	**2.12**	**0.139**				
Smoking status (Ref. no)																
Yes	**-1.53**	**-2.90**	**-0.16**	**0.029**					**-1.75**	**-2.94**	**-0.55**	**0.004**	**-1.75**	**-2.94**	**-0.55**	**0.004**
Mode of transportation, active travel (Ref. no)																
Yes	**0.21**	**-1.34**	**1.78**	**0.782**					**-0.50**	**-1.76**	**0.76**	**0.493**				
Frequency of fruit consumption (Ref. < times per day)																
≥ 1 time per day	**-1.19**	**-2.38**	**-0.01**	**0.049**					**-1.62**	**-2.59**	**-0.641**	**0.001**	**-1.11**	**-2.16**	**-0.05**	**0.040**
Alcohol consumption frequency (Ref. < 3 times per week)																
≥ 3 times a week	**-0.76**	**-2.26**	**0.74**	**0.319**									**-0.19**	**-1.44**	**1.06**	**0.770**
Binge drinking [a] (Ref. < 1 time per week)																
≥ 1 time per week	**1.24**	**-0.05**	**2.54**	**0.060**									**2.03**	**0.89**	**3.17**	**<0.001**

* Fully adjusted model; **Alcohol Use Disorder Identification Test - Consumption; *** Includes separated, divorced, widow; 6+ standard units per occasion; Variables with p values <0.05 were included in the subsequent model. The adjusted R^2 values for models 1, 2, 3, and 4 were 0.22, 0.188, 0.201, and 0.225, respectively. Reference group β=0.00, level of significance $p<0.05$.

4.3.2. Multivariable logistic regression analysis

Multivariable logistic regression analysis was performed to examine the association between harmful alcohol intake and BMI, controlling for sociodemographic and health-related data (Table 4.7). Variables with nonsignificant results (p value >0.05) were excluded from the subsequent model. Out of the four models presented in table 4.7, only models 2 and 3 had good model fit, as the Hosmer–Lemeshow test showed nonsignificant p values of 0.150 and 0.106, respectively, and the Nagelkerke R square values were 0.093 and 0.12, respectively.

After adjustment for possible sociodemographic confounders in model 2, harmful alcohol consumption (AUDIT-C score ≥ 5) was associated with a 19% increased risk of obesity/overweight compared to nonharmful alcohol consumption (OR=1.19, 95% CI: 1.04, 1.35). The odds of overweight/obesity were 2.33-fold higher in the group aged 45 years and older than in the younger age group (OR: 2.33, 95% CI: 2.05, 2.66). Male participants were 72.5% more likely to be overweight/obese than females (OR=1.73, 95% CI: 1.51, 1.97). The odds of overweight/obesity were 1.41-fold higher among married participants than among single participants (OR=1.41, 95% CI: 1.25, 1.60). Participants with a higher educational level had lower odds of overweight/obesity (OR=0.84, 95% CI: 0.73, 0.96) than the reference group. Employment status was positively associated with overweight/obesity; the odds of overweight/obesity were 1.23-fold higher among participants who were employed than among those who were unemployed (OR 1.23, 95% CI: 1.07, 1.41). Those who had full medical cards were significantly more likely to be overweight/obese than those who did not (OR =1.31, 95% CI 1.12, 1.53). No significant association was found between overweight/obesity and residency in urban/rural areas or private health insurance.

After further controlling for health-related data in model 3, the participants who reported harmful alcohol consumption were 25% more likely to be overweight or obese (OR= 1.25, 95% CI: 1.06, 1.471). Gender, age group, marital status, and employment status remained positively associated with overweight and obesity (p <0.001). However, educational status and having a full medical card were no longer associated with overweight/obesity. Moreover, participants who reported their health as fair/poor were 55% more likely to be overweight/obese than those who reported their health as good/very good (OR 1.55, 95% CI 1.10-2.20). Active travel showed a positive and significant association with overweight/obesity, and those who used active transportation were less likely to be overweight/obese than those who did not use active transportation (OR=0.78, 95% CI 0.64, 0.97). No significant associations were found between long-term medical illness, smoking status, and frequency of eating fruit and overweight/obesity in this model. Further adjustment for alcohol-related variables (model 4) showed poor model fit and thus are not discussed here.

Table 4.7: Multivariable logistic regression analysis of the association of alcohol intake, sociodemographic factors and clinical factors with body mass index (kg/m²) based on Healthy Ireland Survey 2017 data

Variable	Model 1	95% CI		p value	Model 2	95% CI		p value	Model 3	95% CI		p value	Model 4*	95% CI		p value
	OR	Lower	Upper		OR	Lower	Upper		OR	Lower	Upper		OR	Lower	Upper	
AUDIT-C score (Ref. less than 5)**																
Score 5 +	1.30	0.99	1.71	0.058	1.19	1.04	1.35	0.010	1.25	1.06	1.47	0.009	1.30	0.987	1.70	0.062
Age class (year) (Ref. less than 45)																
45 and older	2.53	1.98	3.24	<0.001	2.33	2.05	2.66	<0.001	2.19	1.76	2.50	<0.001	2.62	2.065	3.33	<0.001
Gender (Ref.: female)																
Male	1.59	1.29	1.97	<0.001	1.73	1.51	1.97	<0.001	1.85	1.57	2.18	<0.001	1.60	1.301	1.98	<0.001
Marital status (Ref. single*)**																
Married	1.48	1.19	1.85	<0.001	1.41	1.25	1.60	<0.001	1.41	1.20	1.67	<0.001	1.50	1.205	1.85	<0.001
Educational status (Ref. low and medium)																
High	0.95	0.76	1.19	0.661	0.84	0.73	0.96	0.009	0.87	0.74	1.03	0.096				
Urban/rural residency (Ref. rural)																
Urban	1.02	0.82	1.27	0.832	0.99	0.87	1.12	0.830								
Employment status (Ref. unemployed)																
Employee	1.68	1.20	2.34	0.002	1.23	1.07	1.41	0.003	1.92	1.48	2.48	<0.001	1.58	1.144	2.19	0.006
Full medical card (Ref. no)																
Yes	1.20	0.89	1.63	0.227	1.31	1.12	1.53	0.001	1.17	0.95	1.44	0.141				
Private health insurance (Ref. no)																
Yes	1.12	0.89	1.41	0.336	0.93	0.81	1.07	0.306								
General health (Ref. good/very good)																
Fair/Bad	1.84	1.13	3.01	0.015					1.55	1.10	2.20	0.013	2.02	1.257	3.23	0.004
Past medical history (Ref. no)																

Yes		**1.22**	**0.91**	**1.63**	**0.196**	**1.11**	**0.90**	**1.37**	**0.332**				
Smoking status (Ref. no)													
Yes		**0.92**	**0.73**	**1.18**	**0.523**	**0.91**	**0.75**	**1.10**	**0.322**				
Transportation mode, active travel (Ref. no)													
Yes		**0.92**	**0.70**	**1.21**	**0.538**	**0.78**	**0.64**	**0.97**	**0.023**	**0.92**	**0.701**	**1.20**	**0.531**
Frequency of fruit consumption (Ref. < times per day)													
≥ 1 time per day	**0.92**		**0.74**	**1.14**	**0.430**	**0.90**	**0.76**	**1.07**	**0.229**				
Alcohol consumption frequency (Ref. < 3 times per week)													
≥ 3 times a week	**0.63**		**0.48**	**0.83**	**0.001**					**0.65**	**0.493**	**0.85**	**0.002**
Binge drinking [a] (Ref.< 1 time per week)													
≥ 1 time per week		**1.29**	**1.01**	**1.63**	**0.039**					**1.27**	**1.01**	**1.6**	**0.043**

* Fully adjusted model; **Alcohol Use Disorder Identification Test - Consumption; *** Includes separated, divorced, widowed; 6+ standard units per occasion; Variables with p values <0.05 were included in the subsequent model. Model 1: Hosmer-Lemeshow test (H.L.) ≤0.001, Nagelkerke R^2 =0.129; Model 2: H.L.=0.0.150, Nagelkerke R^2=0.-.093; Model 3: H.L.=0.0.106, Nagelkerke R^2=0.120; Model 4: H.L.=0.0.002. Nagelkerke R^2=0.126. Reference group OR =1.00

Chapter 5 Discussion

5.1. Summary of the results

This analytical cross-sectional study highlights the association between harmful alcohol consumption (AUDIT-C score ≥5) and obesity (BMI, WC). The prevalence of overweight and obesity among the study population was more than 60%. Alcohol consumption was prevalent in this study sample, with nearly 9 out of 10 participants (86.5%) reporting alcohol consumption. Less than one-quarter of alcohol drinkers drank three or more times a week, and almost one-third of drinkers engaged in binge drinking at least one time per week. Nearly half of the participants (49.1%) who completed the AUDIT-C questionnaire had harmful alcohol consumption patterns.

In the univariate analyses, all the sociodemographic variables and most of the health-related variables showed significant associations with WC and BMI. Drinking status was significantly associated with BMI but not with WC. Obesity and overweight were significantly associated with alcohol consumption (78.5% and 84.2%, respectively, $p<0.001$). Those who drank frequently (≥ 3 times a week) were less likely to be obese and overweight (23.9% and 22.9%, respectively) than those who drank less frequently. However, this difference was not statistically significant, probably due to the lower proportion of participants who drank three or more drinks per week (22.5%). In contrast with participants who engaged in binge drinking less than once per week, over one-third of those who indulged in more frequent binge drinking were obese (35.9%, $p < 0.001$). Harmful drinkers had a larger WC (93.4±13.86 cm, $p<0.001$) and were significantly more obese (48.2%, $p<0.001$) than nonharmful drinkers.

The results of the multivariable linear regression analysis revealed a positive association between harmful alcohol consumption and WC after adjustment for sociodemographic and health-related factors. However, this association became nonsignificant when controlling for other alcohol-related variables (frequency of alcohol intake and binge drinking). On the other hand, participants who engaged in frequent binge drinking (≥ 1 time per week) had a WC 2.03 times larger than that in those who engaged in binge drinking less frequently (β =2.03, 95% CI: 0.89, 3.17). Additionally, an inverse association between alcohol consumption frequency and mean WC was observed; however, this association was not statistically significant. In the multivariable logistic regression analysis, participants who scored 5 or higher on the AUDIT-C questionnaire had higher odds of overweight/obesity than nonharmful drinkers. Age, gender, marital status, education level, employment status, general health condition, and frequency of fruit consumption were all significantly and independently associated with BMI.

5.2. Data interpretation

5.2.1. Harmful alcohol consumption and obesity

The current study showed positive associations between harmful alcohol consumption (assessed with the AUDIT-C questionnaire) and obesity indicators (both BMI and WC) after controlling for sociodemographic and health-related factors. After further controlling for binge drinking and alcohol consumption frequency, the association between harmful alcohol consumption and obesity was no longer significant. Most of the studies examined either the frequency or quantity of alcohol intake, or both, but did not use the AUDIT-C questionnaire as a tool in the examination of this association. To the best of our knowledge, this is the first study to examine the association between harmful alcohol consumption, using the AUDIT-C, and obesity in a sample of the Irish population. Since the AUDIT-C is a standardized screening instrument that identifies harmful alcohol consumption in primary health care settings, it can be utilized as a tool in future studies on the association between alcohol consumption and obesity and help further validate the controversial evidence of this association.

5.2.2. Frequency of alcohol consumption and obesity

Although the current study showed an inverse association between alcohol consumption frequency (≥ 3 times per week vs. < 3 times per week) and mean WC, this association was not statistically significant (β = -0.19 95% CI: -1.44, 1.06). A possible explanation for this nonsignificant association could be the small proportion of the study population who consumed alcohol at least three times per week (n=886, 22.5%); thus, it was difficult to obtain a significant result. Examining the association between frequency of alcohol consumption and BMI was not possible, as the fully adjusted model showed poor model fit (Hosmer–Lemeshow p = 0.002 and Nagelkerke R^2= 0.126). Previous studies examined the association between alcohol frequency and obesity, and the results were discordant. Tolstrup et al., 2005, and Lean et al., 2018, found inverse associations between the frequency of alcohol consumption and obesity indicators (BMI and WC) in both genders. Dumesnil et al., 2013, found that the inverse association between the frequency of alcohol intake and obesity was present irrespective of total alcohol intake. On the other hand, O'Donovan et al., 2018, found a bell-shaped association between the frequency of alcohol consumption and obesity, and no difference in risk was observed between those who never drank and those who drank most frequently. The possible underlying cause of such an inverse association between alcohol frequency and obesity could be attributed to several factors. First, alcohol intake might affect macronutrient absorption, leading to reduced energy intake. Moreover, alcohol intake might stimulate thermogenesis by activating the ethanol oxidizing system (Foster& Marriott 2006). Park et al., 2017 found no association between the frequency of alcohol consumption and abdominal obesity in individuals with normal weight. However, this lack of an association could be related to the lower prevalence of abdominal obesity in the study population (< 8% in both genders; thus an exact association might be difficult to obtain. Overall, based on the current evidence, the promotion of the consumption of alcohol to reduce the risk of obesity is not advisable, as the exact mechanism is not well explored.

5.2.3. Binge drinking and obesity

Binge drinking was also examined in this study, and the results showed that those who frequently engaged in binge drinking (≥ 1 time per week) had a larger mean WC than those who engaged in binge drinking less frequently. Most of the studies carried out on the association between binge drinking and obesity have shown positive associations. A Korean study carried out in normal-weight, middle-aged adults (of both genders) showed that those who engaged in daily binge drinking had a significantly higher rate of abdominal obesity (WC) than those who engaged in binge drinking less frequently (Park et al. 2017). Similarly, a dose–response relationship between binge drinking and obesity was found by Arif and Rohrer, 2005. Tolestrup et al., 2005, compared binge drinkers with nonbinge drinkers and found that binge drinkers were 77% more likely to be obese (OR= 1.77, 95%: 1.18, 2.65). On the other hand, Rohrer and colleagues used BMI to examine the association between the frequency of binge drinking in nonsmoking participants in the US, and they found no correlation between the frequency of binge drinking and obesity (Rohrer et al., 2005). However, Rohrer et al. used a purposive sample for their study, which might not have allowed the calculation of an exact value for the association. The reason for the positive association between binge drinking and obesity could be the presence of other impulsive behaviours, e.g., binge eating or abnormal eating patterns, which could confound the association between binge drinking and obesity (Fischer &Smith, 2008).

5.3. Causes of the conflicting results of the association between alcohol intake and obesity

The aetiology of obesity is considered multifactorial, with many different common factors contributing to the development of obesity . Not all of these factors have been studied or adjusted for when examining the association between alcohol consumption and obesity, and this in turn might bias the estimated relationship between alcohol consumption and obesity. The current study controlled for a relatively large number of sociodemographic and health-related factors that might confound the relationship between alcohol intake and obesity, with the highest estimated effect sizes for both mean WC and BMI found in males. Type of employment, which was not explored in this study, might act as a potential confounder. Most of the studies on alcohol consumption did not examine individual preferences or cultural influences behind alcohol intake or examine the type of legislation that might regulate alcohol intake within a country.

Epidemiological studies have examined the association between alcohol consumption and obesity using different instruments. This might also contribute to the conflicting results obtained from different studies. Furthermore, it makes comparisons among studies exceedingly difficult, as no single well-established method was used to measure alcohol consumption. Moreover, the baseline prevalence rates of both alcohol consumption and obesity in a study population can also contribute to inconsistencies in the results obtained when analysing this association. The window period used to recall alcohol intake was highly variable between studies, ranging from a 24-hour recall period (Bobak et al., 2003; Park et al., 2017) to a 12-month recall period (Tolstrup et al., 2005). However, most of the literature synthesized in this study used a 7-day recall period (O’donovan et al., 2018; Lukasiewicz et al., 2005; Ferreira et al., 2008). However, a short-term recall period does not account for the usual drinking patterns of individuals, the context under which individuals drink, or the influence of different seasons on alcohol consumption. The current study used a 12-month recall period to examine the association between alcohol consumption and obesity, which is considered more accurate in measurements of the usual consumption trends in individuals.

Types of alcoholic beverages might also affect the life habits of individuals, including eating patterns and physical activity, subsequently affecting body weight. Those who consume beer tend to have worse dietary habits than those who consume other beverages. A US study showed that individuals who drank beer tended to eat fewer fruits, vegetables, and grains than those who consumed wine (Ruidavets et al, 2004) and were more likely to eat ready-made food (Johansen et al 2006). Beer consumption was found to be positively associated with smoking, and an interaction of these factors might alter the effect of smoking on body weight. A study showed that current smokers who were heavy drinkers (> 60 grams/day) had a lower BMI than never smokers/former smokers. On the other hand, WC was largest among smokers with heavy lifetime alcohol consumption (Bergmann et al, 2011). The current study found that smoking was negatively associated with WC but not BMI after adjustment for sociodemographic and health-related factors. Physical activity is another lifestyle factor that might confound the relationship between alcohol intake and obesity; however, it is difficult to measure.

Most of the studies used a self-report questionnaire to collect data; however, self-report questionnaires are prone to different types of bias (nonresponse bias, recall bias, social desirability bias), and the results may be affected by intentional and unintentional misinterpretations of the questions being asked. Bellis et al. found that self-reported alcohol intake accounted for only 40-60% of total sales. Specifically, heavy drinkers tend to underreport their alcohol intake (Bellis et al., 2009). The period for recall can also affect the accuracy of self-reported data. However, the data used in the current study were collected during face-to-face interviews conducted by trained staff with the aid of CAPI to minimize errors that might occur during the interview. However, a 12-month recall period can lead to recall bias, which cannot be avoided in studies with such a design.

A limited number of studies have examined the effect of the interaction between genetic factors and environmental factors on obesity. Lio et al., 2016, examined male twins and concluded that alcohol consumption was positively associated with BMI after controlling for sociodemographic and lifestyle factors. However, this association was not observed in the within-pair analysis (Lio et al, 2016). Edward and colleagues found that in drinkers, alcohol consumption interacted with the presence of a certain allele, (PPARGC1A) rs4619879 (Edward et al., 2012). Yokoyama et al. found that a specific genotype (alcohol dehydrogenase-1 B) acted as a strong determinant of body weight among drinkers (Yokoyama et al, 2013). However, the exact mechanism by which different genes can affect body weight is still not well defined. More research is needed to elucidate the influence of genetic effects on the association between alcohol consumption and obesity.

5.3. Strengths and limitations

This is the first study to examine the association between alcohol consumption and obesity in a nationally representative sample in the Republic of Ireland. Since both obesity and overweight are prevalent in Ireland, the possibility of an association is greater than that in other areas where obesity and/or alcohol consumption are less common. Data collection was performed by trained staff; thus, the possibilities of misinterpretation of questions and missing data are exceptionally low. The anthropometric measurements were performed by trained staff, which helped ensure the accuracy of the collected data and avoid potential bias that might occur with the self-report method. The overall response rate for the Healthy Ireland Survey 2017 was considerably high (above 60%), which makes the data more generalizable to the whole Irish population. Moreover, this study used the AUDIT-C score in the analysis of the association between obesity and alcohol consumption, making the results more generalizable, as the AUDIT-C is a standardized tool to measure harmful alcohol consumption. Last, this study controlled for many sociodemographic and health-related factors that might confound the association between alcohol consumption and obesity.

Nonetheless, this study has several limitations. The major limitation is the cross-sectional design, which precludes the inference of a causal relationship or the confirmation of the inverse association between harmful alcohol consumption and obesity. Additionally, this study was prone to recall bias and social desirability bias, which tends to be more prevalent in face-to-face interviews. This study did not analyse the type of alcohol consumed, as those data were not included in the original survey. Moreover, confounders, such as physical activity and diet, were poorly presented in the original data, which made it impossible to control for them. Other potential confounders (sleep patterns, mental health, type of job) were not addressed because they were not available in the parent dataset. Moreover, overweight and obesity were prevalent in nearly two-thirds of the study population, increasing the likelihood of finding an association between alcohol consumption and obesity. ORs might overestimate the true association in comparison with prevalence ratios (Behrens et al. 2004). However, the prevalence ratio is not yet applicable to this type of study. Furthermore, this study did not stratify participants by gender to identify differences between genders in terms of the association between harmful alcohol consumption and obesity. The current study did not look at total energy intake; thus, it is not clear if the association is a true association or confounded by unmeasured risk factors. Underreporting of the amount of alcohol intake is problematic in both self-reporting and face-to-face interviews, especially among heavy drinkers, which might cause significant bias.

5.4. Implications of the study

The results of this study have many implications owing to the high prevalence of both alcohol consumption and obesity in Ireland. Current national and international guidelines for obesity management have not emphasized the possible association between alcohol intake and the risk of obesity development; thus, no recommendation regarding this matter has been made (National Institute for Health and Care Excellence, 2021; Health service executive, 2021). This is partly because of the conflicting evidence of the association between alcohol consumption (both quantity and frequency) and obesity. Nevertheless, these guidelines should highlight the current evidence available and clear recommendations around the relationship.

Obesity is a public health issue in Ireland, where more than 60% of the population is overweight or obese. The current study showed that men were more likely to be overweight (55.1%), while women were more likely to be obese (56.4%). Additionally, in 2021, the Health Service Executive reported that the prevalence of obesity in the most deprived areas was higher (one in four individuals) than that in the least deprived areas (one in six individuals). The management of obesity and overweight in primary health care is challenging. These challenges include lack of medical service, lack of access to health service, lack of access to healthy food, and lack of a place to perform physical activity. Additionally, treatment of this condition is highly stigmatized, even among health care workers, and obese patients are commonly subjected to negative judgement. Moreover, individuals may lack the skills and knowledge to address obesity, which makes them unable to manage their problems. As many determinants, including alcohol consumption, play a role in the development of obesity, treating obesity is considerably difficult and requires a holistic, multilevel, cross-sectoral approach. Ireland established the “A Healthy Weight for Ireland: Obesity Policy and Action Plan 2016–2025”, which involves different sectors and distributes the responsibility for preventing obesity among the health sector as well as other sectors (transportation, industrial, educational sectors, etc.) (Health service executive, 2016). However, alcohol intake recommendations were not included in the action plan strategies to combat obesity, possibly because of a lack of definitive evidence of the association between alcohol consumption and obesity. However, it is important to increase public awareness of the current evidence of the association between alcohol consumption and obesity, as this could help individuals control their drinking behaviours. Integrating recommendations for alcohol consumption within obesity management action plans is also important at this stage, as this might help standardize the care provided to patients.

Alcohol consumption is a major health issue in Ireland, where more than 80% of the population consumes alcohol. The current study showed that almost half of the participants who completed the AUDIT-C questionnaire were harmful drinkers (scored 5 or more), and over one-third of drinkers engaged in at least one binge drinking occasion per week. Despite current legislation to control alcohol intake, including minimum price units and a ban on advertising alcohol in public areas, the prevalence of harmful alcohol consumption is still high in Ireland. This necessitates a multisectoral approach to tackle the problem and reduce the associated burden. Increasing awareness of psychological as well as physical adverse effects of harmful alcohol consumption is recommended at the population level. It is also important to strengthen the capacity for screening for and treatment of harmful alcohol patterns. Ireland has started a brief advice service through the Making Every Contact Count (MECC) programme that tackles different health-related problems, including obesity and alcohol intake; this service increases awareness of the adverse effects of alcohol dependence on different health factors and provides support for the treatment of harmful alcohol consumption. However, data on the influence of alcohol consumption on obesity are scarce. Thus, it is important to update the information in the MECC programme regarding this topic. Increasing public awareness about the possible contribution of alcohol consumption, especially harmful alcohol consumption and binge drinking, to obesity is important at this stage. Finally, messages delivered by health care workers to patients regarding this issue should be consistent and regularly updated.

When addressing the association between alcohol consumption and obesity in epidemiological studies, it is important to consider the baseline prevalence of obesity and alcohol consumption in the study population, as this might affect the overall results. The measurement of exposure should be standardized to improve the generalizability and applicability of findings to other population settings. The current study was unique in that it used the AUDIT-C questionnaire in the examination of the association between alcohol consumption and obesity. The use of this tool can reduce inconsistencies in the results obtained. Conducting personal interviews is also preferable to self-report questionnaires, as personal interviews provide more accurate, high-quality data. The alcohol intake recall period should be long enough to accurately predict the pattern of alcohol consumption and account for periods where alcohol intake is high. A prospective study design is better for examining temporal sequences and reverse causation than a cross-sectional design, where such relationships cannot be revealed.

Increased spending on research that addresses alcohol consumption and obesity is recommended, especially in Ireland, where both are considered public health issues. This will help deepen the understanding of the exact relationship between alcohol consumption and obesity and further refine the future recommendations regarding alcohol consumption in a population with a high prevalence of obesity. Tailoring advice about alcohol intake according to an individual's medical background is also recommended. The current recommendations promote moderation in the consumption of alcohol, but further elaboration of an individual's risk factors is needed.

5.5. Conclusion

This is the first analytical, cross-sectional study to examine the association between alcohol consumption and obesity in an Irish population. Harmful alcohol consumption was found to be associated with overweight and obesity (BMI ≥ 25.0 kg/m^2) and a larger mean WC after adjustment for sociodemographic and health-related factors. After further controlling for the frequency of alcohol consumption and binge drinking, harmful alcohol consumption was no longer associated with mean WC. Frequent binge drinking was positively associated with mean WC. Alcohol consumption frequency was not associated with mean WC in this study. Further longitudinal studies are required to explore the causal relationship between alcohol consumption and obesity before making further recommendations on obesity management and prevention strategies.

Disclosure statement:

The author declares no conflict of interest regarding this work.

Author contributions

The author carried out the research and performed the statistical analysis with support from their supervisor, Professor Celine.

Funding:

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Ethical approval was originally obtained. Since this study was based on secondary data, no ethical approval was required.

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Appendix 1: Ethical approval for the parent study: Healthy Ireland Survey 2017

ROYAL COLLEGE OF PHYSICIANS OF IRELAND

Frederick House
19 South Frederick Street, Dublin 2
Telephone: +353 1 863 9700
Facsimile: +353 1 672 4707
Website: www.rcpi.ie

22nd of September 2014

Mr. K. O'Leary
Research Director
Ipsos MRBI
Block 3 Blackrock Business Park
Carysfort Avenue
Blackrock
Co. Dublin

Re: Healthy Ireland Study

Dear Mr. O'Leary,

Thank you for submitting your research proposal to the Research Ethics Committee at the Royal College of Physicians and for attending the meeting on the 18th of September.

The Research Ethics Committee's opinion is **Provisionally Favourable.**

The final questionnaire should be submitted for Chair review prior to final approval being granted.

Please include in the participant information and the study consent form that anonymised data from the Healthy Ireland Study may be analysed in the future by different researchers and health service personnel, from other organisations outside the Department of Health, under agreed conditions.

Please note that the committee requires the following to be submitted.

1. A yearly update report.
2. A premature termination report (If research is stopped early).
3. A completion report.

Also in the event of any adverse event occurring in the course of this research (e.g. breach of confidentiality), the committee should be informed as soon as practicable via the chair of the committee.

The committee would like to wish you every success with this project.

Yours Sincerely,

____

Dr. Una B Fallon MB, MA, MSc., MICGP, MRCGP, FFPH, FFPHMI

Chair RCPI Research Ethics Committee

MCRN 014313

Appendix 2: Request to access Healthy Ireland Survey 2017 data submitted to the ISSDA

Date Received
Date Sent

Data Request Form

DATA REQUEST FORM FOR RESEARCH PURPOSES

SECTION 1: CONTACT DETAILS [Please type]

First name *	Salma
Last name *	Alkalbani
Address	Dublin
Country *	Ireland
Institution/Company *	Master student at school of Public Health, Physiotherapy & Sports Science, MPH program.
Email *	
Phone	

SECTION 2: DATASET REQUESTED* [Please type]

Please refer to the full list of datasets on the ISSDA website: www.ucd.ie/issda/data/

Please include Study Number (SN) where appropriate

This Dr salma AL kalbani MPH Master student at UCD, Dublin. Currently I am doing research on the association of alcohol intake pattern and obesity in Irish population. I would Like to apply for secondary data of **healthy Ireland Survey 2017 from ISSDA or the latest available data in Healthy Ireland survey**. *I will apply for ethical exemption at UCD ethical committee but they are asking for permission from your organisation to complete the application form.*

SECTION 3: INTENDED USE OF DATA [Please type]

Subject area *				
	☐ Economics	☐Education	☐Engineering	☐Environment/ Agriculture
	☐Health/ Well-being	☐Law	☐Policy	☐Social issues
	☐ Sport	Technology	☐Other [please specify]	

Please provide a short description (approx. 100 words) of your intended use of the dataset/s, including title and details of your intended research project*:

Type of user *				
	☐Academic Staff	☐ Post Doc	☐PhD	☑Masters
	☐Undergraduate	☐Independent Researcher	☐Government/ Policy researcher	
	☐Other [please specify] ______			

Estimated end date for this use (maximum 5 years from date of application) *	1/7/2021
Funder (where applicable)	n/a

* indicates required field

ISSDA needs to collect and use personal data (information) about individuals requesting access to data in the Archive. Read our Data Protection Policy for further information.

SECTION 4: PERSONS PERMITTED TO ACCESS THE DATA UNDER ARTICLE 3 OF TERMS OF USE*

The data may only be used for the purpose as outlined in Section 3. Data must be re-applied for in the case of new projects being undertaken.

Please indicate the number of users who will have access to and use of the data.

Only the researcher will access the data.

- All users are bound by the same terms and conditions as the End User
- Users may not be given a copy of the data for use outside of the scope of the research project outlined in Section 3
- Users wishing to use the data outside of the scope of the research project outlined in Section 3 can apply directly to ISSDA for a copy of the data, subject to the usual terms and conditions
- The data must be deleted from all computers once the research project outlined in Section 3 has been completed

SECTION 5: REGISTER OF USE*

The Irish Longitudinal Study on Ageing (TILDA) and Growing Up in Ireland (GUI) only

ISSDA would like to facilitate researchers using other datasets to collaborate, where appropriate. If you consent to allowing your details to being published on our website, please tick one of the following options:

☑ Description of project

☐ No details

5

* indicates required field

ISSDA needs to collect and use personal data (information) about individuals requesting access to data in the Archive. Read our Data Protection Policy for further information.

ISSDA
Irish Social Science Data Archive

IRISH SOCIAL SCIENCE DATA ARCHIVE

End User Licence

This Agreement is made between [Dr Salma AlKalbai] (the "End User") and the ISSDA in order to provide the "End User" with the right to use the data collections provided via the ISSDA according to the terms below:

TERMS OF USE

These terms of use cover the use of data files and all related material (hereafter "the data collections") supplied by ISSDA in accordance with the Data Request Form.

The End User undertakes and agrees:

1. To use and to make personal copies of any part of the data collections only for the purposes specified in the part on intended use of data. If it is wished to use the data for any other purpose enquiries should be made to the ISSDA.
2. That this Licence does not operate to transfer any interest in intellectual property from the data collection funders, the ISSDA, the original data creators or depositors, copyright or other right holders to the End User.
3. To ensure that strictly only the End User, and those persons referred to in Section 4, have access to the data provided under this agreement. The End User shall be responsible for controlling access to the data.
4. To ensure that the means of access to the data collections (such as passwords) are kept secure and not disclosed to a third party (excluding those listed in Section 5) except by special written permission or licence obtained from the ISSDA.
5. Not to use the data collections to attempt to obtain or derive information relating specifically to an identifiable individual or household.
6. To be aware at all times of the risk of inadvertently disclosing information, which might result in the identification of an individual. All use of the data and production of all analysis and output should be sensitive to this risk.
7. To undertake to abide by the conditions laid out in the Statistics Act, 1993, and, in particular, Section 34 thereof. Please see http://www.irishstatutebook.ie/1993/en/act/pub/0021/index.html
8. To acknowledge, in any work based in whole or part on resources provided by the ISSDA, the original data creators, depositors or copyright holders and the ISSDA, and to declare, in any such work, that those who carried out the original analysis and collection of the data bear no responsibility for the further analysis or interpretation of it.
9. To ensure that all such works acknowledge that copyright and all other intellectual property rights in the data and associated documentation are vested in the original data creators or depositors. Please see the ISSDA website (www.ucd.ie/issda) for appropriate wording.

* indicates required field

ISSDA needs to collect and use personal data (information) about individuals requesting access to data in the Archive. Read our Data Protection Policy for further information.

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10. To ensure that all such works acknowledge the ISSDA in the following way: "Accessed via the Irish Social Science Data Archive - www.ucd.ie/issda".

11. To reference the recommended bibliographic citation in any publication that employs resources provided by the ISSDA.

12. To send to the ISSDA citations of any publication based in whole or part on resources provided by the ISSDA for inclusion in a database of related publications.

13. That ISSDA may submit details of the End User's research, as outlined in Section 3, for statistical purposes to the original data creator or depositor.

14. To notify the ISSDA of any errors discovered in the data or accompanying documentation.

15. Any breach of any of the provisions of this Agreement will lead to immediate termination of the End User's access to all services provided by the ISSDA either permanently or temporarily, and may result in legal action being taken against the End User. The End User acknowledges that the data depositor will be notified in the event of a breach coming to the notice of the End User within 72 hours. Permission to use the data for the specified purpose may be withdrawn by the ISSDA at any time, without notice and without cause assigned, by written notice to the End User, signed by or on behalf of the Director of the ISSDA.

INDEMNITY

End User agrees to indemnify and shall keep indemnified each member of the ISSDA against any costs, actions, claims, demands, liabilities, expenses, damages or losses (including without limitation consequential losses and loss of profit, and all interest, penalties and legal and other professional costs and expenses) arising from or in connection with any third party claim made against any member of the ISSDA relating to End Users use of the data collections or any other activities in relation to the data collection where such use is in breach of this licence.

DISCLAIMERS

To the extent that applicable law permits:

a. The ISSDA bears no legal responsibility for the accuracy or comprehensiveness of the data supplied.

b. The ISSDA accepts no liability for, and the End User will not be entitled to claim against them in respect of, any direct, indirect, consequential or incidental damages or losses arising from use of the data collections, or from the unavailability of, or break in access to, the service, for whatever reason.

c. Whilst steps have been taken to ensure all licences, authorisation and permissions required for the granting of this Licence have been obtained, this may not have been possible in all cases, and no warranties or assurance are given in this regard. To the extent that additional licences, authorisations and permissions are required to use the data collections in accordance with this Licence, it is the End User's responsibility to obtain them.

* indicates required field

ISSDA needs to collect and use personal data (information) about individuals requesting access to data in the Archive. Read our Data Protection Policy for further information.

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I acknowledge that by signing my name below, I confirm that I have read, understood, and agree to abide by all of the terms and conditions in the ISSDA End User Licence (including the obligations imposed on the End User).

Signed ______________________	**Signed** ________
Administrator	
Irish Social Science Data Archive	**END USER**
Date ______________________	**Date** 28/1/2021_________
For office use only	

Please note that any reference to signature and date in this document can be read as meaning the typed name and date where such an application is forwarded electronically.

Definitions

"data collection funder" means the persons or organisations that funded the collection and/or creation of the data collections. The data collection funder for a particular data collection is identified in the metadata applicable to that data collection;

"**original data creator or depositor**" means the persons or organisations that originally collected, created or deposited the materials making up the data collections and/or who own the intellectual property rights in the data collections. The original data creator or depositor for a particular data collection is identified in the metadata applicable to that data collection;

"**metadata**" means any additional or bibliographic information about one or more of the data collections, as notified to the End User from time to time. Metadata may be supplied by electronic means

Appendix 3: Ethical exemption

UCD School of Public Health,
Physiotherapy and Sports Science

[illegible] UCD

University College Dublin,
[illegible] House,
Belfield, Dublin 4, Ireland

An [illegible]
Belfield, [illegible] 4, Éire

tmrec-sphpss@ucd.ie
www.ucd.ie/sphpss

25 February 2021

[redacted]

Application: Declaration of Ethical Review Exemption

Decision: Contingent Acceptance (accept, subject to implementation of recommended changes – submission of amendments to committee not required)

REFRN: [redacted]

Applicant: [redacted]

Supervisor/PI: [redacted]

Thank you for notifying the Taught Masters Ethics Committee - SPHPSS (TMREC) of *your declaration* that your research is exempt from a full ethical review.
In any future correspondence regarding this study and exemption, please quote the Research Ethics Exemption Reference Number (REERN) indicated above.
Should the nature of your research change, and thereby alter the exempt status, please submit an application for full ethical review.

Please observe the following:

- If you are declaring low risk on the basis that the work has been ethically approved from another approved body (e.g. National Research Ethics Committee [NREC], Hospitals, hospices, prisons, health authorities), then provide a pdf copy of that approval as a supporting document.

- Store evidence that only anonymised data is being involved, for example a hardcopy download of the ISSDA flyer (link here); at the time of writing, that ISSDA flier stated that "all data that arises from surveys or administrative records relating to individuals or groups of individuals that have been cleansed of personal identifiers or other information that may enable identification of individuals represented in a dataset"

- Section 2b – proposed start date cannot be before ethics approval
- Section 6c – need to follow up and make sure the permission confirmation is included

Appendix 4: Case report form

Case report form: The Association Between Alcohol Intake and Obesity in a Sample of the Irish Adult Population (Secondary data from the Healthy Ireland Survey 2017)

Investigator

A. Administrative data

1 Participant # ________________

2 Date Administered (dd/mm/yyyy) ________________

B. Demographic data

1	Date of birth (dd/mm/yyyy)		----------------------
2	Age category		1= 15-24 years
			2= 25-44 years
			3= 45-64 years
			4=65 years or older
3	Gender		1=Male
			2=Female
4	What is your current marital status?		1=Single
			2= Married
			3=Widowed
			4=Divorced, legally dissolved
			5= Separated (including deserted)
5	Urban/rural residency		1= Urban
			2= Rural
6	What is the highest education level achieved?		1=Low (Primary/none)
			2=Medium (Secondary)
			3=High (Tertiary/Higher)
7	What is your current employment status?		1=Working for payment or profit
			2=Looking for my first regular job
			3=Unemployed (lost or left my last job)
			4=Actively looking for a job
			5=Student or pupil
			6=Retired from employment
			7=Unable to work due to permanent disability
			8=Other, please specify

9	Do you have a full medical card?	1=Yes 2=No
11	Do you have private health insurance?	1=Yes 2=No

C. General health

1	How is your general health condition?	1-Very Good 2=Good 3=Fair 4=Poor 5= Very poor 6= Do not know 7 Refuse to answer
2	Do you have a long-term illness or health problem (i.e., lasting more than 6 months)?	1=Yes 2 No 3=Do not know 4=Refuse to answer
3	Did you ever smoke tobacco products (in the past)?	1=Yes, daily 2=Yes, occasionally 3= No 4= Do not Know 5=Refuse to answer

D. Alcohol data

1	Have you ever drunk any type of alcoholic beverage?	1=Yes 2=Never 3=I had only a few sips 4=Do not Know 5=Refuse to answer
2	How often did you consume alcohol in the past 12 months?	1 = Daily 2 = 5-6 times per week 3= 4 times per week 4= 3 times per week 5 =2 times per week 6 =1 time per week 7 =2–3 times per month 8 =1 time per month 9= 6–11 times per year 10 =2–5 times per year 11 = 1 time per year

			12=Not in the last year, but I have drunk alcohol
			13 = I have dramatically changed my drinking pattern
			14 = Do not know
			15 = Refuse to answer
4	During the last 12 months, how often did you consume (drink) the equivalent of 6 standard drinks on one occasion?		1 = Daily
			2 = 5–6 times per week
			3= 4 times per week
			4 =3 times per week
			5 = 2 times per week
			6 =1 time per week
			7 =2–3 times per month
			8 1 time per month
			9= 6–11 times per year
			10 =2–5 times per year
			11 = 1 time per year
			12 =Never

E. Diet and nutrition

6	How often do you consume fruit, including fruit juice?		1= Once or more per day
			2= 4–6 times per week
			3=1–3 times per week
			4=less than 1 time per week
			5-Never
			6=Do not Know
			7=Refuse to answer

F. Weight management and anthropometric measurements

1	Are you willing to record your weight, height, and waist circumference?		1=Yes
			2=No
2	Record weight (kg)		------------------------------
3	Record hight (cm)		------------------------------
4	Record weight circumference (cm)		-----------------------------

#	Abbreviation	Variable name	Variable definition	Type of variable: Quantitative or qualitative	Type of variable: Categorical, discrete or continuous	Level of measurement	Coding reference
Data Dictionary: The Association Between Alcohol Intake and Obesity in a Sample of the Irish Adult Population (Secondary data from the Healthy Ireland Survey 2017)							
1	**SI**	Study ID	Unique identification number for each respondent	Quantitative	Discrete	Nominal	Enter as given
2	**AGECAT**	Age	Age category	Quantitative	Categorical	Ordinal	1= "15-24years", 2="25-44 years", 3="45-64 years", 4=65+years"
3	**GENDCAT**	Gender	Gender	Qualitative	Categorical	Nominal	1= "Male", 2=" Female"
4	**MARTCAT**	Marital status	Current marital status	Qualitative	Categorical	Nominal	1= "Single, never married; widowed; divorced or separated" 22= "Married/in a civil relationship"
5	**URBRUR**	Urban/rural residency	Urban or rural residency	Qualitative	Categorical	Nominal	1= "Urban"; 2= "Rural"
6	**EDUC**	Highest education	Highest education level achieved	Qualitative	Categorical	Ordinal	1= "Low (primary/none)", 2= "Moderate (secondary)", 3= "High (tertiary/higher)"
7	**EMPLOYSTAT**	Employment status	Current employment status	Qualitative	Categorical	Ordinal	1= "Employed", 2= "Unemployed", 3= "Retired", 4= "Pupil/student"
8	**MEDCARD**	Medical card	Possession of a full medical card	Qualitative	Categorical	Nominal	1= " Yes", 2= "No"
9	**PHICARD**	Private health insurance	Possession of private health insurance	Qualitative	Categorical	Nominal	1= "Yes", 2= "No"
10	**GENH**	General health	General health condition	Qualitative	Categorical	Ordinal	1= "Good", 2= "Fair", 3= "Poor"
11	**CSMOK**	Current smoking status	Current smoker or not	Qualitative	Categorical	Nominal	1= "Yes" 2= "No", 3= "Do not know", 4= "Refuse to answer"
12	**PMH**	Long-term medical illness	Any past long-term medical illness	Qualitative	Categorical	Nominal	1= "Yes", 2= "No"; 3= "Do not know"
13	**EATFRUIT**	Fruit consumption	Frequency of fruit consumption	Quantitative	Categorical	Ordinal	1= "Once or more a day", 2= "4-6 times a week", 3= "1-3 times a week", 4= "Less than once a week", 5= "Never", 6= "Do not know", 7= "Refuse to answer"
14	**ACTIVTRAV**	Travel using active transportation	Travel from home to regular place of work or college using a bicycle or by	Qualitative	Categorical	Nominal	0= "No"; 1= "Yes"

			walking				
15	**ALC**	Alcohol consumption frequency	Ever consumed any type of alcoholic beverages	Qualitative	Categorical	Nominal	1= “Yes”, 2= “Never”, 3= “I have had only few sips”; 4= “Do not know”, 5= “Refuse to answer”
16	**ALC12**	Alcohol consumption in the past 12 months	Frequency of consumption of alcohol in the last 12 months	Quantitative	Categorical	Ordinal	1= “Daily”, 2= “5-6 times a week” 3 = “4 times a week”, 4= “3 times a week”, 5= “2 times a week”, 6= “1 time a week”, 7= “2-3 times a month”, 8= “1 time per month”, 9= “6-11 times per year”, 10= “2-5 times per year”, 11= “1 time per year”, 12= “Not in the last year but I have consumed alcohol”, 13= “I have dramatically changed my drinking pattern”, 14= “Do not know”, 15= “Refuse to answer”
17	**ALCBING**	Binge drinking	Frequency of the consumption of the equivalent of 6 or more standard drinks on one occasion the last 12 months	Quantitative	Categorical	Ordinal	1= “Daily”, 2= “5-6 times a week” 3= “4 times a week”, 4= “3 times a week”, 5= “2 times a week”; 6= “1 time a week”, 7= “2-3 times per month”, 8= “1 time per month”, 9= “6-11 times per year”, 10= “2-5 times per year”, 11= “once per year”; 12= “Never”
18	**AUDITC**	AUDIT-C	AUDIT-C score	Quantitative	Categorical	Ordinal	1= “0”; 2= “1-2”; 3= “3-4”, 4= “5+”
19	**WT**	Weight (kg)	Weight of respondent	Quantitative	Continuous	Interval	Enter as given
20	**HT**	Height (m)	Hight of respondent	Quantitative	Continuous	Interval	Enter as given
21	**WS**	Waist circumference	Waist circumference of respondent (cm)	Quantitative	Continuous	Interval	Enter as given
22	**BMI**	Body mass index (kg/m^2)	Weight/height^2	Quantitative	Continuous	Interval	Enter as given
23	**BMICAT**	BMI categories	BMI category	Quantitative	Categorical	Ordinal	1= “<25 kg/m^2”, 2 = “25.0 to 29.9 kg/m^2”, 3= “>=30 kg/m^2”