Faculty of Social Sciences
University of Helsinki
Dissertationes Universitatis Helsingiensis 43/2026

Sociodemographic and health-related factors associated with harmful gambling:

Results from Finnish population-based studies

Tanja Grönroos

ACADEMIC DISSERTATION

To be presented, with the permission of the Faculty of Social Sciences of the University of Helsinki, for public examination in lecture room Karolina Eskelin, University main building,
on 25 February 2026, at 12 noon.

Helsinki 2026

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Publisher: University of Helsinki
Series: Dissertationes Universitatis Helsingiensis 43/2025

ISBN 978-952-84-1866-5 (print)
ISBN 978-952-84-1865-8 (online)
ISSN 2954-2898 (print)
ISSN 2954-2952 (online)
PunaMusta, Joensuu 2026

Abstract

The gambling industry is expanding rapidly, driven largely by digitalisation, which has made gambling more accessible than ever through the internet. Globally, gambling is highly prevalent, with approximately half of the adult population engaging in some form of gambling. For many individuals, however, gambling can lead to significant harm, affecting their health and well-being. An estimated 9% of adults worldwide engage in at-risk or problem gambling or meet the criteria for gambling disorder (GD). Harmful gambling is a broad term referring to any repetitive gambling that leads to or exacerbates recurring negative consequences. The distribution of harmful gambling is uneven across the population. Emerging evidence suggests that harmful gambling is more prevalent amongst socially disadvantaged groups, such as individuals with lower socioeconomic position (SEP) or co-occurring health conditions, thereby reinforcing inequalities in health. However, significant research gaps remain, and further studies are needed to help develop, target, and implement policies aimed at reducing and preventing harmful gambling.

The aim of this dissertation was to expand knowledge on the sociodemographic and health-related factors associated with harmful gambling. Harmful gambling was examined from three perspectives: high gambling expenditure (GE), problem gambling severity, and diagnosed GD. The first two were based on self-reported data, whereas GD was identified through a physician's diagnosis. The specific aims were to examine: (1) the associations between sociodemographic factors, gambling behaviour, and the level of GE; (2) the associations between health risk behaviours (HRBs), obesity, and problem gambling severity amongst women and men; and (3) the gender-specific incidences of somatic and psychiatric disorders amongst Finnish adults with diagnosed GD. To address these issues, the following population-based surveys were utilised: the Gambling Harms survey 2016 (n = 7,186) and 2017 (n = 2,624), and the Healthy Finland survey 2022–2023 (n = 28,154). In addition, register-based data retrieved from national registers were used (n = 4,374,192). The main statistical methods used included multinomial logistic regression and negative binomial regression. Standardised incidence ratios (SIRs) were also calculated.

The results of Sub-study I showed that a small proportion of individuals accounted for half of the total GE. Individuals in this group were more likely to be men, older, have low education, higher net income, and receive a disability pension or sickness allowance compared with those in the lowest GE group. Notably, most of the total GE in this group came from those engaging in at-risk or problem gambling. Sub-study II found that harmful gambling was closely linked to HRBs. Individuals with low-risk, moderate-risk, and problem gambling exhibited higher rates of daily smoking, excessive drinking, low fruit and vegetable (F & V) consumption, insufficient sleep, and obesity than those with non-problem gambling. After controlling for potential confounders, nearly all HRBs and obesity were associated with an increased Problem Gambling Severity Index (PGSI) score. Sub-study III, in turn, found that harmful gambling was associated with a range of other health conditions. The incidence of each diagnostic group was higher for individuals diagnosed

with GD compared to the general population, except for cancer. The highest incidences were found for psychiatric disorders, memory disorders, nervous system diseases, chronic respiratory diseases, diabetes and digestive diseases. Sub-studies II and III found some gender differences in HRBs and comorbidities amongst individuals with harmful gambling.

To conclude, the findings of this dissertation strengthen previous evidence that harmful gambling is unevenly distributed across population groups, potentially contributing to inequalities in health. Moreover, they broaden the understanding of health-related factors linked to harmful gambling, particularly non-substance-related HRBs and somatic comorbidities. These co-occurring vulnerabilities may further complicate individuals' difficulties and make it harder to improve their situations. Accordingly, the main aim of gambling policy in Finland, as in other countries, should be to prevent and reduce harms from gambling, with particular attention to alleviating the disproportionate burden on disadvantaged groups, such as individuals with low SEP or those with health problems. In 2027, the Finnish gambling system will undergo major changes as it transitions to a licence system for online gambling. This shift is expected to increase the availability and accessibility of the most harmful gambling products, which is thought to also lead to higher consumption and greater harms. It is therefore essential to closely monitor how harmful gambling is distributed across different population groups in the coming years.

Tiivistelmä

Rahapeliteollisuus kasvaa voimakkaasti. Tähän on vaikuttanut erityisesti digitalisaatio, jonka myötä rahapelit ovat entistä helpommin saatavilla internetissä. Rahapelaaminen on hyvin yleistä ympäri maailman, ja arvioilta noin puolet aikuisväestöstä on pelannut jotain rahapeliä. Monelle ihmiselle rahapelaamisesta aiheutuu merkittävää hyvinvointi- ja terveyshaittaa. Noin yhdeksän prosenttia aikuisista pelaa joko riski- tai ongelmapelaamisen tasolla tai täyttää diagnosoidun rahapeliriippuvuuden kriteerit. Haitallinen rahapelaaminen on laaja termi, joka pitää sisällään kaikenlaisen toistuvan pelaamisen, joka aiheuttaa tai pahentaa toistuvia kielteisiä seurauksia. Väestössä haitallinen rahapelaaminen jakautuu epätasaisesti. Yhä useammassa tutkimuksessa on havaittu, että haitallinen rahapelaaminen on yleisempää heikossa asemassa olevilla henkilöillä, kuten heillä, joilla on alhainen sosioekonominen asema tai samanaikaisia terveysongelmia. Tämä osaltaan vahvistaa yhteiskunnassa ilmeneviä terveyseroja. Merkittäviä tutkimusaukkoja on kuitenkin edelleen, ja tarvitaan lisää tutkimusta, joka tukee poliittisten toimenpiteiden kehittämistä, kohdentamista ja toteuttamista haitallisen rahapelaamisen ehkäisemiseksi sekä vähentämiseksi.

Tämän tutkielman tavoitteena on lisätä ymmärrystä haitalliseen rahapelaamiseen yhteydessä olevista sosiodemografisista ja terveydellisistä tekijöistä. Haitallista rahapelaamista tarkasteltiin kolmesta eri näkökulmasta: korkea rahapelikulutus, rahapeliongelman vakavuus ja diagnosoitu rahapeliriippuvuus. Näistä kaksi ensimmäistä indikaattoria pohjautui itseraportoituihin tietoihin, kun taas rahapeliriippuvuus pohjautui lääkärin antamaan diagnoosiin. Tutkimuksen tarkemmat tavoitteet olivat tarkastella: 1) sosiodemografisten tekijöiden, rahapelikäyttäytymisen ja rahapelikulutuksen välistä yhteyttä, 2) terveysriskikäyttäytymisten, lihavuuden ja rahapeliongelman vakavuuden välistä yhteyttä naisilla ja miehillä ja 3) somaattisten ja psykiatristen sairauksien esiintyvyyttä naisilla ja miehillä, joilla on diagnosoitu rahapeliriippuvuus. Näiden kysymysten tarkasteluun käytettiin seuraavia väestöpohjaisia kyselyaineistoja: Rahapelikysely 2016 (n = 7 186) ja 2017 (n = 2 624) sekä Terveys Suomi -kysely 2022–2023 (n = 28 154). Lisäksi hyödynnettiin kansallisista rekistereistä saatua rekisteripohjaista aineistoa (n = 4 374192). Pääasiallisina tilastollisina menetelminä käytettiin multinomiaalista logistista regressiota ja negatiivista binomiregressiota. Myös vakioidut ilmaantuvuussuhteet (SIR) laskettiin.

Osatutkimuksen I tulokset osoittivat, että vain pieni osa ihmisistä tuottaa puolet rahapelaamisen kokonaiskulutuksesta. Verrattuna alhaisimman rahapelikulutuksen ryhmään tässä ryhmässä korostuivat miehet, matalammin koulutetut, korkeimpaan tuloryhmään kuuluvat sekä työkyvyttömyyseläkkeen tai sairauspäivärahan saajat. Huomionarvoista oli, että valtaosa tämän joukon rahapelikulutuksesta tuli heiltä, joilla oli riski- tai ongelmatason rahapelaamista. Osatutkimuksessa II puolestaan havaittiin, että haitallinen rahapelaaminen oli selvästi yhteydessä muihin terveysriskikäyttäytymisiin. Tulokset osoittivat, että henkilöillä, joilla oli alhaisen riskin, kohtalaisen riskin tai

ongelmatason pelaamista, esiintyi selvästi enemmän päivittäistä tupakointia, liiallista alkoholinkäyttöä, vähäistä hedelmien ja vihannesten syömistä, riittämätöntä unta ja lihavuutta kuin heillä, joilla ei ollut rahapelaamiseen liittyviä ongelmia. Kun mahdolliset sekoittavat tekijät otettiin huomioon, melkein kaikki terveysriskikäyttäytymiset ja lihavuus olivat yhteydessä korkeampaan Problem Gambling Severity Index (PGSI) -pistemäärään. Osatutkimuksessa III puolestaan havaittiin, että haitallinen rahapelaaminen oli yhteydessä monenlaisiin terveysongelmiin. Tulokset osoittivat, että kunkin diagnoosikategorian ilmaantuvuus oli korkeampi heillä, joilla oli diagnosoitu rahapeliriippuvuus verrattuna koko väestöön. Ainoa poikkeus oli syövät. Korkeimmat ilmaantuvuusluvut olivat seuraavissa diagnoosikategorioissa: mielenterveyden ja käyttäytymisen häiriöt, muistisairaudet, hermoston sairaudet, krooniset keuhkosairaudet, diabetes ja ruuansulatuselimistön sairaudet. Osatutkimusten II ja III tulokset osoittivat, että terveysriskikäyttäytymisessä ja liitännäissairastavuudessa oli jonkin verran eroja naisten ja miesten välillä, joilla on haitallista rahapelaamista.

Tämän tutkielman tulokset vahvistivat aiempia havaintoja siitä, että haitallinen rahapelaaminen jakautuu epätasaisesti väestössä ja saattaa siten lisätä terveyden eriarvoisuutta. Lisäksi tulokset syvensivät ymmärrystä haitalliseen rahapelaamiseen liittyvistä terveystekijöistä, erityisesti muiden kuin päihteiden käyttöön liittyvien terveysriskikäyttäytymisten sekä somaattisten liitännäissairauksien osalta. Huomionarvoista on, että nämä samanaikaiset muut haavoittuvuudet voivat entisestään vaikeuttaa yksilön tilannetta ja sen parantamista. Rahapelijärjestelmän tulisi niin Suomessa kuin muissakin maissa ennen kaikkea ehkäistä ja vähentää rahapelaamisesta aiheutuvia haittoja. Erityistä huomiota tulisi kiinnittää heikommassa asemassa olevien, kuten matalan sosioekonomisen aseman omaavien tai niiden, joilla on samanaikaisia terveysongelmia, rahapelaamisesta aiheutuvan suhteettoman kuormituksen vähentämiseen. Vuonna 2027 suomalaisessa rahapelijärjestelmässä tapahtuu merkittäviä muutoksia, sillä siirrytään lisenssijärjestelmään internetissä pelattavien rahapelien osalta. Tämän muutoksen on ajateltu lisäävän kaikista haitallisimpien rahapelien saatavuutta ja saavutettavuutta, minkä on ajateltu myös lisäävän rahapelien kulutusta ja niihin liittyviä haittoja. Siksi on erityisen tärkeää seurata haitallisen rahapelaamisen jakautumista eri väestöryhmien välillä tulevina vuosina.

Acknowledgements

I would like to warmly thank everyone who has contributed to or supported this doctoral dissertation. In particular, I wish to express my deepest gratitude to my excellent supervisors, Anne Kouvonen and Anne Salonen, for their invaluable guidance, support, and encouragement throughout the dissertation process. I am also grateful to Katja Kuusisto for kindly accepting the invitation to serve as the opponent at the public defence of my dissertation. My sincere thanks go to Aino Suomi and Ståle Pallesen for acting as the pre-examiners of this work; their insightful and constructive comments have greatly improved the quality of the dissertation.

I am grateful to Anne Kouvonen, Heikki Hiilamo, Minna van Gerven, and my fellow doctoral researchers for their helpful feedback on the sub-studies of this doctoral dissertation during the social policy PhD seminars at the University of Helsinki. I also thank the Finnish Foundation for Alcohol Studies for initial funding, which allowed me to fully focus on my dissertation at the start of my doctoral journey. A warm thank you to all my highly skilled colleagues at the Finnish Institute for Health and Welfare, especially those in the Gambling Harm Unit. It is a pleasure to work with you. I am grateful to our recently retired former team leader Saini Mustalampi and current team leader Susanna Raisamo.

A special thank you to the co-authors of the sub-studies in my doctoral dissertation: Anne Salonen, Anne Kouvonen, Jukka Kontto, Tiina Latvala, Timo Partonen, and Annamari Lundqvist. Thank you to Jukka Kontto for his guidance with statistical matters. I am also truly thankful to Maria Heiskanen, Sari Castrén, Kalle Lind, and Tiina Latvala for carefully reading the summary of my dissertation and providing valuable feedback. I am deeply thankful to Tiina Latvala for her exceptional support during the final stages of my doctoral dissertation.

I am truly grateful to my parents for their unwavering help and support over the years. My sincere thanks go to Antti for his invaluable statistical guidance and for the countless skiing trips to Finnish Lapland, which have provided a perfect balance to my academic work. Finally, I am thankful to our dog Oskari for bringing joy to each day.

Ylläsjärvi, Finland, December 2025
Tanja Grönroos

List of abbreviations

AUDIT-C	Alcohol Use Disorder Identification Test for Consumption
BMI	Body mass index
CI	Confidence interval
DSM	Diagnostic and Statistical Manual of Mental Disorders
F & V	Fruit and vegetables
GD	Gambling disorder
GE	Gambling expenditure
GPA	Grade point average
HRB	Health risk behaviour
ICD	International Classification of Diseases
IRR	Incidence rate ratio
LRGG	Lower-Risk Gambling Guidelines
MHI-5	Mental Health Inventory
OR	Odds ratio
PGSI	Problem Gambling Severity Index
PPGM	Problem and Pathological Gambling Measure
SEP	Socioeconomic position
SIR	Standardised incidence ratio
THL	Finnish Institute for Health and Welfare

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List of original publications

This thesis is based on the following publications:

I **Grönroos T**, Kouvonen A, Kontto J, Salonen AH. Socio-demographic factors, gambling behaviour, and the level of gambling expenditure: A population-based study. *Journal of Gambling Studies*. 2022 Dec;38:1093–1109.

II **Grönroos T**, Salonen AH, Latvala TA, Kouvonen A, Lundqvist A, Kontto J. Health risk behaviours, obesity, and gambling severity: findings from a nationwide population study. *European Journal of Public Health*. 2025; ckaf216.

III **Grönroos T**, Kontto J, Kouvonen A, Latvala TA, Partonen T, Salonen AH. Somatic and psychiatric comorbidity in people with diagnosed gambling disorder: A Finnish nation-wide register study. *Addiction*. 2024 Nov;119(11):2015–22.

The publications are referred to in the text by their Roman numerals. All Sub-studies are published under an open access license.

1 Introduction

The global gambling industry is expanding rapidly. This is largely driven by digitalisation, which has made gambling more accessible than ever through mobile phones and the internet. As a result, gambling is no longer limited to traditional venues but can take place at home, school, work, or nearly anywhere. This means that online gambling products, which are designed to be fast and intensive and are associated with a higher risk of harm to consumers, are now more widely and easily available (Sulkunen et al., 2019; Wardle et al., 2024). At the same time, gambling is increasingly recognised as a public health issue, with a wide range of harms that affect not only individuals but also their families, social networks, communities, and societies (Langham et al., 2016). These harms can include, for example, financial losses, relationship breakdowns, job loss, health problems, and criminal involvement (Marionneau et al., 2023). In its most severe form, gambling can even result in loss of life (Andreeva et al., 2022). The consequences of gambling can often be long-lasting, with effects that can persist long after gambling has ceased, and may even extend across generations (Hillbrecht et al., 2020).

A recent meta-analysis estimated that gambling is highly prevalent worldwide, with 46% of adults having gambled in the past 12 months (Tran et al., 2024). Globally, around 1.4% of adults engage in problem gambling or meet the criteria for a gambling disorder (GD). Problem gambling refers to an intermediate or subclinical form of GD. However, harms are experienced across the full spectrum of gambling behaviour, affecting many people who gamble, but would not be classified as having a gambling problem or GD (Browne et al., 2018; 2020). Overall, around 9% of adults fall into the low-risk, moderate-risk, problem gambling, or GD categories (Tran et al., 2024). The first two categories often involve some harm, and typically precede problem gambling. In this dissertation, the term 'harmful gambling' refers to any repetitive gambling that leads to, or exacerbates, recurring negative consequences (Abbott et al., 2018).

Although gambling can harm anyone who participates, certain population groups are at higher risk. Male gender and young age are amongst the most frequently identified risk factors for harmful gambling (e.g., Calado et al., 2016; Allami et al., 2021). Emerging evidence suggests that individuals with vulnerabilities, such as low socioeconomic position (SEP), are disproportionately affected by harmful gambling (e.g., Raybould et al., 2021). For example, numerous

studies have found that the risk of harmful gambling is higher amongst those with low education, low income, or who are unemployed (Raybould et al., 2021; Latvala et al., 2021; Hahmann et al., 2021). Moreover, some studies suggest that harmful gambling is more common amongst recipients of welfare benefits (Latvala et al., 2021), further supporting the view that vulnerable individuals are more likely to be affected.

Other forms of vulnerability are also linked to harmful gambling. It often co-occurs alongside mental health issues (Lorains et al., 2011; Salonen et al., 2025), and is linked to higher rates of suicidal thoughts, suicide attempts, and suicide deaths (Andreeva et al., 2022; Kristensen et al., 2024; Kidane et al., 2025). Some evidence suggests that physical health conditions are associated with harmful gambling, although research in this area is limited (e.g., Subramaniam et al., 2015; Ekholm et al., 2018; Abdul-Rahim et al., 2023). Harmful gambling is linked to various health risk behaviours (HRBs). Whilst the strong link with substance use is well documented (e.g., Abbott et al., 2018; Sharma et al., 2025), other HRBs such as an unhealthy diet, insufficient sleep, and low physical activity have received less attention. The available evidence suggests that people who engage in harmful gambling are more likely to exhibit these behaviours (e.g., Algren et al., 2015; Bonnaire et al., 2017; Butler et al., 2020). Patterns of health conditions and HRBs may differ between women and men who engage in harmful gambling; however, research in this area is scarce (Hing et al., 2016).

A person's state of health in general is not just a matter of individual choice, but rather shaped by complex, interconnected social, economic, and environmental factors (Dahlgren & Whitehead, 1991; Bartley & Kelly-Irving, 2025). The same applies to harmful gambling, which similarly emerges from the interplay of individual, social, and structural determinants (Abbott et al., 2018). One such factor is the commercial determinants of health, referring to private sector actions that promote products and behaviours impacting health (Kickbush et al., 2016). In gambling, this includes strategies similar to those used by other unhealthy commodity industries, such as alcohol, tobacco, and ultra-processed foods (de Lacy-Vawdon et al., 2023), including marketing and product design, lobbying, political framing, and influence over research (van Schalkwyk et al., 2022; de Lacy-Vawdon et al., 2023; Johnson et al., 2023). The main goal of companies is often to maximise profits, but practices aimed at profit maximisation by commercial gambling operators can cause significant harm to individuals, their families, communities, and society more broadly (Wardle et al., 2024).

The majority of the gambling industry's revenue is generated from a small proportion of consumers. For example, in Finland in 2023, only 2.2% of individuals who had gambled in the past 12 months contributed to half of the total gambling revenue, whilst 15.5% accounted for 80% (Grönroos et al., 2024). Similar patterns have been observed in several other studies (e.g., Salonen et al., 2017; Fiedler et al.,

2019). This raises questions about the sociodemographic backgrounds of these individuals and, in particular, how much of the revenue comes from those experiencing harmful gambling. A few studies suggest that these 'vital few' are generally socially disadvantaged and more likely to experience harmful gambling (Salonen et al., 2017; Fiedler et al., 2019; Kesaite et al., 2024). Research has also shown that gambling-related tax revenues tend to be regressive (e.g., Worthington et al., 2001; Beckert & Lutter, 2009; Roukka & Salonen, 2020). Given that gambling can worsen or reinforce social disadvantages, governments face important ethical challenges (Goodman, 1996; Adams, 2007). Whilst they recognise the need to regulate gambling in the public interest, governments often depend, at least in part, on gambling revenues (Wardle et al., 2024).

Finland has long had a state-owned monopoly on all land-based and online gambling, and these revenues have provided an important source of public sector income (Kotakorpi et al., 2016; Sulkunen et al., 2019). Until 2024, these revenues were allocated to 'the public good', such as art, sport, science, youth work, and social and welfare associations. Since 2024, however, gambling revenues have been transferred directly to the state budget. Under the current government programme, the monopoly is set to be opened to a licenced market for online gambling in 2027. Its objectives are to prevent and reduce gambling-related harm, as well as to improve the channelling rate of the gambling system (Finnish Government, 2023). The channelling rate refers to the amount of gambling that takes place using services regulated by national legislation. The programme has been criticised for placing too much focus on the channelling rate, whilst giving less priority to harm prevention and reduction (Ministry of the Interior, 2025). As a result of this change, a number of new operators with financial interests will enter the Finnish gambling market. The availability of the most harmful gambling products is expected to increase, which is thought to lead to higher consumption and greater harms. A thorough understanding of the distribution of harmful gambling across the population, and its association with other vulnerabilities, is particularly important in light of the ongoing changes in the Finnish gambling system.

This dissertation aims to broaden the knowledge of sociodemographic differences in harmful gambling, as well as comorbid health conditions amongst individuals with harmful gambling. Harmful gambling is examined from three perspectives: gambling expenditure (GE), problem gambling severity, and diagnosed GD. More specifically, Sub-study I examines the relationships between sociodemographic factors, gambling behaviour, and the levels of GE, comparing individuals with the highest GE to other GE groups. Sub-study II explores associations between HRBs, obesity, and problem gambling severity amongst women and men. Finally, Sub-study III investigates gender-specific incidences of somatic diseases and psychiatric disorders amongst individuals diagnosed with GD, with corresponding rates in the general population provided for reference.

2 Conceptual framework

This section introduces the conceptual framework of the dissertation. First, in Section 2.1, key concepts used in this study are defined: gambling and harmful gambling (Section 2.1.1), sociodemographic factors (Section 2.1.2), HRBs (Section 2.1.3), and comorbidities (Section 2.1.4). Then, Section 2.2 presents a general model of the main determinants of health (Dahlgren & Whitehead, 1991; 2021) to provide an overview that helps to understand the broad range of factors influencing health. This general framework is briefly considered in relation to harmful gambling, highlighting how these determinants may be relevant in this specific context. Building on this, a model (Abbott et al., 2018) specifically designed to identify the multifaceted factors associated with harmful gambling is presented in more detail. Together, these two models form the rationale for examining the specific sociodemographic and health-related factors explored in this dissertation. Lastly, Section 2.3 provides a brief overview of the prevalence of gambling and harmful gambling in Finland, followed by a short description of the Finnish gambling system to illustrate the context in which gambling takes place. It also outlines the main changes that have occurred in the Finnish gambling environment in the past decade.

2.1 Key concepts and their definitions

2.1.1 Gambling and harmful gambling

'Gambling' is generally defined as 'staking money or something of material value on an event having an uncertain outcome in the hope of winning additional money and/or material goods' (Williams et al., 2017). This definition includes not only the legal and public understanding of gambling, but also the key elements identified in gambling research. In the Finnish context, the Lotteries Act (1047/2001) defines gambling and other chance-based games as lotteries, described as 'an activity in which participants may win a prize of monetary value based in full or in part on chance and in which there is a charge for participation'. These two definitions are largely consistent, both emphasising monetary stakes, chance, and the possibility

of winning material value. In this dissertation, the concept of gambling is used as defined in the Finnish Lotteries Act.

Gambling includes a wide range of game types, such as lottery games, electronic gaming machines, scratch cards, and sports betting, which can be offered in both land-based and online settings. It should be noted that 'gaming' is sometimes used interchangeably with 'gambling', but the two are not the same. Gaming outcomes are primarily skill-based, whereas gambling outcomes are largely based on chance (Abbott et al., 2018), as defined above. Nevertheless, the distinction between the two is becoming increasingly blurred (King et al., 2015; Macey & Kinnunen, 2020; King & Delfabbro, 2020; Kim & King, 2020). In this dissertation, the term 'gambling' excludes console, mobile, computer, video or other digital games that are not played for money or monetary stakes, as well as purchasable items in video games, such as loot boxes.

Terminology in gambling research is not yet universally standardised; instead, the choice of term often depends on the gambling measure used or on how the research problem is framed. The term 'harmful gambling' is used as a general term in this dissertation, defined as 'any type of repetitive gambling that a person engages in that leads to (or aggravates) recurring negative consequences, such as significant financial problems, or physical and mental health issues' (Abbott et al., 2018). Harmful gambling is examined from three perspectives: high GE, problem gambling severity, and diagnosed GD. Information on GD is drawn from register data on clinical diagnoses, whereas information on problem gambling severity and GE is based on self-reported survey data. Figure 1 illustrates the main gambling concepts used in this dissertation and their interrelationships. These concepts are described in more detail below. Other terms are used only when directly citing a particular source.

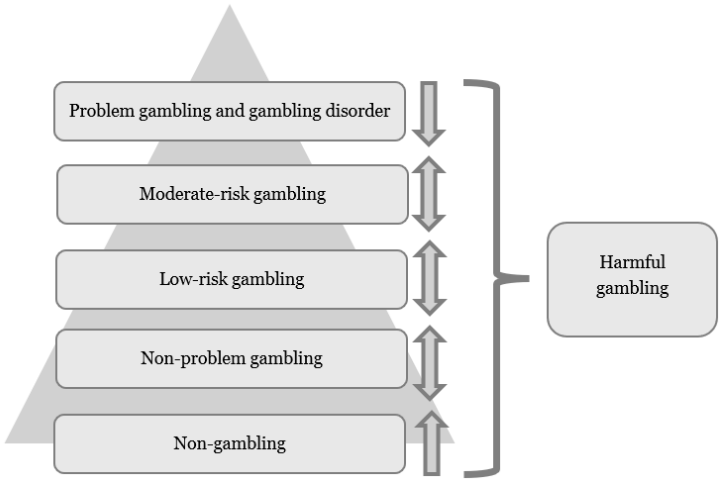

Figure 1 Relationships amongst the main gambling concepts used in this dissertation

Gambling used to be viewed in binary terms: an individual either had a gambling problem or did not. However, the perspective has shifted towards understanding gambling along a continuum (Wardle et al., 2024). This approach recognises that harms can occur across a wide spectrum, from non-gambling to problem gambling and GD, and that severity may vary across life situations. For example, the same individual may engage in low-risk gambling at one point in time and problem gambling at another (Williams et al., 2015; Sleczka & Romild, 2021).

GD represents the most severe form on the continuum of gambling severity. It is a clinical diagnosis which, in Finland, can only be made by a physician based on an evaluation of an individual fulfilling diagnostic criteria. GD has long been recognised as a psychiatric disorder, although its name, definition, and classification within different categories of psychiatric disorders have been subject to debate (Alexandris et al., 2015). In both the 10th revision of International Classification of Diseases (ICD-10; World Health Organization, 1993) and the 4th revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 2013), it was classified under the term 'pathological gambling' alongside other impulse control disorders, such as kleptomania and pyromania. In the ICD-10, it is described as a disorder consisting of frequent, repeated episodes of gambling that dominate the patient's life to the detriment of social, occupational, material, and family commitments and values (WHO, 1993).

In the DSM-5, several major changes were introduced. First, the term 'pathological gambling' was replaced with 'GD' to avoid the label 'pathological', which has been criticised as being a stigmatising term (Reilly & Smith, 2013). Secondly, GD was reclassified under 'addiction and related disorders' as the prototypical 'behavioural addiction' (Alexandris et al., 2015). This change was supported by strong evidence of shared underlying mechanisms with substance use disorders (e.g., vulnerability factors, neuropsychological processes) (Grant et al., 2014), as well as overlapping clinical features such as craving, tolerance, and high relapse rates (Potenza, 2006; Olsen, 2011). Similarly, in the ICD-11 (WHO, 2019), the diagnostic term 'pathological gambling' was replaced by GD, which was placed under 'disorders due to substance use or addictive behaviours'. Although the diagnoses examined in this dissertation are based on the ICD-10 criteria, where the code F63.0 refers to pathological gambling, the more recent term 'GD' is used here, since it is considered more up to date. In Finland, GD is always diagnosed by a physician, both in health services and in the context of social services.

Rates of gambling problems are typically estimated through population surveys, often by using the Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001) that identifies individuals at non-problem, low-risk, moderate-risk, and problem gambling levels. At the highest end of the continuum of problem gambling severity, problem gambling refers to gambling behaviour that can lead to multiple harms

affecting personal, family, financial, and occupational circumstances (Wardle et al., 2024). The term 'problem gambling' is broad, including individuals who meet severe difficulties with gambling, but do not meet the diagnostic criteria of GD, as well as those who have received an official diagnosis of GD. In the middle of the continuum of gambling severity, low- and moderate-risk gambling refers to behaviour that causes some harm and may precede the development of problem gambling or GD (Wardle et al., 2024). Non-problem gambling refers to gambling that causes no identified harm to the individual. It is sometimes also referred to as recreational gambling. Although the term 'problem gambling' is sometimes used more broadly to include all degrees of problem, from mild to severe, in this dissertation it refers more narrowly to the most severe forms of problem gambling.

Harmful gambling can also be assessed by examining gambling behaviour, such as gambling frequency, the number of game types gambled, and GE. These three factors are also included in the Lower-Risk Gambling Guidelines (LRGGs), developed by the Canadian Centre on Substance Use and Addiction to address the lack of evidence-based guidance on how to gamble in a way that minimises risk (Young et al., 2021, 2022; Hodgins et al., 2023; Canadian Centre on Substance Use and Addiction, 2024). In particular, GE has been found to be a strong indicator of harmful gambling, since higher spending is associated with greater problem gambling severity (Markham et al., 2014; Brosowski et al., 2015; Fiedler et al., 2019). Whilst all these factors reflect harmful gambling, it should be noted that high levels of time or money spent on gambling do not always imply harm. In this dissertation, GE is used as a measure of harmful gambling alongside problem gambling severity and diagnosed GD.

2.1.2 Sociodemographic factors

In this dissertation, the term 'sociodemographic factors' refers to a combination of social and demographic characteristics. Social factors include, for example, SEP, whilst demographic factors cover characteristics such as gender, age, and family structure. SEP is defined as 'the socially derived economic factors that influence what positions individuals or groups hold within the multiple-stratified structure of society' (Krieger et al., 1997; Lynch & Kaplan, 2000; Galobardes et al., 2006). It is sometimes used interchangeably with terms such as social class, social stratification, or socioeconomic status, although these concepts have different theoretical bases and distinct interpretations (Krieger et al., 1997; Galobardes et al., 2007). For example, the widely used term 'socioeconomic status' obscures the distinction between two aspects of SEP: a) actual resources and b) status, referring to prestige- or rank-related characteristics (Krieger et al., 1997). In this dissertation, the term 'SEP' is used.

SEP is most commonly measured by education, occupation, and income, each of which has been shown to be useful in describing health inequalities (Galobardes et al., 2006). In addition, broader measures, such as macro-level indicators, have sometimes been used (Bartley & Kelly-Irving, 2025). None of these indicators is more useful than the others on its own; rather, each captures a specific aspect of social stratification, with their relevance to health outcomes varying in strength and across different stages of the life course (Naess et al., 2004). Although distinct, SEP indicators are often correlated since they all reflect different aspects of the underlying social hierarchy (Galobardes et al., 2007). SEP is typically divided into three levels (low, middle, and high) to represent the relative standing of an individual or family within society. Classification into one of these categories can be based on one or more indicators (education, occupation, and income). The use of different SEP indicators varies across countries. In the United States, income is the most commonly used measure, whilst in the United Kingdom, occupational social class is more prevalent. Elsewhere in Europe, education tends to be the preferred indicator (Fujishiro et al., 2010; Smith et al., 2016).

Education is often used as a general indicator of SEP, which reflects not only an individual's material but also non-material resources. It is typically measured by the highest education level achieved or the total number of years in education (Galobardes et al., 2007). Education generally reflects the knowledge, skills, and values acquired through schooling, and provides the formal qualifications that enable access to certain occupations (Lynch & Kaplan, 2000). It also shapes health awareness and behaviours, thereby influencing overall health outcomes (Lahelma, 2010). Using education as an indicator of SEP has the advantage of being less prone to non-response bias compared with income. However, education has its limitations. Education levels and their implications vary across birth cohorts due to changes in education systems, access to schooling, and compulsory education duration. Thus, studies spanning multiple cohorts should account for these cohort effects to avoid bias (Khalatbari-Soltani et al., 2022; Bartley & Kelly-Irving, 2025).

Occupation is the second main indicator of an individual's position in the social hierarchy, often measured through occupational social class and typically grouped by skill, power, and status (Krieger et al., 1997). It can influence health in several ways. It reflects social status, which can improve health outcomes by providing advantages such as better access to high-quality healthcare. At the same time, physically demanding jobs or hazardous working conditions may adversely affect health (Galobardes et al., 2007; Lahelma, 2010). A limitation of this measure is that occupational structures change over time, and it is most applicable to those who are or have been employed (Galobardes et al., 2007). Nevertheless, occupational classification allows for a rigorous and detailed categorisation of employed individuals (Krieger et al., 1997; Lahelma, 2010).

Income is a key indicator of the material resources that influence health (Galobardes et al., 2006), although it is used less frequently than education or occupation as a measure of SEP (Bartley & Kelly-Irving, 2025). Like other SEP indicators, income has a dose–response relationship with health, meaning that higher income can positively affect a wide range of material conditions with direct implications for health. It also has cumulative effects over the life course but, unlike other SEP indicators, can fluctuate relatively quickly in the short term (WHO, 2010a). Income is usually measured by self-reported net income or predefined categories, with household income being more commonly used than individual income. However, since income is a sensitive topic and people may be reluctant to disclose their earnings, its use is limited (Galobardes et al., 2007). In Finland, this information is often obtained from national registers, which avoids this problem.

2.1.3 Health risk behaviours

Health behaviours are actions taken by individuals that affect morbidity and mortality. They may be either intentional or unintentional and can either promote health or adversely affect it. These behaviours are fluid, meaning that they change over the lifespan, between cohorts, in different settings, and over time (Short & Mollborn, 2015). This dissertation focuses on those that adversely affect health, so-called HRBs, defined as 'any activity undertaken by individuals with a frequency or intensity that increases risk of disease or injury' (Steptoe & Wardle, 2004). Examples of HRBs include cigarette smoking or other tobacco use, unhealthy diet, low physical activity, excessive alcohol consumption, risky sexual behaviour, and insufficient sleep. This definition recognises that the amount of the behaviour may be important. This is not the case for most behaviours, but there are instances in which moderate levels may be harmless or even beneficial (Steptoe et al., 2010). For example, a diet can still be considered healthy even if it occasionally includes small amounts of foods high in fat or sugar (Cena & Calder, 2020).

HRBs play a crucial role in health. In fact, they serve as major factors in the development of chronic diseases, such as cardiovascular diseases, cancer, diabetes, and chronic respiratory diseases, which are amongst the leading causes of mortality and morbidity worldwide (WHO, 2014). HRBs are modifiable, meaning that adopting a healthier lifestyle can reduce the risk of disease or premature death. Studies have shown that adopting healthy behaviours even at the age of 50 can add more than a decade to life expectancy (Li et al., 2018). Moreover, a meta-analysis by Loef and Walach (2012) demonstrated that individuals engaging in four or more healthy behaviours have a 66% lower overall risk of mortality compared to those with at least one HRB. HRBs typically co-occur or cluster together (Noble et al., 2015), and there is evidence of a synergistic effect, whereby combinations of HRBs are more detrimental to health than the sum of their individual effects (Poortinga,

2007). As with health more broadly, engagement in HRBs is socially patterned: individuals with lower SEP are more likely to engage in HRBs and less likely to adopt health-promoting behaviours (Bartley & Kelly-Irving, 2025).

2.1.4 Comorbidities

The term 'comorbidity' was originally defined as 'any distinct additional entity that has existed or may occur during the clinical course of a patient who has the index disease under study' (Feinstein, 1970). Since then, it has been defined various ways, with no clear consensus on a single definition (van den Akker et al., 1996; Nicholson et al., 2019). All definitions, however, share the assumption that multiple health-related states or conditions can co-occur (van den Akker et al., 1996). Some definitions are broad, merely implying the co-occurrence of multiple diseases, whereas others define comorbidity more narrowly, as the presence of additional medical conditions alongside a primary index disease (van den Akker et al., 1996; Valderas et al., 2009; Nicholson et al., 2019). Closely related to comorbidity is the term 'multimorbidity', which is sometimes used interchangeably but represents a distinct concept (van den Akker et al., 1996; Nicholson et al., 2019; Harrison et al., 2021). Whilst both terms describe the occurrence of multiple chronic conditions within the same individual, multimorbidity implies that no single condition holds priority over the others. By contrast, the concept of comorbidity focuses on a single index condition (van den Akker et al., 1996; Nicholson et al., 2019; Harrison et al., 2021). In this dissertation, the term 'comorbidity' refers to multiple co-occurring chronic conditions, with a focus on a single index condition, such as comorbidity in GD. These additional conditions may be either current or have occurred at some point in the lifetime. Moreover, the term 'comorbidity' is used primarily for diagnosed disorders; when referring more broadly to conditions beyond diagnosed diseases, the term 'physical and mental health conditions' is used.

2.2 Approaches to complex factors of harmful gambling

Main determinants of health

Overall, the range of social factors shaping population health is broad and complex. Based on evidence from epidemiological research, these factors have been summarised in the classic 'Rainbow Model' by Dahlgren and Whitehead (1991) and are illustrated in Figure 2. The model consists of five levels, which interact with one another since broader contextual factors influence more proximal processes, and vice versa. It should be noted that the model does not represent causal relationships; rather, it provides a conceptual framework for understanding multifaceted factors that influence health at the individual, community, and societal

levels. The following section offers a brief overview of each level of the model, although this dissertation focuses only on selected factors presented within it.

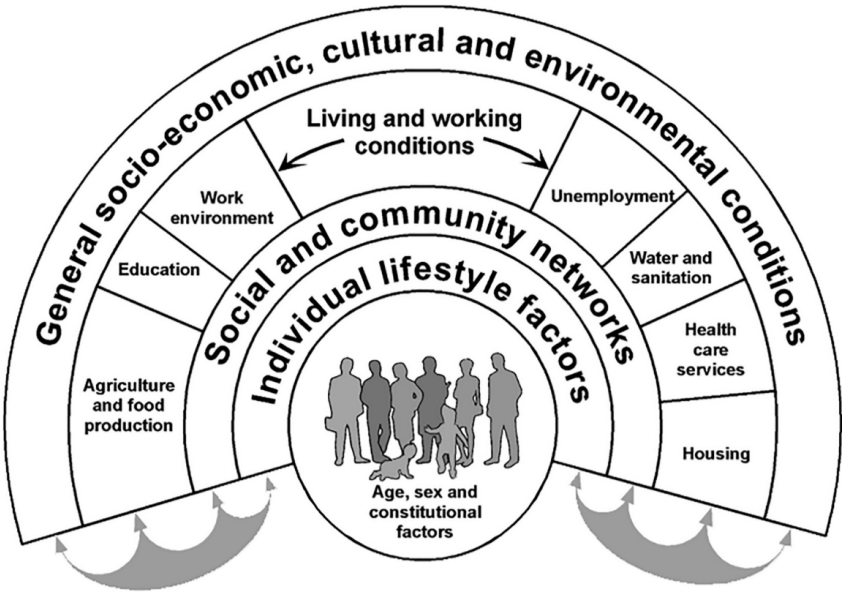

Figure 2 Main determinants of health. Source: Dahlgren and Whitehead, 1991.

In the middle of the figure is the individual, together with characteristics such as age and gender. Harmful gambling shows clear differences across age groups and genders, being particularly prevalent amongst younger individuals and men (e.g., Tran et al., 2024; Grönroos et al., 2024). These differences are discussed in more detail in Section 3.1. The next level of the figure represents individual health behaviours, such as smoking, drinking, physical activity, and diet. Gambling can also be considered amongst these factors since it may function as both an HRB and a health problem; in this dissertation, however, it is primarily addressed from the perspective of a health problem. Harmful gambling has been found to be strongly associated with HRBs, and previous research on this topic is presented in more detail in Section 3.2.

Whilst individuals can modify their behaviour to some extent to improve health, their choices are strongly shaped by the outer layers of the model. The third level of the figure represents social and community networks, where individuals interact with one another and provide mutual support that helps sustain their health. For example, participation in a mutual support group may help individuals stop gambling. They receive support to avoid gambling, find new non-gambling friends, and feel valuable and needed when helping others with harmful gambling (Binde, 2012). Conversely, having family members or friends who gamble regularly has been identified as a risk factor for harmful gambling, whereas fewer gambling-

involved relatives or friends is associated with non-gambling (Mazar et al., 2018; Lind et al., 2022). A gambling-oriented social network may therefore both encourage participation and normalise excessive gambling (Mazar et al., 2018).

The fourth level of the figure represents living and working conditions. Such conditions include socioeconomic and institutional factors that affect an individual's ability to maintain good health. Individuals with low education, unemployment, or low income are found to have higher rates of harmful gambling (Ekholm et al., 2014; Hahmann et al., 2021; Latvala et al., 2021). The association between harmful gambling and sociodemographic factors is discussed in more detail in Section 3.1. One factor highlighted in the figure is healthcare services. It is estimated that only one in five individuals with problem gambling seek any help for their difficulties (Bijker et al., 2022). In general, help is sought only when problems are prolonged and result in significant harm (Bellringer et al., 2008; Bijker et al., 2022). Typical reasons for delays in treatment-seeking include shame, guilt, denial, and stigma (Suurvali et al., 2009; Khayyat-Abuaita et al., 2015; Kaufman et al., 2017). Furthermore, a major barrier to treatment is that harmful gambling remains relatively under-recognised within health and social care services (Salonen et al., 2022; Latvala et al., 2023).

Finally, the fifth level of the figure represents general socioeconomic, cultural, and environmental conditions, which contribute to an individual's health and its social patterning. Recently, there has been growing discussion on the commercial determinants of health, which can be defined as 'strategies and approaches used by the private sector to promote products and choices that are detrimental to health' (Kickbusch et al., 2016; Bartley & Kelly-Irving, 2025). In the context of gambling, this term refers to a range of commercial practices used by the industry, many of which are similar to those employed by other sectors producing unhealthy commodities, such as alcohol and highly processed foods (de Lacy-Vawdon et al., 2023). These practices include efforts to influence consume behaviour, such as marketing and product design, as well as broader strategies sometimes described as a corporate playbook, including political framing, lobbying, and industry influence over research (van Schalkwyk et al., 2022; de Lacy-Vawdon et al., 2023; Johnson et al., 2023). In recent years, the global gambling industry has expanded rapidly, driven by digitalisation, increased legalisation, and the introduction of commercial gambling into new areas, making gambling more accessible than ever. Together, these developments present an escalating challenge for the reduction and prevention of harmful gambling (Wardle et al., 2024).

Conceptual Framework of Harmful Gambling

In addition to the general model presented above, several frameworks have been developed to specifically categorise the diverse factors associated with harmful gambling (Langham et al., 2016; Abbott et al., 2018; Wardle et al., 2019; Latvala et

al., 2019). Similar approaches have also been applied in alcohol and drug research (Newcombe, 1992; Room et al., 2010). These models provide a robust conceptual basis for understanding not only the factors linked to harmful gambling but also the groups most affected by it (Marionneau et al., 2023). Consequently, they help to develop and target harm prevention and reduction strategies (Gainsbury et al.,2014; McMahon et al., 2019).

One such framework is the Conceptual Framework of Harmful Gambling (Abbott et al., 2018; Hilbrecht et al., 2020). Unlike some other models (Langham et al., 2015; Wardle et al., 2018; Latvala et al., 2019), this framework does not primarily focus on the consequences of gambling. Instead, it highlights the factors that are generally associated with harmful gambling, somewhat similar to the general model by Dahlgren and Whitehead (1991). In the model by Abbott et al. (2018), some of the factors may exist prior to the onset of gambling and be exacerbated by it, whilst others are directly caused by gambling. This model recognises the need to examine factors associated with harmful gambling not only at the individual level, but also amongst family members and other close contacts, within communities, and across society, highlighting the idea of gambling as a public health issue. Nonetheless, much of the focus within this and other frameworks is still concentrated at the individual level (Marionneau et al., 2023).

The framework by Abbott et al. (2018) consists of eight interrelated factors that are grouped into two thematic sets: gambling-specific and general factors (Abbott et al., 2018). The gambling-specific factors include gambling environment, gambling exposure, gambling types, and gambling resources, whilst the general factors contain social, psychological, biological, and cultural aspects. Each of these aspects is further divided into two to nine subfactors, reflecting the key themes within its domain. In this dissertation, the focus is on the general factors that are directly or indirectly related to the life course of harmful gambling and may interact with one another. In particular, attention is given to social and psychological factors, including, for example, gender, sociodemographic characteristics, and comorbidities, which are examined in this study.

The framework highlights the areas that have been well studied, as well as those for which research is still limited, thereby pointing to directions for future research (Abbott et al., 2018). Of its eight factors, research on psychological aspects of harmful gambling is clearly the most dominant (Baxter et al., 2015). Within this category, a subfactor called ‘comorbidities’ includes psychiatric disorders and substance abuse. However, physical health issues and HRBs unrelated to substances are not formally included into the model (Abbott et al., 2018). The framework does emphasise the need for further research on the links between harmful gambling and physical health conditions, and its definition of harmful gambling explicitly recognises that gambling may cause or exacerbate physical health conditions. In contrast, the frameworks by Langham et al. (2016) and Wardle

et al. (2019) include physical health conditions, as well as HRBs beyond those related to substance abuse. In Section 3, previous research on the associations between sociodemographic and health-related factors (including comorbidities and HRBs) and harmful gambling is examined in greater detail, and the existing research gaps are identified.

2.3 Context: Finnish gambling environment

Gambling is highly prevalent in Finland by international standards (Tran et al., 2024). According to the latest Finnish Gambling survey conducted in 2023, 70% of the population aged 15–74 had gambled at least once in the past 12 months (Grönroos et al., 2024). The prevalence of gambling has declined slightly in recent years, compared with 78% in 2019. One in four people gamble at least once a week, highlighting that a substantial proportion of the population engage in frequent gambling. Finland has a wide legal availability of different gambling formats, both in land-based environments and online. Unlike most other countries, electronic gaming machines are available not only in casinos but also in everyday locations such as grocery stores, restaurants, kiosks, and gas stations, where lottery tickets and scratch cards are also sold. In addition, the Finnish gambling operator Veikkaus Oy offers a wide range of online games on its website. In 2023, 44% of the population reported gambling online, and this figure has increased markedly over the past decade, mirroring global trends. This proportion also includes individuals who had participated in gambling on unregulated online websites operated by offshore providers. In the same year, 7% of the population reported having gambled on offshore sites. The most popular types of gambling are lottery games, scratch cards, slot machines outside casinos, and daily draw games. In 2023, 9.0% of the population engaged in low-risk gambling, 2.9% in moderate-risk gambling, and 1.3% in problem gambling. The prevalence of problem gambling has slightly increased in recent years (Grönroos et al., 2024). Taken together, these figures indicate a fairly strong gambling culture in Finland.

All land-based and online games in mainland Finland have long been state-owned. Until 2016, three separate gambling operators operated in Finland: Finland's Slot Machine Association (RAY), Fintoto Oy, and Veikkaus Oy. However, in 2017, these were merged into a single state-owned company, Veikkaus Oy. The rationale behind the reform was that a single monopoly operator would be more effective at preventing gambling-related harms than three operators competing with each other (Salonen et al., 2017). The Finnish gambling system, regulated under the Lotteries Act (1047/2001), aims to prevent and reduce the financial, health, and social harms caused by gambling.

Revenues generated by state-owned gambling have provided an important and stable source of public sector income (Kotakorpi et al., 2016; Sulkunen et al., 2019).

Until 2024, gambling revenues were directed to fund, for example, art, sport, science, youth work, and social and welfare associations. This allocation of revenues to 'the public good' contributed to the high public acceptability of both gambling and the monopoly system, and it was often used as a justification for maintaining the monopoly, under which all citizens were seen as beneficiaries (Matilainen, 2017; Lerkkanen et al., 2020). However, this justification also received criticism from researchers, politicians, and the public. Although profits were partly directed to 'the public good', revenues were found to disproportionately come from socially disadvantaged individuals, illustrating the regressive nature of the system (e.g., Salonen et al., 2017; Castrén et al., 2018; Roukka & Salonen, 2020; Selin et al., 2024). Furthermore, since 2024 Veikkaus Oy's revenues are no longer earmarked for specific purposes, but are instead allocated to cover expenditure in the state budget.

A range of other reforms have taken place in the Finnish gambling system in recent years. Since 2019, Veikkaus Oy has significantly reduced the number of electronic gaming machines, closed some of its separate gambling arcades, and discontinued offering table games in restaurants and bars (Veikkaus, 2019; 2022). During the Covid-19 pandemic, electronic gaming and gambling venues were closed to reduce the risk of infection, and mandatory limits on fast-paced online gambling products were temporarily lowered (Marionneau et al., 2024). In 2024, mandatory player identification was introduced for all gambling activities. Initially, this applied only to certain types of games (e.g., electronic gaming machines), but it was eventually extended to cover the entire range of games.

By far the biggest change in the Finnish gambling system in decades is about to happen in the coming years. In 2027, Finland will re-regulate the national online gambling market by introducing licences for external providers. The licence system covers only online casino games and online betting. This reform is driven by the significant competition that Veikkaus Oy faces from unlicenced gambling providers. The aim of the reform is to prevent and reduce gambling-related harm and to improve the channelling rate of the gambling system (Finnish Government, 2023). The channelling rate refers to the proportion of gambling that takes place through services regulated by national legislation and supervised by the national authorities. The programme has been criticised for prioritising the channelling rate too heavily, whilst giving comparatively less attention to the prevention and reduction of gambling-related harm (Ministry of the Interior, 2025). This change is expected to bring several new financially driven operators into the Finnish gambling market, likely increasing access to the most harmful gambling products and, consequently, contributing to higher consumption and greater gambling-related harms.

3 Review of the literature

This section reviews the literature on the associations between sociodemographic and health-related factors and harmful gambling, with a focus on those most relevant to the present study. The review concentrates on register-based and population-based survey studies. Section 3.1 presents sociodemographic factors linked to harmful gambling, whilst Section 3.2 addresses health-related factors, including HRBs and comorbidities. Despite a growing body of research, important gaps remain in understanding the relationships between harmful gambling and sociodemographic as well as health-related factors. These sections also highlight the gaps identified in previous studies that the present dissertation seeks to address.

3.1 Sociodemographic factors and harmful gambling

Harmful gambling is markedly more prevalent amongst men than women (e.g., Tran et al., 2024). For example, in Finland in 2023, 8.4% of women had engaged in low-risk, moderate-risk, or problem gambling, compared with 18.0% of men (Grönroos et al., 2024). These gender differences are thought to be mainly due to differences in gambling behaviour (Abbott et al., 2021). In particular, the type and number of games played have been identified as central factors underlying these differences. Men are at higher risk because they gamble more frequently, participate in a wider variety of games, and are more likely to engage in riskier games. In contrast, women's risk is linked to their preference for chance-based games, particularly electronic gaming machines, which are strongly associated with harmful gambling (Stark et al., 2012). Men also engage in online gambling more often (Pallesen et al., 2021; Grönroos et al., 2024), and at-risk and problem gambling is particularly common amongst individuals who gamble online (Tran et al., 2024). It has been argued that although gender is linked to gambling behaviour patterns, more direct factors associated with gender, such as impulsivity and risk-seeking in men, may be more important than gender itself in explaining harmful gambling (Abbott et al., 2018; Allami et al., 2021). Research on harmful gambling has traditionally focused more on men than women. However, given the well-documented gender differences in gambling behaviour, several studies have highlighted the importance of analysing men and women separately (e.g., Desai et al., 2008; Hing et al., 2016; McCarthy et al., 2019). Otherwise, combined analyses

may obscure meaningful differences since the stronger effect sizes often observed amongst men can dominate the results (Allami et al., 2021).

Of the sociodemographic factors, young age, together with male gender, has been identified as the strongest risk factor for problem gambling (Allami et al., 2021). A recent meta-analysis by Dellosa and Browne (2024) found that young adults showed a 1.5 times higher likelihood of reporting problem gambling or GD compared to the middle-aged group, whereas older adults were 0.8 times less likely to report problem gambling or GD. Some evidence suggests that middle-aged women may be particularly at risk for gambling problems of varying severity (Hing et al., 2016); however, a meta-analysis by Allami et al. (2021) did not support this. These age-related patterns in harmful gambling are mirrored in GE, with certain age groups contributing disproportionately to total spending. Amongst men, a quarter of total weekly GE is accounted for by those aged 25–43, whilst women aged 55–74 account for around 63% of women's total weekly GE (Castrén et al., 2018).

Numerous studies have found harmful gambling to be more common amongst individuals with low SEP than amongst those with a higher position (e.g., Raybould et al., 2021; Latvala et al., 2021; Hahmann et al., 2021). This association is particularly important to examine since financial difficulties are amongst the most severe consequences of harmful gambling (Marionneau et al., 2023). People with lower education levels are more likely to engage in problem gambling and tend to spend a larger share of their income on gambling than those with higher education (Ekholm et al., 2014; Salonen et al., 2017; Roukka & Salonen, 2020). Harmful gambling is also more prevalent amongst those who are unemployed (Latvala et al., 2021; Hahmann et al., 2021) or have low income (Hahmann et al., 2021). Moreover, lower-income individuals spend proportionally more of their income on gambling compared to middle- and high-income groups (Castrén et al., 2018).

A growing, though still limited, body of research has shown harmful gambling to be associated with the receipt of welfare benefits (Volberg et al., 2008; Ekholm et al., 2014; Latvala et al., 2021; Månsson et al., 2024; Kolberg et al., 2025). In Finland, a population study found that nearly one-third of individuals with at-risk or problem gambling had received at least one form of welfare benefit (Latvala et al., 2021). Notably, even income support, a last-resort benefit for the most socially disadvantaged, was linked to an increased risk of at-risk and problem gambling (Latvala et al., 2021). Earlier research from Nordic countries has particularly focused on disability pension, showing that its receipt is associated with the entire continuum of harmful gambling, covering at-risk gambling, problem gambling, and GD (Ekholm et al., 2014; Brunborg et al., 2016; Latvala et al., 2021; Månsson et al., 2024; Kolberg et al., 2025). Together, these findings highlight a consistent link between social disadvantage and harmful gambling.

3.2 Health-related factors and harmful gambling

Health risk behaviours (HRBs) and harmful gambling

Previous research has shown that at-risk and problem gambling tends to co-occur with HRBs: 19% of individuals with low-risk gambling and 31% of those with moderate-risk or problem gambling engage in at least two HRBs (Butler et al, 2020). When multiple HRBs occur together, they may exacerbate each other's harmful effects. For example, excessive drinking may be used as a coping mechanism for gambling-related anxiety, but it can also trigger the urge to gamble (Griffiths et al., 2002). A recent study found that individuals engaging in heavy episodic drinking, who also tend to consume alcohol whilst gambling, are more likely to engage in risky gambling (Smit et al., 2023). The co-occurrence of HRBs can increase the risk of developing new health problems or worsening existing ones, ultimately reducing quality of life and, at the societal level, contributing to higher healthcare costs.

High rates of alcohol consumption, smoking, and illicit drug use amongst individuals with harmful gambling have been consistently documented (e.g., Griffiths et al., 2010; Barnes et al., 2015; Algren et al., 2015; Bonnaire et al., 2017; Butler et al., 2020; Thorne et al., 2021; Burton et al., 2023). There is also evidence that changes in substance use behaviours often align with changes in gambling behaviour (Bellringer et al., 2024). Excessive drinking, for example, has been linked to both a higher likelihood of starting to gamble as well as to a lower likelihood of stopping gambling or moving out of harmful gambling. Interestingly, stopping excessive drinking has also been associated with a greater likelihood of starting to gamble. Taken together, these findings highlight the complex and dynamic nature of the relationship between excessive drinking and gambling.

These findings are consistent with evidence showing that substance-related disorders are also highly prevalent amongst individuals with problem gambling or GD (Lorains et al., 2011; Dowling et al., 2015; Håkansson et al., 2018). Although GD is currently classified as an impulse control disorder in the ICD-10 (WHO, 1993), evidence suggests that shared genetic, environmental, and social factors contribute to both the development and persistence of addictive disorders and GD (Potenza, 2006). Reflecting this evolving understanding, the new 11th revision of the ICD classifies GD as a disorder due to addictive behaviour (WHO, 2019), and in the DSM-5, GD is already recognised as a behavioural addiction (APA, 2013).

There are some research gaps concerning the links between harmful gambling and HRBs. Firstly, whilst the relationship between harmful gambling and substance-related HRBs has been extensively studied, much less is known about its associations with non-substance-related HRBs. Expanding knowledge in this area is important since harmful gambling has been linked to various physical and mental health conditions (Morasco et al., 2006; Lorains et al., 2011; Dowling et al., 2015;

Håkansson et al., 2018; Ekholm et al., 2018; Abdul-Rahim et al., 2023), and such HRBs may further increase the risk of developing these conditions. However, some evidence suggests that individuals with moderate-risk or problem gambling are more likely to have an unhealthy diet and low physical activity compared to those with non-problem gambling (Algren et al., 2015; Butler et al., 2020). In addition, problem gambling has been associated with insufficient sleep (Bonnaire et al., 2017; Thorne et al., 2021), even after controlling for psychiatric comorbidities (Parhami et al., 2013), which are known to be linked to sleep difficulties (Freeman et al., 2020).

Secondly, prior research on these associations has primarily focused on problem gambling or GD, rather than examining the full spectrum of problem gambling severity. An exception to this is research examining gambling and substance use. This gap is partly due to measurement tools used to assess problem gambling severity or sample sizes being too small to allow for analyses across different severity levels. This distinction is important because the underlying factors and associations with other HRBs may vary across low-risk, moderate-risk, and problem gambling. To gain a more comprehensive understanding of the relationships between problem gambling severity, HRBs, and obesity, it is essential to extend analyses to include lower levels of severity, as suggested by Butler et al. (2020). This is also important from a public health perspective since far more individuals engage in low- and moderate-risk gambling than in problem gambling, meaning they contribute a greater health burden at the population level (Browne et al., 2018; Browne et al., 2020).

Lastly, research examining these associations separately for men and women remains limited, despite clear evidence that HRBs are gendered in the general population. Men are more likely than women to engage in most HRBs, and gambling is no exception: both gambling participation and gambling problems of varying severity are more prevalent amongst men (Courtenay et al., 2000; Tran et al., 2024). When analyses are not conducted separately by gender, important differences may be obscured since the stronger effect sizes often observed amongst men can dominate the results (Hing et al., 2016). Previous studies have highlighted the importance of analysing men and women separately, both in gambling research more broadly (Hing et al., 2016; Desai et al., 2008; Abbott et al., 2018) and in studies examining the links between gambling and other HRBs (Bonnaire et al., 2017). A gendered understanding of health-related factors associated with gambling can help tailor prevention and intervention strategies more effectively by addressing the specific needs and risk profiles of men and women.

Psychiatric and somatic comorbidities in harmful gambling

A large body of research has focused on comorbidities in problem gambling or GD. However, most of these studies have relied on survey data or have been conducted

in small-scale clinical settings, such as individual clinics, which may lead to non-representative sampling biases (Lorains et al., 2011; Dowling et al., 2015). Moreover, individuals may not always be aware of or accurately recall all their diagnoses, which makes register-based data especially valuable for studying comorbidities. Whilst still relatively limited, register-based research on GD comorbidities has increased in recent years. This line of research has been particularly active in Sweden, Finland, and Norway, where register-based health data have been extensively utilised (e.g., Håkansson et al., 2018; Karlsson & Håkansson, 2018; Leino et al., 2021; Abdul-Rahim et al., 2023; Salonen et al., 2025). This has been made possible by the availability of unique, high-quality nationwide registers (Laugesen et al., 2021).

Psychiatric comorbidity is strongly associated with problem gambling and GD (Lorains et al., 2011; Dowling et al., 2015; Håkansson et al., 2018; Armoon et al., 2023; Salonen et al., 2025). A recently published Finnish register study found that 89% of individuals diagnosed with GD had at least one additional comorbid psychiatric disorder (Salonen et al., 2025). Somewhat similar findings have been reported in Sweden, where the corresponding figure was 73% (Håkansson et al., 2018). However, the two studies are not fully comparable since the Swedish study included only specialised healthcare, whereas the Finnish study also covered primary healthcare and social services (Håkansson et al., 2018; Salonen et al., 2025). Mood, anxiety, and substance use disorders have been consistently identified as the most common psychiatric comorbidities in individuals with problem gambling or GD (Lorains et a., 2011; Håkansson et al., 2018; Leino et al., 2023; Salonen et al., 2025). In addition, individuals with gambling problems of varying severity are found to have elevated rates of suicidal thoughts, suicide attempts, and completed suicides (Andreeva et al., 2022; Kristensen et al., 2024; Kidane et al., 2025).

Nearly all previous register-based studies on comorbidities in GD have focused on psychiatric disorders, whereas only a few have examined somatic diseases (Karlsson & Håkansson et al., 2018; Abdul-Rahim et al., 2023). Physical health has also been relatively understudied in population-based surveys. In these studies, it has often been examined narrowly, with focus primarily on specific conditions or symptoms, such as various types of pain, or, conversely, in a broader sense by asking participants to report their general perceptions of their health. Consequently, physical health issues in harmful gambling remain understudied from a comprehensive perspective, and it has been emphasised that additional information is needed on the physical health problems associated with gambling (Abbott et al., 2018).

A recent register-based case–control study showed that cardiovascular diseases, diabetes, chronic respiratory diseases, and obesity were more prevalent amongst individuals with GD than amongst matched controls (Abdul-Rahim et al., 2023).

Another register-based study examining mortality, suicidality, and associated comorbidities in individuals with GD included both somatic diseases and psychiatric disorders (Karlsson & Håkansson, 2018). In that study, all-cause mortality amongst individuals with GD was predicted by older age and any treatment episode for cardiovascular diseases, whereas suicide death was predicted by depression. Other common comorbidities did not predict overall mortality. However, neither of these studies examined somatic comorbidities in GD at the population level, including both primary and specialised healthcare.

Other studies on physical health in individuals with harmful gambling have relied on self-reported data, rather than diagnoses verified from healthcare registers or medical records. A lifetime diagnosis of GD has been associated with several self-reported medical conditions, such as tachycardia, angina, cirrhosis, and other liver diseases (Morasco et al., 2006). Another population study linked problem gambling with multiple pain and discomfort conditions across different parts of the body (Ekholm et al., 2018). Furthermore, problem gambling has been associated with chronic bronchitis and fibromyalgia (Afifi et al., 2010; Black et al., 2013; Ekholm et al., 2018). Overall, moderate-risk and problem gambling have also been linked to suboptimal self-rated health (Griffiths et al., 2010; Butler et al., 2020). Some studies have also yielded conflicting results. For example, a survey study by Cowlishaw and Kessler (2016) found that although there were trends indicating elevated rates of physical health issues (e.g., high blood pressure, digestive problems, and liver problems) amongst individuals with problem gambling, there were no effects after sociodemographic factors, substance use, and depressive episodes were controlled for. By contrast, at-risk gambling was associated with migraine and frequent headaches, a finding that has also been reported in other studies (Afifi et al., 2010; Black et al., 2013; Cowlishaw & Kessler, 2016; Ekholm et al., 2018).

Whilst problem gambling and GD are more frequent amongst men than women (Grönroos et al., 2024; Salonen et al., 2022), comorbid disorders are significantly more common amongst women (Håkansson et al., 2018; Karlsson et al., 2021; Larsson & Håkansson, 2022; Abdul-Rahim et al., 2023). In particular, mood and anxiety disorders are more prevalent in women with GD (Håkansson et al., 2018). Women and men also differ in their gambling behaviours, as described in Section 3.1, and in the development of problem gambling and GD (Abbot et al., 2018). Women tend to start gambling at an older age but progress more quickly to problem gambling and seek treatment sooner than men (Miller et al., 2023). They may also use gambling as a coping mechanism for depression or anxiety more often than men, which can lead to over-involvement (Desai et al., 2008). For this reason, it is important to consider women and men separately when examining comorbidities amongst individuals diagnosed with GD.

4 Aim of the study

This study aims to provide a deeper understanding of the associations between sociodemographic and health-related factors and harmful gambling, examined across the full spectrum of severity. The study population in each sub-study consisted of adults from the Finnish population, and the analyses were based on register data and population surveys. Harmful gambling is examined from three perspectives: high gambling expenditure (GE), problem gambling severity, and diagnosed gambling disorder (GD).

This dissertation study consisted of three sub-studies, with the following specific aims to examine:

I The relationship between sociodemographic factors, gambling behaviour, and the level of GE.

II The association between health risk behaviours (HRBs), obesity, and problem gambling severity amongst Finnish women and men.

III The gender-specific incidences of somatic and psychiatric disorders amongst Finnish adults with diagnosed GD.

5 Data and methods

5.1 Study population and data

This dissertation utilised three different data sources: two based on population surveys and one consisting of nationwide register data. Sub-study I was based on the Gambling Harms Survey, Sub-study II on the Healthy Finland Survey, and Sub-study III on national health register data. In Sub-studies I and II, register-based background variables from Statistics Finland and the Digital and Population Data Services Agency were linked to the survey data. Table 1 summarises the characteristics of the samples used in each sub-study.

Table 1 Description of the data used in Sub-studies I–III.

	Sub-study I	**Sub-study II**	**Sub-study III**
Name of the data	Gambling Harms Survey	Healthy Finland Survey	Register of Primary Healthcare, Care Register for Healthcare, and Care Register for Social Welfare
Years included	2016–2017	2022–2023	2011–2022
Study population	Permanent Finnish residents aged 18 or older living in Uusimaa, Pirkanmaa or Kymenlaakso	Permanent Finnish residents aged 20 years or older	All Finnish residents aged 18 or older who have used social and health services
Sampling design	Population-based systematic random sample	Population-based stratified random sample	All cases of GD diagnosed as a primary, secondary, or long-term diagnosis
Population size	n = 7,186 (Wave 1) and n = 2,624 (Wave 2)	n = 28,154	Individuals with diagnosed GD (ICD-10; F63.0; n = 3,605) and the average population with the same age range (n = 4,374,192)
Response rate	36% (Wave 1) and 57% (Wave 2)	46%	-

GD = gambling disorder; ICD = International Classification of Diseases

Gambling Harms Survey 2016–2017

The data for Sub-study I were drawn from the longitudinal, nationally representative Gambling Harms Survey, which was conducted by the Finnish Institute for Health and Welfare (THL) in collaboration with the University of Helsinki and Statistics Finland (Salonen et al., 2019; Table 1). The survey includes a comprehensive set of questions on gambling behaviour, harmful gambling, and opinions on gambling marketing. The data were collected by Statistics Finland between January 2017 and March 2017 (Wave 1) and between January 2018 and April 2018 (Wave 2). Since the survey examined the participants' gambling during the previous year, the title of the survey refers to the years 2016 and 2017.

At Wave 1, a total of 20,000 permanent Finnish residents of selected areas were randomly selected from the national Population Information System. The inclusion criteria were as follows: 1) aged 18 and older; 2) Finnish, Swedish, Sami, Norwegian or Danish as first language, or Finnish citizens whose first language was Russian, or Finnish citizens whose first language was some other language and who had obtained Finnish citizenship before the year 2013; and 3) living in Uusimaa, Pirkanmaa or Kymenlaakso, excluding the institutionalised population. A total of 4,611 participants at Wave 1 gave their permission to be re-contacted at Wave 2. Responses were collected by using paper and online questionnaires. At Wave 1, all potential participants received a participant information sheet. The first reminder was sent by mail, and individuals aged 25 to 44 also received the reminder via text message. Altogether, four reminders were sent, with the last two also including a paper questionnaire. At Wave 1, the response rate was 36% (n = 7,186). At Wave 2, the response rate was 57% (n = 2,624) amongst those eligible participants who had participated in the Wave 1 survey and had given permission for re-contact.

At Wave 1, the response rate was lower amongst men than amongst women, whereas at Wave 2, men responded more actively than women (Salonen et al., 2017; 2019). At both waves, individuals who were older or had the highest education level participated most actively. The data were weighted using the following procedure: first, design weights were calculated based on the six-region strata. Second, these design weights were calibrated using the SAS macro CALMAR 2 to align with the population distributions of gender, age, education level, region, and urban–rural classification, thereby correcting for potential non-response bias in the sample (Sautory, 2003; Salonen et al., 2017; Kontto et al., 2025). Using personal identification numbers, the survey data were linked to register data from Statistics Finland on sociodemographic factors, including gender, age, education level, employment status, and personal net income. The register data also included information on whether the individual had received income support, unemployment benefits, disability pension, or sickness allowance, as well as the amounts received.

Healthy Finland Survey 2022–2023

The data for Sub-study II were obtained from the large, high-quality Healthy Finland survey, a population-based study conducted by the THL from September 2022 to February 2023 (Sääksjärvi et al., 2025; Table 1). The survey covered a broad range of questions on health, well-being, quality of life, functioning, lifestyle, health and social services, and background information. A nationally representative sample of 61,600 permanent Finnish residents aged 20 years and over, with no upper age limit, was selected using stratified random sampling. The questionnaire was in four languages: Finnish, Swedish, Russian, and English, and participants had the option to respond either via a paper form or an online version. The data collection process began by sending a paper questionnaire to individuals aged 75 and older, whilst younger participants were invited to complete the survey online. Those who did not respond received two text messages and three postal reminders, one of which included a paper version of the questionnaire. The response rate was 46% (n = 28,154).

The response rate was lowest amongst individuals aged 20–39 years and highest amongst individuals aged 64–74 years or older (Sääksjärvi et al., 2025). With the exception of those aged 75 years or older, women had higher response rates than men. Response rates also varied by education level: individuals with lower education levels participated less actively than those with higher education levels. To improve representativeness, the data were weighted to reflect the Finnish general adult population in terms of age, gender, marital status, education level, first language, and area of residence. Information on these variables was obtained from the Digital and Population Data Services Agency, which were also used to assess non-response and to calculate weights applied in the analyses (Sääksjärvi et al., 2025). The weights were constructed using the Inverse Probability Weighting method, which has been applied in various population surveys and has been shown to be suitable for correcting the non-response bias in the Finnish population (Koskela et al., 2023; Härkänen et al., 2014).

National healthcare registers 2011–2022

Sub-study III utilised unique, high-quality aggregated register data on GD and comorbid somatic and psychiatric disorders for individuals aged 18 or older between 2011 and 2022 (Table 1). The data were retrieved from three separate national health registers administered by the THL: 1) Register of Primary Healthcare Visits, 2) Care Register for Healthcare, and 3) Care Register for Social Welfare. The Register of Primary Healthcare Visits covers all Finnish primary healthcare centres, occupational healthcare services, and private clinics. The Care Register for Healthcare contains data on specialised outpatient and inpatient care including information regarding each visit, such as diagnoses. The Care Register for

Social Welfare includes data on institutional care and housing services that provide 24-hour or part-time assistance.

This study included all individuals in the aforementioned three registers who had received a diagnosis of GD (ICD-10: F63.0). The data include all cases of GD diagnosed as a primary, secondary, or long-term diagnosis. Each person and each of their diagnoses were counted only once. All comorbid somatic diseases and psychiatric disorders diagnosed before, after, or at the same time as the GD diagnosis were included in the dataset. These registers include information on each visit of an individual, including all medical diagnoses and their registration dates. Diagnoses of individuals under the age of 18 (n = 108, aged 4–17 years) and those residing in the Åland islands (n = 8) were excluded from the data. A total of 3,605 individuals with registered GD (men n = 2,574; women n = 1,031) were included in the dataset. Ages ranged from 18 to over 90 years at the time of the GD diagnosis (mean age = 35.4 years). The average population within the same age range, drawn from the same national health registries, was used as the reference group (n = 4,374,192; mean age = 50.4 years). Since the age of individuals with diagnosed GD differed from that of the general population, we used estimates of disease/disorder incidence in a population relative to the expected morbidity if individuals with GD had the same morbidity as the general population.

5.2 Measurements and variables

Outcome variables

Table 2 presents the dependent variables, independent variables, and covariates used in the sub-studies. GE in Sub-study I was measured by asking participants to estimate the amount of money they had spent on gambling in 2016 (or 2017), on average per week, per month, or over the entire year, in euros. All reported GE figures were converted into weekly estimates for analysis. To categorise participants into three groups based on GE, the cumulative distribution of total GE was examined. Firstly, individuals' GE values were sorted in descending order. Then, the point at which 50% of the total GE had accumulated was identified. Lastly, drawing on the Pareto Principle (Juran, 1975), which suggests that approximately 80% of outcomes are typically attributable to 20% of causes, the cumulative distribution of total GE was examined to identify the point at which 80% of the total GE had accumulated. Participants were divided into three groups based on their weekly GE: 1) the highest GE group, accounting for 50% of the total GE and spending 40.0 euros or more per week; 2) the intermediate GE group, accounting for 30% of the total GE and spending 10.0–39.9 euros per week; and 3) the lowest GE group, accounting for 20% of the total GE and spending 9.9 euros or less per week. At Wave 2, the highest GE value was identified as an outlier and was therefore

replaced. Firstly, all participants who showed an increase in GE between the two waves were selected. Then, the average growth in GE amongst these participants was calculated. The outlier value was imputed by multiplying the participant's GE in Wave 1 by this average growth rate.

Table 2 Summary of main statistical methods and variables used in Sub-studies I–III.

	Sub-study I	**Sub-study II**	**Sub-study III**
Dependent variables	Gambling expenditure (GE)	Problem gambling severity index (PGSI)	Diagnoses of somatic diseases and psychiatric disorders
Independent variables	Income support or unemployment benefit, disability pension or sickness allowance, gambling frequency, game type, gambling mode, gambling severity (the PPGM)	Daily smoking, excessive drinking (AUDIT-C), low F & V consumption, insufficient sleep, low physical activity, obesity	-
Covariates	Gender, age, education level, employment status, net income tertiles	Gender, age, education level, household's annual income, family structure, suboptimal self-rated health, psychological distress (MHI-5)	Gender
Methods	Multinomial logistic regression	Negative binomial regression	Standardised incidence ratio (SIR)

F & V = fruit & vegetable; PPGM = Problem and Pathological Gambling Measure; PGSI = Problem Gambling Severity Index; MHI-5 = Mental Health Inventory; AUDIT-C = Alcohol Use Disorder Identification Test for Consumption.

In Sub-study II, the PGSI (Ferris & Wynne, 2001) was used to assess past-year problem gambling severity. The PGSI consists of nine self-report items on harmful gambling rated on a four-point scale (0 = never, 1 = sometimes, 2 = most of the time, 3 = almost always). The total PGSI score ranges from 0 to 27 and was used both as a continuous and as a categorical variable. Four categories were defined as follows: 0 = non-problem gambling, 1–2 = low-risk gambling, 3–7 = moderate-risk gambling, and ≥8 = problem gambling. Sub-study III included diagnoses of somatic diseases and psychiatric disorders. The diagnoses were categorised into diagnostic groups based on their ICD-10 codes: allergies, cancer, cardiovascular diseases, chronic respiratory diseases, diabetes, digestive diseases, memory disorders, musculoskeletal diseases, nervous system diseases, and psychiatric disorders (Table 3). All comorbid diseases and disorders diagnosed before, after, or at the same time as the diagnosis of GD were included in the data.

Table 3 International Classification of Diseases 10th revision (ICD-10) codes and diagnostic groups included in Sub-study III.

Diagnostic group	ICD-10 code
Allergies	D69.0, H10.1, J30, J39.3, K52.2, L20, L23, L25, L27, L50, M36.4, R68, T78, Z88
Cancer	C00–D48, N87.2
Cardiovascular diseases	I05–89, G45–46, O87.1, O88.2
Chronic respiratory diseases	J40–46, J60–99
Diabetes	E10–14, O24
Digestive diseases	K20–93
Memory disorders	F00–03, F05.1, G30
Musculoskeletal diseases	M00–99, D86
Nervous system diseases	G20, G35, G40–41, G43–44, G47, G81–82
Psychiatric disorders	F04–99 (excl. F05.1, F63.0)

Independent variables

In Sub-study I, past-year gambling frequency was assessed for 18 different game types. The questionnaire included not only games provided by the Finnish gambling monopoly Veikkaus Oy, but also offshore games, as well as games available in Åland and on ferries operating between Finland, Sweden, and Estonia. Overall gambling frequency was determined based on the game type in which the participant reported gambling most frequently. Frequency was categorised into four groups: daily, several times a week, once a week, and 1–3 times a month or less. The number of different game types gambled was categorised as follows: 1–3 game types, 4–5 game types, 6–10 game types, and 11–18 game types. Gambling mode was also classified into four categories: multi-mode, online only, land-based only, and do not know /missing.

The Problem and Pathological Gambling Measure (PPGM; Williams & Volberg, 2010) was used to assess problem gambling severity. The PPGM is a 14-item instrument comprising 3 conceptual domains: gambling-related harms (7 items), impaired control (4 items), and other addiction symptoms (3 items). The total score ranges from 0 to 14. Problem gambling severity was categorised into three groups: 1) problem gambling (including pathological gambling) defined as a total score of 2 or more; 2) at-risk gambling, defined as a score of 1; and 3) recreational gambling (including those gambling less than monthly), defined as a score of 0.

The amount of income support, unemployment benefit, disability pension, and sickness allowance were recorded in euros. These monetary values were used to create new dichotomous variables indicating whether the participant had received each type of benefit (yes/no). Due to the relatively small number of observations,

income support and unemployment benefit were combined into a single variable, and sickness allowance was merged with the disability pension variable.

In Sub-study II, HRBs were considered as independent variables. Daily use of tobacco or nicotine products (yes/no) was assessed based on a question asking whether the participants currently smoke (cigarettes, cigars, or pipe) or use any nicotine products (snus, e-cigarettes with nicotine, heated tobacco products, or nicotine pouches). The response options were: daily, occasionally, not at all, or I have never smoked. Alcohol consumption was determined using a modified version of the Alcohol Use Disorders Identification Test for Consumption (AUDIT-C), which is a three-item screening tool designed to identify hazardous drinking and potential alcohol use disorder (Bush et al., 1998). The AUDIT-C uses a 5-point Likert scale, with each item scored from 0 to 4. Total scores were calculated by summing the points across all three items. The following cut-off points were used to define excessive drinking: ≥6 for men aged 20–64 years, ≥5 for women aged 20–64 years, and ≥4 for both men and women aged 65 years and older (Seppä, 2010; Current Care Guidelines: Alcohol abuse, 2017).

Insufficient sleep (yes/no) was assessed based on a question asking whether participants felt they get enough sleep. The response options were: yes, almost always; yes, often; rarely or hardly ever; and not sure. Participants who answered 'rarely or hardly ever' were classified as having insufficient sleep. Low fruit and vegetable (F & V) consumption (yes/no) was defined as consuming vegetables or root vegetables (excluding potatoes), or fruits or berries (excluding juice), less than once per day. Participants were asked how often they usually consume these foods, with the following response options: once a week or less often, 2–6 times a week, 1–2 times a day, or 3 times a day or more often. Low physical activity (yes/no) was determined using two sets of questions. Participants were classified as having low physical activity if they reported engaging in: 1) less than 2 hours 30 minutes of moderate-intensity endurance training or 1 hour 15 minutes of high-intensity endurance training per week, and 2) 2 sessions of exercise maintaining or developing muscle health. Obesity (yes/no) was defined as a body mass index (BMI) ≥30 kg/m² (Weir & Jan, 2025), calculated from self-reported weight and height.

Covariates

Gender was classified as either man or woman in each sub-study. Analyses were stratified by gender in Sub-studies II and III. Age was calculated based on the year of birth and categorised for descriptive analyses and statistical adjustments in Sub-studies I and II. In Sub-study I, age categories were 18–24, 25–34, 35–44, 45–54, 55–64, 65+, whilst in Sub-study II, the categories were 20–29, 30–44, 45–59, 60–74, and 75+. Education level was classified as upper secondary, short-cycle tertiary education, bachelor's or equivalent, master's or doctoral degree or equivalent (Sub-study I) and low, intermediate, and high (Sub-study II). Employment status was

classified as outside the labour force, retired based on age or service years, unemployed, and employed (Sub-study I). Personal net income was divided into three tertiles: T1 (lowest net income), T2, and T3 (highest net income) in Sub-study I, whilst in Sub-study II household annual net income was classified as 15,000€ or less, 15,001–35,000€, 35,001–55,000€, and 55,001€ or more. In Sub-study II, family structure was classified as: living alone, family with children, and family with only adults.

In Sub-study II, suboptimal self-rated health (yes/no) was defined based on participants' responses to the question 'How would you describe your current state of health?' (good, fairly good, average, fairly poor, and poor). Participants who rated their health as average, fairly poor, or poor were classified as having suboptimal self-rated health (Nordin et al., 2024). Psychological distress was assessed using the Mental Health Inventory (MHI-5; Berwick et al., 1991). The MHI-5 consists of five items assessing symptoms of anxiety, depression, and positive mood. Participants were asked: 'How large a portion of your time during the past 4 weeks have you spent: a) feeling very anxious, b) feeling so low that nothing could cheer you up, c) feeling serene and calm, d) feeling inferior and melancholic, and e) feeling happy?'. Response options ranged from 1 (all of the time) to 6 (none of the time). Items c) and e), which reflect positive mood, were reverse coded. The item scores were then summed and transformed to a standardised scale ranging from 0 to 100, with lower scores indicating greater psychological distress. A score of 52 or below was used to indicate clinically relevant psychological distress (Viertiö et al., 2021).

5.3 Statistical methods

The main statistical methods used in the sub-studies are summarised in Table 2. In Sub-study I, multinomial logistic regression analysis was used to estimate the association between sociodemographic factors, gambling behaviour, and the level of GE. Multinomial logistic regression was applied because the dependent variable (GE) was categorical with more than two unordered categories that were mutually exclusive and exhaustive. Model reliability was assessed by checking for potential multicollinearity amongst the independent variables. The results were reported as odds ratios (ORs) and their 95% confidence intervals (CIs). Participants who did not provide information on their GE or did not answer the questions regarding problem gambling severity were excluded from the analyses. Data were analysed using IBM SPSS Statistics software (version 27.0, Armonk, NY, USA, IBM Corp. Released 2020). In addition, the cumulative GE by PPGM category and the cumulative GE by income tertiles were constructed using R software (version 3.5.1, R Core Team, 2020).

In Sub-study II, negative binomial regression analysis was used to examine the association between HRBs, obesity, and problem gambling severity separately for

women and men. Negative binomial regression is an analytical method suitable for situations where there is overdispersion in the continuous dependent variable (such as the PGSI score) but no evidence of zero-inflation. The negative binomial coefficients were reported as incidence rate ratios (IRRs) with their 95% CIs. In addition, the Wald test was used to evaluate whether gender interacted with HRBs or obesity. Data were analysed using IBM SPSS Statistics software (version 29.0.2.0, Armonk, NY, USA) and R software (version 4.3.3, R Core Team, 2023).

In Sub-study III, the incidences of somatic diseases and psychiatric disorders were calculated separately for individuals diagnosed with GD and for the general population, stratified by gender. The expected number of disease and disorder cases was calculated as the sum of products of an age-specific expected number of cases. These were obtained by multiplying the age-specific population of individuals with GD by the corresponding age-specific incidence rates in the Finnish general population. Standardised incidence ratios (SIRs) were calculated by dividing the observed number of cases by the expected number and multiplying the result by 100. A shortcut method was used to calculate the 95% CIs for the SIRs (Jensen et al., 1991). A SIR of 100 indicates that the number of disease/disorder cases observed amongst individuals with GD is equal to the number expected if they had the same rate of disease/disorder as the general population. In this context, a SIR of 125 suggests 25% more cases than expected, whilst a SIR of 75 indicates 25% fewer cases than expected. Differences between women and men in each diagnostic group were tested by calculating CIs for the gender ratio, defined as the ratio of gender-specific SIRs (Jensen et al., 1991). Data were processed and analysed using Microsoft Excel for Windows and the R epitools package (Fay & Feuer, 1997; Anderson & Rosenberg, 1998).

Some terminological choices in Sub-study III need clarification. Different measures of disease frequency can be used to describe how often a disease occurs in a population. Prevalence refers to the number of existing cases of a disease at a specific time or period, whereas incidence refers to the number of new cases over a specific period (Noordzij et al., 2010). In this dissertation, 'incidence' is used throughout when reporting or interpreting the results of Sub-study III. This applies even when reporting the prevalence of certain diseases or disorders amongst individuals diagnosed with GD. Since SIRs were used in the study, the term 'incidence' was chosen to improve readability.

5.4 Ethical considerations

In Sub-study I, the Gambling Harms Survey was approved by the Ethics Committee of the THL (THL/1390/6.02.01/2016). Potential participants were informed about the voluntary nature of participation and provided verbal informed consent. They were also informed that participation involved linkage to national registers, in

accordance with the national data protection regulations of the time. In addition, the letter to potential participants included information about the registrars and their statutory right to disclose data for scientific purposes. Because the survey addressed a sensitive topic and included detailed questions on gambling and related harms, participants were provided with information about Peluuri's national helpline for support with harmful gambling at the end of the questionnaire. The Ethics Committee of Statistics Finland approved (5/2016, 17.11.2016) the use of sociodemographic data. An application for the licence has also been approved (Dnro TK-53-1418-18). In Sub-study II, the necessary research permits were obtained for the Healthy Finland survey (Sääksjärvi et al., 2025). Potential participants received written information about the study and the principles of voluntary participation. Completion of the questionnaire was considered as providing informed consent. The research protocol of the survey was approved by the Ethics committee of the THL (THL/72/6.02.01/2022).

Sub-study III adheres to the Declaration of Helsinki and its subsequent amendments (World Medical Association, 2013). The study did not require separate approval from an ethics committee or a procedure for obtaining informed consent. The analyses are based on aggregated data obtained from the THL. The processes and principles defined by the THL were followed. First, the study was designed and the request for the data was prepared by the research group. Then, the data request was sent to the Data and Analytics Unit at the THL. The request was then processed and implemented by the THL data extractors. They used individual-level health register data to produce the aggregated dataset. The data were accessed and processed in a secured computational environment at the THL. After this, the aggregated dataset was delivered to the research group. Lastly, the research group used aggregated data for the purposes of this paper. Therefore, the authors of this paper did not have any access to the individual-level register data: individual-level register data and aggregated data were handled in stages by different people. The results of each sub-study were reported in such a way that individual participants could not be identified.

A person-centred approach is adopted in this dissertation to avoid stigmatising language, as suggested in gambling research (Biggar & Wardle, 2024) and more broadly in health contexts (Thornicroft et al., 2022). Accordingly, terms such as 'individuals who gamble', 'individuals with GD', and 'individuals experiencing gambling-related harms' are used (Biggar & Wardle, 2024). However, some gambling measures, such as the PGSI (Ferris & Wynne, 2001), which is one of the most widely used population-based measures of harmful gambling, rely on terminology that can be considered stigmatising (e.g., 'problem gambling'). In this dissertation, such terminology is avoided wherever possible and used only when necessary for accuracy, for example when describing outcome measures (e.g., in Sub-study II) or reporting findings from specific cited studies.

6 Results

This section summarises the main results of Sub-studies I–III. Further details are presented in the original articles, which are listed in the *List of Original Publications* section (page ix). Table 4 provides an overview of the aims and main findings of the sub-studies. The results of each sub-study are described in more detail in the following sections.

Table 4 Summary of the aims and main results of the sub-studies.

Sub-study	Aim of the study	Main results
Sub-study I: Grönroos et al., 2022	To examine the relationship between sociodemographic factors, gambling behaviour, and the level of gambling expenditure (GE).	Only 4.2% of individuals accounted for half of the total GE. As much as 76% of GE in this group came from those with at-risk or problem gambling. Compared to the lowest GE group, individuals in the highest GE group were more likely to be men, aged 25 or older, have the lowest education level, the highest net income, and to have received a disability pension or sickness allowance.
Sub-study II: Grönroos et al., 2025	To examine the association between health risk behaviours (HRBs), obesity, and problem gambling severity amongst women and men.	After controlling for potential confounders, all HRBs (daily smoking, excessive drinking, low F & V consumption, insufficient sleep) and obesity were associated with a higher PGSI score, except for low physical activity.
Sub-study III: Grönroos et al., 2024	To examine the gender-specific incidences of somatic diseases and psychiatric disorders amongst adults with diagnosed gambling disorder (GD).	Amongst individuals diagnosed with GD, the most common comorbid illnesses were psychiatric disorders, musculoskeletal diseases, digestive diseases, cardiovascular diseases, and nervous system diseases. After age standardisation, the incidence of each diagnostic group was consistently higher amongst those with GD compared to the general population, apart from cancer.

F & V = Fruit and vegetable; PGSI = Problem Gambling Severity.

6.1 Sociodemographic factors, gambling behaviour and gambling expenditure

Sub-study I examined the associations between sociodemographic factors, gambling behaviour, and the level of GE using data from a longitudinal, nationally representative population study (Wave 1: n = 7,186; Wave 2: n = 2,624). Individuals who had gambled during the past year were included in the analyses (Wave 1, n = 5,805; both Waves, n = 2,165). Participants in the highest GE group were compared with those in the intermediate and lowest GE groups. Figure 3 presents the cumulative GE by problem gambling severity assessed by the PPGM in 2016. Of the total GE, 18.8% was produced by individuals with problem gambling, 32.2% by those with at-risk gambling, and 49.0% by individuals with recreational gambling. Furthermore, 4.2% of individuals produced half of the total GE. In this 4.2% subgroup, 33.1% of the GE was generated by those with problem gambling, 43.3% by those with at-risk gambling, and 23.6% by those with recreational gambling. Overall, 21.4% of individuals accounted for 80.0% of the total GE; within this group, 23.1% was produced by those with problem gambling, 36.9% by those with at-risk gambling, and 40.1% by those with recreational gambling.

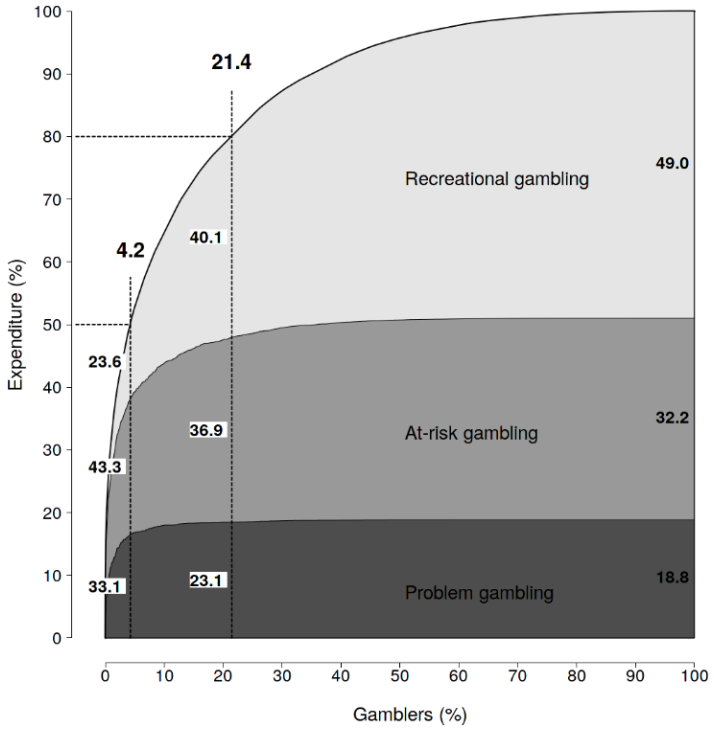

Figure 3 The cumulative gambling expenditure (GE) by PPGM (Problem and Pathological Gambling Measure; Williams & Volberg, 2010) amongst individuals who had gambled in 2016. Adapted from Grönroos et al., 2022 (Sub-study I).

Of those participants who had gambled during the past year, 4.2% (n = 255) were classified into the highest GE group, 20.3% (n = 1,179) into the intermediate GE group, and 75.5% (n = 4,204) into the lowest GE group. The construction of the GE variable is described in detail in Section 5.2. Multinomial logistic regression analyses were conducted to examine the associations between sociodemographic factors, gambling behaviour, and the level of GE (Table 5). Compared to the lowest GE group, individuals in the intermediate GE group had higher odds of being male, aged 25 or older, and having upper secondary or short-cycle tertiary education. They also had lower odds of having the lowest net income. Furthermore, individuals in the intermediate GE group had higher odds of gambling at least once a week, gambling four or more game types, gambling multi-modally, and being in the at-risk or problem gambling category (Appendix 1). Compared to the lowest GE group, individuals in the highest GE group had higher odds of being male, aged 25 or older, having the lowest education level, the highest net income, and receiving a disability pension or sickness allowance (Table 5). Furthermore, they had higher odds of gambling at least once a week, gambling six or more game types, and being in the at-risk or problem gambling category (Appendix 1).

Table 5 Association between sociodemographic factors, gambling behaviour and gambling expenditure (GE) groups amongst Finnish adults. Multinomial logistic regression.

	Highest vs. lowest GE			Intermediate vs. lowest GE		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Gender						
Men	2.5	1.7, 3.7	<0.001	1.8	1.6, 2.2	<0.001
Women	Ref.			Ref.		
Age						
65+	40.9	12.2, 137.3	<0.001	5.5	3.2, 9.7	<0.001
55–64	27.5	9.9, 75.9	<0.001	4.6	2.9, 7.3	<0.001
45–54	9.1	3.3, 25.0	<0.001	2.8	1.8, 3.0	<0.001
35–44	5.3	1.9, 14.3	0.001	1.9	1.2, 3.1	0.005
25–34	7.5	2.8, 20.1	<0.001	1.8	1.2, 2.8	0.010
18–24	Ref.			Ref.		
Education level						
Missing	2.5	1.2, 5.3	0.018	2.5	1.8, 3.5	<0.001
Upper secondary	2.3	1.1, 4.6	0.024	2.3	1.7, 3.1	<0.001
Short-cycle tertiary education	1.5	0.6, 3.5	0.347	1.5	1.0, 2.2	0.031
Bachelor's degree	1.3	0.5, 3.1	0.555	1.4	1.0, 2.1	0.068
Master's or doctoral degree	Ref.			Ref.		

(Continues from the previous page)

	Highest vs. lowest GE			Intermediate vs. lowest GE		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Employment status						
Outside the labour force	1.6	0.6, 3.8	0.327	1.1	0.7, 1.7	0.730
Retired	1.1	0.5, 2.0	0.887	1.0	0.7, 1.4	0.922
Unemployed	1.4	0.7, 3.0	0.366	0.9	0.6, 1.4	0.749
Employed	Ref.			Ref.		
Net income tertiles						
T1 (low net income)	0.6	0.4, 1.0	0.049	0.8	0.6, 1.0	0.019
T2	Ref.			Ref.		
T3 (high net income)	2.0	1.3, 3.2	0.002	1.1	0.9, 1.3	0.575
Income/unempl. benefit						
Yes	0.8	0.4, 1.4	0.788	0.8	0.6, 1.1	0.218
No	Ref.			Ref.		
Disab. pens./sick. all.						
Yes	2.0	1.1, 3.8	0.028	1.3	0.9, 1.9	0.128
No	Ref.			Ref.		
R^2 (Nagelkerke)			0.53			

Weighted based on gender, age, education, and region of residence. OR = odds ratio; CI = confidence interval. Income/unempl. benefit = income support or unemployment benefit; Disab. pens./sick. all. = disability pension or sickness allowance. The GE groups are: 1) spends ≥40.0 euros per week and produces 50% of the total GE (highest), 2) spends 10.0–39.9 euros per week and produces 30% of the total GE (intermediate); 3) spends ≤9.9 euros per week and produces 20% of the total GE (lowest).

The cumulative GE by net income tertiles in 2016 is presented in Figure 4. The analysis included only participants who had gambled in the past year, participated in both waves, and had available income information (n = 2,140; non-weighted). Overall, 20.6% of the total GE was generated by those with the lowest net income, 51.5% by those of the intermediate income group, and 27.9% by those in the highest income group. Amongst the 22.0% of individuals that produced 80.0% of the total GE, 19.2% came from the lowest income group, 55.0% from the intermediate income group, and 25.8% from the highest income group. In the group of 4.2% of individuals that produced 50.0% of the total GE, 14.7% of GE came from those with the lowest income, 65.4% from the intermediate income group, and 19.8% from the highest income group.

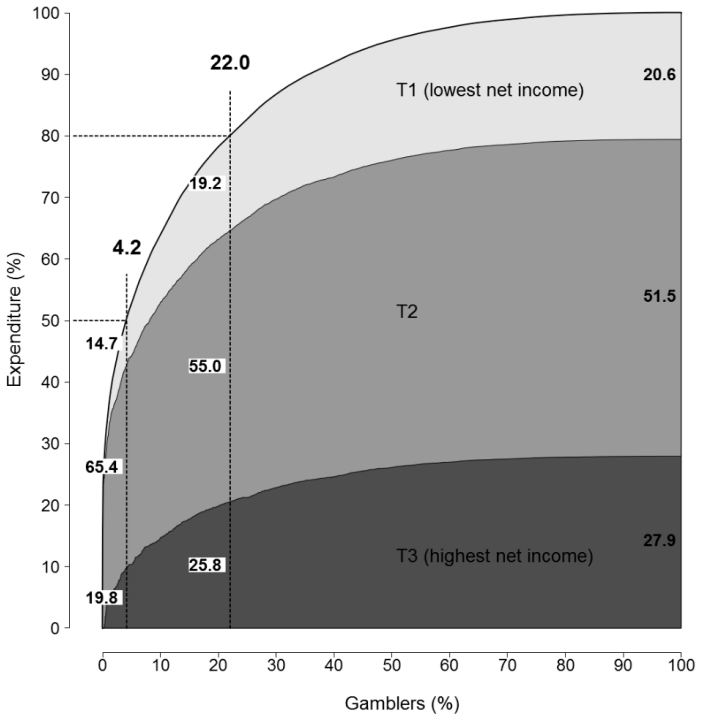

Figure 4 The cumulative gambling expenditure (GE) by net income tertiles amongst individuals who had gambled in 2016. Adapted from Grönroos et al., 2022 (Sub-study I).

6.2 Health risk behaviours, obesity and problem gambling severity

Sub-study II examined the associations between HRBs, obesity, and problem gambling severity amongst women and men using a large, nationally representative population sample (n = 28,154). Figure 5 presents the prevalences of HRBs and obesity by the PGSI categories: non-problem gambling (0); low-risk gambling (1–2); moderate-risk gambling (3–7); problem gambling (8+). Daily smoking, excessive drinking, low F & V consumption, and insufficient sleep were clearly associated with problem gambling severity. Their prevalence was lower in the non-problem gambling category compared to the low-risk, moderate-risk, and problem gambling categories. Additionally, daily smoking, excessive drinking, and low F & V consumption were more prevalent in the problem gambling group than in the low-risk group. Obesity was less prevalent in the non-problem gambling category compared to the low-risk category, but its prevalence was similar in the moderate-risk and problem gambling categories.

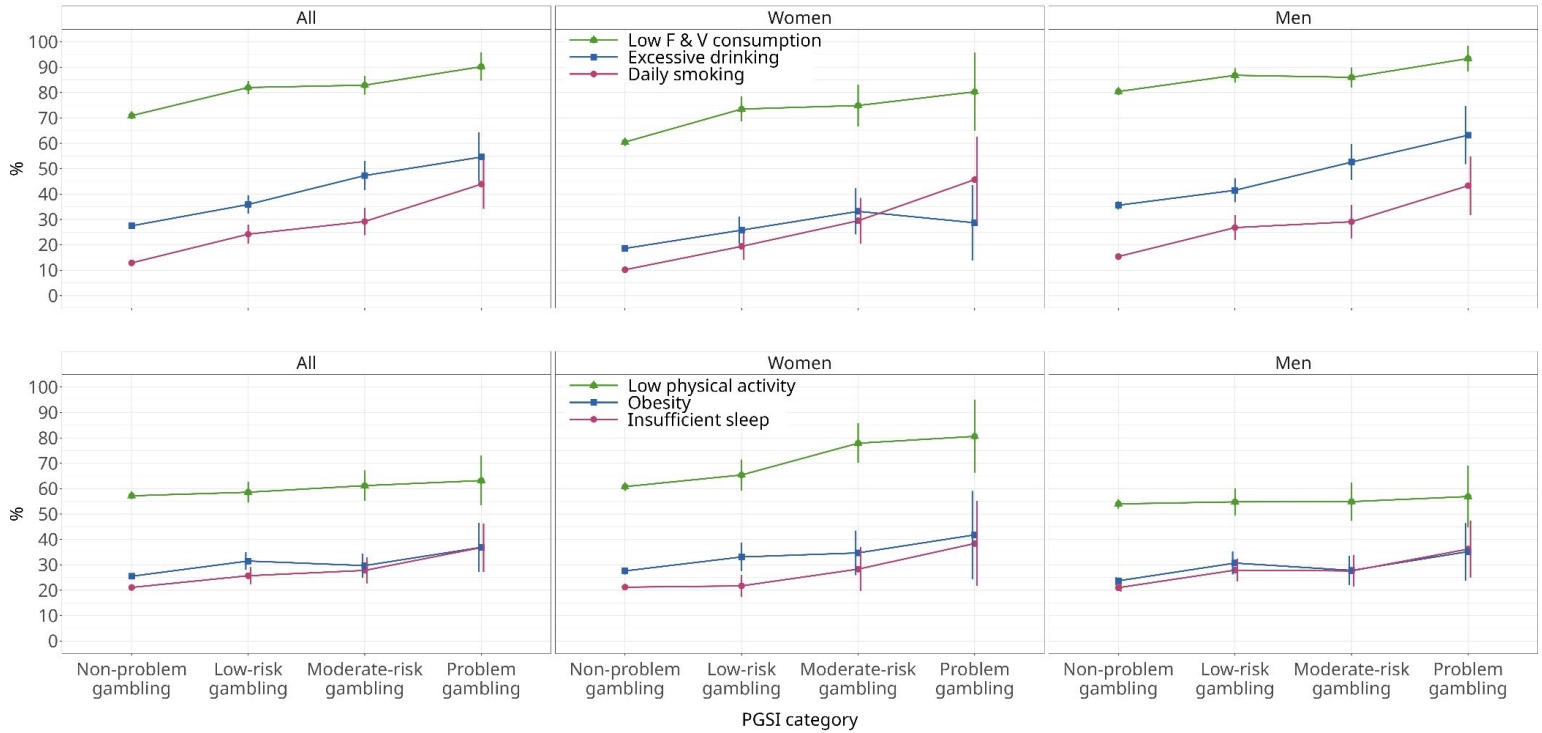

Figure 5 Prevalences of health risk behaviours (HRBs) and obesity by the Problem Gambling Severity Index (PGSI) category amongst women and men (%). F & V = fruit & vegetable. Adapted from Grönroos et al., 2025 (Sub-study II).

Table 6 The association between health risk behaviours (HRBs), obesity, and the Problem Gambling Severity Index (PGSI) score amongst participants who gambled within the past 12 months. Negative binomial regression. IRR = Incidence rate ratio; CI = confidence interval; F & V = fruit & vegetable. Adapted from Grönroos et al., 2025 (Sub-study II).

	All			Women			Men		
Characteristics	**IRR**	**95% CI**	**p-value**	**IRR**	**95% CI**	**p-value**	**IRR**	**95% CI**	**p-value**
Daily smoking									
Yes	2.1	1.7, 2.4	<0.001	2.8	2.1, 3.9	<0.001	1.8	1.5, 2.2	<0.001
No	Ref.			Ref.			Ref.		
Excessive drinking									
Yes	1.4	1.2, 1.6	<0.001	1.5	1.2, 2.0	0.002	1.5	1.3, 1.8	<0.001
No	Ref.			Ref.			Ref.		
Low F & V consumption									
Yes	1.3	1.2, 1.6	<0.001	1.4	1.1, 1.8	0.007	1.2	1.0, 1.5	0.050
No	Ref.			Ref.			Ref.		
Insufficient sleep									
Yes	1.3	1.1, 1.5	0.003	1.2	1.0, 1.6	0.110	1.2	1.0, 1.5	0.030
No	Ref.			Ref.			Ref.		
Low physical activity									
Yes	1.0	0.9, 1.1	0.800	1.3	1.0, 1.6	0.039	0.8	0.7, 1.0	0.013
No	Ref.			Ref.			Ref.		
Obesity									
Yes	1.4	1.2, 1.6	<0.001	1.5	1.2, 1.9	<0.001	1.2	1.0, 1.5	0.017
No	Ref.			Ref.			Ref.		

Amongst both women and men, daily smoking and low F & V consumption were less prevalent in the non-problem gambling category compared to the low-risk, moderate-risk, and problem gambling categories (Figure 5). In addition, amongst women, low physical activity was less prevalent in the non-problem gambling category compared to the moderate-risk and problem gambling categories. Amongst men, excessive drinking was less prevalent in the non-problem gambling category compared to the moderate-risk and problem gambling categories.

A negative binomial regression analysis was carried out to investigate the association between HRBs, obesity, and the PGSI score (Table 6; Appendix 2). After controlling for gender, age, net income, education level, suboptimal self-rated health, and psychological distress, almost all HRBs as well as obesity were significantly associated with the PGSI score. Daily smoking, in particular, was associated with more than a twofold increase in PGSI score (IRR = 2.1; 95% CI = 1.7, 2.4), whilst excessive drinking (IRR = 1.4; 95% CI = 1.2, 1.6), low F & V consumption (IRR = 1.3; 95% CI = 1.2, 1.6), insufficient sleep (IRR = 1.3; 95% CI = 1.1, 1.5), and obesity (IRR = 1.4; 95% CI = 1.2, 1.6) were also associated with higher scores. The results were largely similar even when only sociodemographic factors were controlled for (Appendix 2). A Wald test was used to assess whether gender interacted with HRBs and obesity. Statistically significant interactions were found between gender and daily smoking ($p = 0.012$), as well as between gender and low physical activity ($p = 0.001$).

The associations between HRBs, obesity, and PGSI score were also analysed separately for women and men (Table 6; Appendix 3 & 4). Amongst women, after controlling for potential confounders, all HRBs and obesity were significantly associated with higher PGSI score, except for insufficient sleep. The strongest association was observed for daily smoking (IRR = 2.8; 95% CI = 2.1, 3.9). Amongst women, low physical activity slightly increased the PGSI score (IRR = 1.3; 95% CI = 1.0, 1.6), whereas amongst men, it slightly decreased it (IRR = 0.8; 95% CI = 0.7, 1.0). Amongst men, after controlling for potential confounders, all other HRBs as well as obesity were significantly associated with higher PGSI scores.

6.3 Somatic and psychiatric comorbidities of gambling disorder

Sub-study III examined the gender-specific incidences of somatic diseases and psychiatric disorders amongst Finnish adults with diagnosed GD (ICD-10 F63.0; n = 3,605) between 2011 and 2022 using unique, nationwide health register data. The corresponding incidences for the general population (n = 4,374,192) are presented as references. Amongst individuals diagnosed with GD, the most common comorbid illnesses were as follows: psychiatric disorders (88%), musculoskeletal diseases (67%), digestive diseases (34%), cardiovascular diseases (31%), and

nervous system diseases (27%) (Table 7). Overall, both men and women diagnosed with GD had the same most common comorbid illnesses (Tables 8 and 9).

After age standardisation, the incidence of each diagnostic group was higher amongst individuals diagnosed with GD compared to the general population, with the only exception being cancer (Table 7). The highest age-standardised incidences were found for psychiatric disorders (SIR = 234.2; 95% CI = 226.1, 242.4), memory disorders (SIR = 172.1; 95% CI = 119.1, 234.8), nervous system diseases (SIR = 162.8; 95% CI = 152.8, 173.1), chronic respiratory diseases (SIR = 150.6; 95% CI = 137.6, 164.2), diabetes (SIR = 141.4; 95% CI = 127.9, 155.5), and digestive diseases (SIR = 134.5; 95% CI = 127.1, 142.2).

Amongst men diagnosed with GD, the incidence of each diagnostic group, with the exception of cancer and memory disorders, was higher than in men in the general population (Table 8). The highest age-standardised incidences were found for psychiatric disorders (SIR = 246.1; 95% CI = 236.0, 256.4), nervous system diseases (SIR = 164.5; 95% CI = 151.7, 177.9), diabetes (SIR = 142.4; 95% CI = 123.7, 162.6), chronic respiratory diseases (SIR = 138.6; 95% CI = 123.0, 155.1), and digestive diseases (SIR = 129.0; 95% CI = 120.0, 138.4).

Amongst women diagnosed with GD, the incidence of each diagnostic group, with the exception of allergies and cancer, was higher than in women in the general population (Table 9). The highest age-standardised incidences were found for psychiatric disorders (SIR = 210.2; 95% CI = 197.0, 223.8), memory disorders (SIR = 182.5; 95% CI = 112.8, 268.8), chronic respiratory diseases (SIR = 171.2; 95% CI = 148.6, 195.5), nervous system diseases (SIR = 160.1; 95% CI = 144.4, 176.7), digestive diseases (SIR = 145.1; 95% CI = 131.9, 158.8) and diabetes (SIR = 140.3; 95% CI = 121.5, 160.4).

To assess gender differences for each diagnostic group, 95% CIs were calculated for the gender ratio, defined as the ratio of gender-specific SIRs. The SIRs for women and men in each diagnostic group were compared, with statistically significant differences observed only for psychiatric disorders (gender ratio = 1.17; 95% CI = 1.09, 1.26) and chronic respiratory diseases (gender ratio = 0.81; 95% CI = 0.68, 0.97).

Table 7 Observed (obs) and expected (exp) number of cases of somatic diseases and psychiatric disorders amongst individuals diagnosed with gambling disorder (GD) and in the Finnish general population in 2011–2022. SIR = Standardised Incidence Ratio; CI = confidence interval. Adapted from Grönroos et al., 2024 (Sub-study III).

Diagnostic group	Finnish population (n = 4,374,192)		Individuals diagnosed with GD (n = 3,605)			SIR	95% CI
	%	N	%	N Obs	N Exp		
Allergies	13	567,276	16	584	512	114.2	105.1–123.6
Cancer	30	1,313,628	18	654	628	104.1	96.2–112.2
Cardiovascular diseases	49	2,153,782	31	1,116	909	122.8	115.7–130.1
Chronic respiratory diseases	14	621,340	14	490	325	150.6	137.6–164.2
Diabetes	15	661,137	11	405	286	141.4	127.9–155.5
Digestive diseases	34	1,481,038	34	1,210	899	134.5	127.1–142.2
Memory disorders	6	265,328	1	34	20	172.1	119.1–234.8
Musculoskeletal diseases	67	2,935,769	67	2,405	2,143	112.2	107.8–116.8
Nervous system diseases	20	857,842	27	983	604	162.8	152.8–173.1
Psychiatric disorders	34	1,491,035	88	3,181	1,358	234.2	226.1–242.4

Table 8 Observed (obs) and expected (exp) number of cases of somatic diseases and psychiatric disorders amongst men diagnosed with gambling disorder (GD) and men in the Finnish general population in 2011–2022. SIR = Standardised Incidence Ratio; CI = confidence interval. Adapted from Grönroos et al., 2024 (Sub-study III).

Diagnostic group	Men in Finnish population (n = 2,142,986)		Men diagnosed with GD (n = 2,574)			SIR	95% CI
	%	N	%	N Obs	N Exp		
Allergies	10	212,452	15	380	322	118.1	106.5–130.3
Cancer	25	540,490	14	363	327	111.0	99.8–122.7
Cardiovascular diseases	48	1,019,254	26	674	566	119.0	110.2–128.2
Chronic respiratory diseases	14	289,847	11	285	206	138.6	123.0–155.1
Diabetes	15	311,216	8	206	145	142.4	123.7–162.6
Digestive diseases	32	694,277	30	762	590	129.0	120.0–138.4
Memory disorders	5	106,201	1	13	8	157.7	83.6–255.0
Musculoskeletal diseases	62	1,327,770	61	1,572	1,437	109.4	104.0–114.8
Nervous system diseases	18	376,339	24	606	368	164.5	151.7–177.9
Psychiatric disorders	30	632,127	87	2,234	908	246.1	236.0–256.4

Table 9 Observed (obs) and expected (exp) number of cases of somatic diseases and psychiatric disorders amongst women diagnosed with gambling disorder (GD) and women in the Finnish general population in 2011–2022. SIR = Standardised Incidence Ratio; CI = confidence interval. Adapted from Grönroos et al., 2024 (Sub-study III).

Diagnostic group	Women in Finnish population (n = 2,231,206)		Women diagnosed with GD (n = 1,031)			SIR	95% CI
	%	N	%	N Obs	N Exp		
Allergies	16	354,824	20	204	190	107.5	93.2–122.7
Cancer	35	773,138	28	291	301	96.6	85.8–108.0
Cardiovascular diseases	51	1,134,528	43	442	343	129.0	117.2–141.3
Chronic respiratory diseases	15	331,493	20	205	120	171.2	148.6–195.5
Diabetes	16	349,921	19	199	142	140.3	121.5–160.4
Digestive diseases	35	786,761	44	448	309	145.1	131.9–158.8
Memory disorders	7	159,127	2	21	12	182.5	112.8–268.8
Musculoskeletal diseases	72	1,607,999	81	833	705	118.1	110.2–126.2
Nervous system diseases	22	481,503	37	377	235	160.1	144.4–176.7
Psychiatric disorders	39	858,908	92	947	451	210.2	197.0–223.8

7 Discussion

This section discusses the main findings of the dissertation in relation to previous research. This study examined the associations of sociodemographic and health-related factors with harmful gambling amongst Finnish adults utilising both register data and population surveys. Overall, key findings were that a small group of individuals, which mostly consists of those with harmful gambling, accounted for the majority of gambling revenues. These individuals were more likely to have low education and to receive disability pension or sickness allowance, suggesting that high GE is associated not only with social disadvantage but also with health problems. Harmful gambling was closely linked to HRBs and a range of other health conditions: individuals with low-risk, moderate-risk, and problem gambling exhibited higher rates of additional HRBs and obesity than those with non-problem gambling. In addition, individuals with diagnosed GD had markedly higher rates of both somatic diseases and psychiatric disorders compared with the general population. All in all, these findings suggest that individuals with harmful gambling may also experience an accumulation of other problems. Section 7.1 presents the main results from Sub-studies I–III, followed by a discussion of their theoretical and practical implications in Section 7.2, as well as strengths and limitations in Section 7.3.

7.1 Main findings

Sociodemographic factors and level of gambling expenditure (GE)

Previous studies have shown that GE is highly concentrated amongst a small proportion of individuals who gamble (e.g., Salonen et al., 2017; Castrén et al., 2018; Fiedler et al., 2019; Grönroos et al., 2024). This concentration raises important questions about the extent to which gambling revenue is produced by individuals from different sociodemographic groups, and particularly by those experiencing gambling problems of varying severity. A large body of research has examined the association between sociodemographic factors and GE. However, very little has been known about the small group of individuals who generate most of the gambling revenue. Sub-study I investigated the associations between sociodemographic factors, gambling behaviour, and the level of GE. Individuals

with the highest GE were compared to those in the intermediate and lowest GE group.

This study found that about half of total GE came from individuals with either at-risk or problem gambling, which aligns with previous research showing that a disproportionately large share of gambling revenue is contributed by those with harmful gambling (Fiedler et al., 2019). However, previous studies have reported a wide range of estimates, which may reflect differences in data collection methods, study periods and locations, and the types of gambling examined (Fiedler et al., 2019). Individuals with harmful gambling typically gamble more frequently, for longer sessions, and with greater intensity than those with non-problem gambling (Hing & Russell, 2020; Grönroos et al., 2024), which explains their disproportionately large share of total spending. Notably, amongst the 4.2% of individuals responsible for half of the total GE, 76% of that expenditure came from those experiencing at-risk or problem gambling, confirming that a small, high-spending group, which are mostly individuals with at-risk or problem gambling, drives the majority of gambling losses, in line with previous findings (e.g., Salonen et al., 2017; Grönroos et al., 2024).

Another concerning finding was that, compared to the lowest GE group, individuals in the highest GE group had higher odds of receiving a disability pension or sickness allowance. This is not surprising given that high GE is strongly associated with harmful gambling, which in turn is linked to a range of somatic and psychiatric health issues, as observed in Sub-study III and reported in previous research (e.g., Lorains et al., 2011; Håkansson et al., 2018; Abdul-Rahim et al., 2023). Psychiatric disorders are particularly common amongst individuals with harmful gambling, and represent one of the leading causes of disability pension and sickness allowance in Finland (Social Insurance Institution of Finland, 2025; Finnish Centre for Pensions, 2025). Earlier studies have shown that receipt of income support and unemployment benefits are more prevalent amongst those with harmful gambling compared to those with non-problem gambling (Latvala et al., 2021). However, in the present study, receipt of neither of these benefits was associated with the highest GE. This may be partly explained by the fact that the individuals simply do not have the financial resources to spend enough on gambling to belong to the highest GE group.

In addition, compared to the lowest GE group, those in the highest GE group had higher odds of having a low education level, indicating that high GE is linked to social disadvantage. This aligns with previous research showing that higher education is associated with lower gambling prevalence and reduced GE (MacDonald et al., 2004). Consistently, individuals with lower education have been found to be more likely to experience harmful gambling, either during their lifetime or in the past year (Ekholm et al., 2014). It has been suggested that this may be partly explained by individuals with higher education having stronger decision-

making skills and improved cognitive skills gained through education, which may buffer against gambling and harmful gambling (MacDonald et al., 2004). For example, a study by Latvala et al. (2022) showed that individuals with lower compulsory school achievement (measured by grade point average; GPA) differed from those with higher GPA by having greater GE later in youth.

This study showed that those in the highest GE group had higher odds of having a high net income compared to the lowest GE group. This finding is consistent with earlier studies indicating that GE tends to increase with income (MacDonald et al., 2004). However, previous studies have also shown that individuals with low income spend proportionally more on gambling compared to those with middle- and high-income (Castrén et al., 2018). Unfortunately, it was not possible in the present study to examine GE in relation to income because this variable could not be included in the model due to multicollinearity. It should be noted that although individuals in the lowest income tertile accounted for 21% of the total GE, their representation remained notable even within the most heavily spending group. Amongst the top 4.2% of individuals who accounted for half of the total GE, 15% were from the lowest income group. For individuals with low income, even a small amount spent on gambling can lead to financial difficulties since they are less likely to have the necessary resources to cover gambling losses (Sulkunen et al., 2018).

Health risk behaviours (HRBs), obesity and problem gambling severity

Several HRBs, particularly smoking and excessive drinking, have been linked to harmful gambling (e.g., Algren et al., 2015; Butler et al., 2020). However, more research is needed to gain a better understanding of these HRBs, amongst people with harmful gambling as well as gender differences. Previous research on HRBs and gambling has primarily focused on problem gambling, with limited attention given to lower levels of problem gambling severity. Moreover, few studies have analysed these associations separately for women and men. Sub-study II aimed to address these gaps by investigating the associations between HRBs, obesity, and the full continuum of problem gambling severity in both women and men, using a large, nationally representative sample (n = 28,154).

A key finding of Sub-study II was that many HRBs were more prevalent amongst individuals with low-risk, moderate-risk, and problem gambling compared to those with non-problem gambling. This aligns with previous research suggesting that the association between HRBs and gambling is not limited to severe gambling problems (Butler et al., 2020). From a public health perspective, this is a crucial finding since individuals with lower levels of problem gambling severity represent a much larger proportion of the population than those with problem gambling. Consequently, the potential adverse effects of co-occurring HRBs may impact a substantially broader portion of the population. In 2023, 12.0% of individuals in Finland aged 15 to 74 years engaged in low- or moderate-risk gambling, whereas only 1.3% engaged in

problem gambling (Grönroos et al., 2024). Having several HRBs at the same time increases the likelihood of developing new illnesses or exacerbating existing ones, which can have a negative impact on overall health and well-being (Kvaavik et al., 2010). On a larger scale, this also leads to higher costs for society and the healthcare system. Additionally, individuals who engage in low- or moderate-risk gambling may develop more serious gambling problems over time (Wardle et al., 2012), and experiencing other HRBs may accelerate this process. For example, a study by Suomi et al. (2024) showed that risky levels of alcohol consumption were associated with transitions from low to more severe gambling over a three-year period.

Sub-study II also found that nearly all HRBs and obesity were significantly associated with a higher PGSI score. These associations remained largely unchanged even when potential confounders, including psychological distress, were taken into account. This finding was somewhat unexpected, given that mental health issues such as stress, anxiety and depression have been shown to be strongly linked with HRBs (Umberson et al., 2008; Liu et al., 2016; Schuch et al., 2018). Individuals may engage in risky yet enjoyable behaviours, such as eating high-fat, sugary foods or drinking alcohol, as a way of coping with negative emotions (Park & Iacocca, 2014; Hill et al., 2022). Therefore, it would be reasonable to expect that the observed associations between HRBs, obesity, and PGSI scores might have weakened after controlling for psychological distress, given its known role in both HRBs and gambling problems.

It is likely that a range of other underlying mechanisms also contribute to engagement in HRBs. One such factor is impulsivity, a psychological trait that has been linked to both gambling behaviours and various HRBs (Granö et al., 2004; Lorains et al., 2011; Ioannidis et al., 2019). Impulsivity refers to actions or behaviours that are excessively hasty, risky, or inappropriate, often leading to negative consequences (Evenden, 1999). Unfortunately, we were unable to adjust our models for psychological traits such as impulsivity. This would have provided a more comprehensive understanding of the phenomenon. However, in future research, linking national health registers with survey data could enable us to investigate the relationship between problem gambling severity and other HRBs in more detail, whilst controlling for impulsivity-related variables.

Our results showed that low physical activity was the only HRB that was not significantly associated with PGSI score. This finding was in line with previous research (Butler et al., 2020). However, when the analyses were stratified by gender, low physical activity was associated with slightly higher PGSI scores amongst women and slightly lower scores amongst men. Although low physical activity was a relatively weak risk factor compared to other HRBs and obesity, it nevertheless represented a noteworthy finding. One possible explanation for the gender differences is that women are more likely than men to use gambling as a coping mechanism for negative emotions such as stress, anxiety, and depression

(Desai et al., 2008). Such emotions have also been linked to lower levels of physical activity (Schuch et al., 2018).

Another point to consider is that women and men have different motivations, preferences and behaviours, which may result in different patterns of participation in physical activity. Men, for example, are more likely than women to participate in competitive team sports such as football and ice hockey (Deaner et al., 2012). Previous research has suggested that people who play team sports may be more likely to experience gambling problems (Gavriel-Fried et al., 2015; Grall-Bronnec et al., 2016; Jensen et al., 2019). This association may be partly explained by the desire to win, which is a motivational factor underlying both gambling and participation in competitive team sports (Curry et al., 1995). Notably, studies examining professional athletes and individuals who frequently exercise at the gym have found that they are more likely to experience gambling problems than the general population (Håkansson et al., 2021; Håkansson et al., 2020). However, this has mainly only been found for men, not women. Furthermore, it has been argued that the difference in the prevalence of gambling problems between women and men may be even greater in athletes than in the general population (Håkansson et al., 2020). Overall, these contrasting findings underscore the importance of conducting separate analyses for women and men. Furthermore, the complex and potentially gender-specific relationship between physical activity and gambling problems highlights the need for further research in this area.

Somatic and psychiatric comorbidity in individuals with gambling disorder (GD)

A novel finding in Sub-study I was that individuals in the highest GE group had higher odds of receiving a disability pension or sickness allowance compared to those in the lowest GE group, suggesting that high GE is linked to underlying health conditions. Furthermore, Sub-study II found that many HRBs were more prevalent amongst individuals with low-risk, moderate-risk, and problem gambling compared to those with non-problem gambling. These HRBs are well-established risk factors for major chronic diseases, which are leading causes of morbidity, disability, and premature death both in Finland and globally, making them a significant public health concern (WHO, 2010b). These results inspired Sub-study III to investigate the health status of individuals with gambling problems in greater depth, with a particular focus on the most prevalent chronic diseases. To our knowledge, Sub-study III was the first study to examine somatic comorbidity amongst individuals diagnosed with GD using nationwide, register-based data covering the entire Finnish population. Previous research has primarily focused on psychiatric comorbidities and/or relied on data from population-based surveys.

Overall, the age-standardised incidence of each diagnostic group was higher amongst individuals diagnosed with GD compared to the general population, except for cancer. Psychiatric disorders showed the highest incidence, followed by memory

disorders, nervous system diseases, chronic respiratory diseases, diabetes, and digestive diseases. These findings expand upon earlier studies (e.g., Lorains et al., 2011; Dowling et al., 2015; Håkansson et al., 2018) by highlighting a wider variety of comorbid conditions, including somatic illnesses. This is a concerning finding since comorbid health conditions can exacerbate harmful gambling further (Yakovenko & Hodgins et al., 2018). Similarly, harmful gambling can exacerbate existing health conditions, particularly since it is frequently accompanied by financial difficulties (Abbott et al., 2018), which can limit access to food, medication, and healthcare services.

Sub-study III showed that individuals diagnosed with GD had a notably higher incidence of psychiatric disorders, nervous system diseases, and cardiovascular diseases compared to the general population. This may be partly explained by the fact that GD is strongly associated with stress-related disorders (Håkansson et al., 2018), and that harmful gambling more broadly has been linked to elevated levels of perceived stress (Ekholm et al., 2018; Loo et al., 2019). Therefore, illnesses with a stress-related component, such as many psychiatric disorders, nervous system diseases, and cardiovascular diseases, may be more prevalent amongst individuals diagnosed with GD than in the general population. Stress has been shown to aggravate the symptoms of numerous somatic conditions, and complicate diseases accompanied by pain (Kivimäki et al., 2006; Qin et al., 2014; Pellegrino et al., 2018). Nonetheless, these findings do not necessarily imply that stress is the primary cause of these diseases.

Since we used aggregated data, it remains unclear which condition was diagnosed first: the comorbid disease or GD. The temporal relationship between gambling and comorbidities is the subject of ongoing debate (Hartmann & Blaszczynski, 2018). Gambling may cause health outcomes, or it may be a consequence of them. For example, gambling may serve as a maladaptive coping mechanism for managing symptoms of mood and anxiety disorders, both of which are commonly observed amongst individuals diagnosed with GD (Håkansson et al., 2018). Conversely, gambling problems can contribute to the development or worsening of mental health problems, for instance through excessive financial losses, social strain, or feelings of guilt and shame. Research has been conducted on the temporal relationship between psychiatric disorders and gambling problems (Hartmann & Blaszczynski et al., 2018), revealing notable gender differences (Haw et al., 2016; Sundqvist & Rosendahl, 2019). However, to our knowledge, there is a lack of research on the sequencing of somatic conditions in this context. Some studies (Bellringer et al., 2024) suggest that the onset of chronic illness may influence gambling behaviours, but the temporal relationship remains unclear. Therefore, future studies should utilise longitudinal data and apply advanced analytical approaches, such as quasi-experimental or other causal inference

methods, to explore somatic morbidity trajectories amongst individuals diagnosed with GD, with separate analyses for women and men.

Sub-study III found that women diagnosed with GD had a higher prevalence of comorbid psychiatric disorders (92%) compared to men diagnosed with GD (87%), consistent with previous studies (Håkansson et al., 2018; Larsson & Håkansson, 2022). Interestingly, however, the relative difference in psychiatric morbidity between men with GD and men in the general population was greater than the corresponding difference between women with GD and women in the general population. This pattern may be partly explained by the higher baseline prevalence of psychiatric disorders amongst women in the general population (39%). Consequently, the relative increase in these disorders associated with GD may be greater amongst men, whose baseline level of psychiatric morbidity is lower (30%).

Comorbid chronic respiratory diseases were more prevalent amongst women diagnosed with GD (20%) than amongst men diagnosed with GD (11%), which is in line with earlier findings (Abdul-Rahim et al., 2023). Furthermore, the relative difference in chronic respiratory disease between women with GD and women in the general population was greater than the corresponding difference between men with GD and men in the general population. No other significant gender differences in relative comorbidity patterns were observed. Since there are some differences between women and men in gambling behaviour (Abbott et al., 2018), the development of gambling problems (Desai et al., 2008; Ronzitti et al., 2016; Miller et al., 2023), and associated comorbidities (Håkansson et al., 2018; Larsson & Håkansson, 2022; Abdul-Rahim et al., 2023), it is important to conduct analyses separately for women and men in order to identify gender-specific patterns.

7.2 Theoretical and practical implications

Altogether, the findings of this dissertation provide new insights into health-related factors associated with harmful gambling, building upon the knowledge summarised in the Conceptual Framework of Harmful Gambling (Abbott et al., 2018). Sub-study I found that receiving a disability pension and/or sickness allowance was associated with high GE. Similarly, Sub-study II showed that several HRBs and obesity were linked not only to problem gambling but also to low-risk and moderate-risk gambling. Finally, Sub-study III revealed that individuals diagnosed with GD had markedly higher rates of both psychiatric and somatic diseases compared with the general population. Although the Conceptual Framework of Harmful Gambling identifies mental health conditions and substance-related HRBs associated with harmful gambling, it does not formally include physical health conditions or non-substance-related HRBs. Nevertheless, it highlights the need for further research on these associations. Overall, the findings of this dissertation add to the existing literature on harmful gambling summarised

in the framework and could be used to complement and expand it if an updated version is published in the future.

The findings of Sub-study II emphasise the importance of preventive efforts that go beyond individuals with severe gambling problems and target the broader population engaging in gambling at any level of risk. The LRGG are an evidence-based, population-level tool for primary prevention, which were developed by the Canadian Centre on Substance Use and Addiction (Young et al., 2021, 2022; Hodgins et al., 2023; Canadian Centre on Substance Use and Addiction, 2024). The guidelines aim to reduce harm from gambling before it occurs by promoting clear and actionable limits. Finland is on track to implement national guidelines by the end of 2025, following models already established for alcohol use (Palomäki et al., 2024; Grönroos et al., 2025; Egerer et al., 2025). As in other health domains, these guidelines serve an important public health function and are most effective when integrated into broad health promotion strategies. Together, guidelines for gambling, alcohol, and nutrition may have a greater impact since HRBs often cluster within individuals (Nodle et al., 2015; Burton et al., 2023). To be effective, it is essential that such tools are perceived as both relevant and accessible to the general public.

The findings of this dissertation also have important practical implications for health and social care services. Sub-study III showed that psychiatric disorders are highly prevalent comorbidities amongst individuals diagnosed with GD. These findings underscore the need for systematic screening for GD amongst individuals seeking treatment for psychiatric disorders. It should be noted that GD is rarely the primary reason for seeking treatment, although it may be a significant underlying problem. Therefore, gambling should be discussed routinely in health and social care settings. Models and tools for early interventions exist but are underutilised in both healthcare and social services (available in Finland: Gambling problem: Current Care Guidelines, 2023). Effective treatment of comorbid psychiatric disorders is essential for the successful management of GD, and vice versa: untreated GD may worsen the prognosis of comorbid disorders such as anxiety or depression. Sub-study III also found that somatic comorbidities are highly prevalent amongst individuals diagnosed with GD, highlighting the need for health and social care professionals to be aware of the potential presence of somatic comorbidities when working with people with GD, even though they are, on average, relatively young. A multidisciplinary approach amongst health and social care professionals is needed to effectively address GD, taking into account social, psychological, and physical factors. A key challenge is that these problems are often not recognised early enough, which can lead to more severe difficulties and a decline in overall quality of life.

7.3 Strengths, limitations and future directions

A key strength of this study was the use of large, high-quality, nationally representative data in each sub-study. Sub-studies I and II were both based on population surveys. The extensive range of questions in these surveys allowed for a comprehensive examination of the research topics. Another major strength of these studies was the possibility to link survey data with register-based information. Sub-study III was entirely based on national health registers. To the best of our knowledge, this was the first study to examine somatic diseases amongst adults with diagnosed GD compared to the general population using nationwide register-based data. Furthermore, the register data covered the entire Finnish mainland population that had used social and healthcare services between 2011 and 2022, allowing us to include all individuals who received a GD diagnosis during this period. However, several limitations should be taken into account when interpreting the findings of the sub-studies.

The response rates in Sub-study I and II were not particularly high, being 36% in Sub-study I (Wave I) and 46% in Sub-study II (Salonen et al., 2017; Sääksjärvi et al., 2025). Internationally, response rates for surveys have declined over the past decade, and a response rate of 30–40% is often considered as good (Beullens et al., 2018; Eggleston, 2024). In both surveys, participation varied notably by age, with the youngest age groups, particularly young men, participating the least (Salonen et al., 2017; Sääksjärvi et al., 2025; Kontto et al., 2025). In the Healthy Finland Survey used in Sub-study II, the response rate amongst men aged 20–39 years was only 22% (Sääksjärvi et al., 2025). This is particularly relevant since gambling problems have been shown to be especially prevalent amongst young men (Grönroos et al., 2024), potentially leading to an underestimation of gambling problems in this high-risk group. An additional limitation of the Healthy Finland Survey used in Sub-study II was that participants had to be at least 20 years old. On the other hand, a strength of the study was that there was no upper age limit. To mitigate bias resulting from non-participation, survey weights were applied in both sub-studies since register-based information was available for the entire sample, including non-participants. The procedure for calculating the survey weights in the datasets of Sub-studies I and II is described in Section 5.1, *Study Population and Data*.

It should also be noted that the data used in Sub-study I do not cover the entire country since the Gambling Harms Survey was conducted in only three selected regions (Uusimaa, Pirkanmaa, and Kymenlaakso). Nevertheless, these regions represent approximately 42% of the Finnish population (Salonen et al., 2017). Furthermore, the data were collected in 2017 and 2018, and since then, notable changes have taken place in the Finnish gambling environment due to policy reforms, as described in Section 2.3. Finns' gambling behaviour has also changed during this period, with, for example, an increase in online gambling participation

as well as a rise in gambling at least at a moderate-risk level (Grönroos et al., 2024). Therefore, the present findings may not fully reflect the current situation, and future studies using more recent data are warranted to confirm these findings. However, Sub-studies II and III were based on more recent data.

Another point to consider is the use of self-reported data on gambling, HRBs, and obesity in Sub-study I and II. Previous studies suggest that people tend to underreport their engagement in gambling and other HRBs, possibly due to recall difficulties or the tendency to respond in a socially desirable manner (Newell et al., 1999; Northcote et al., 2011). For example, individuals tend to slightly overestimate their height and underestimate their weight (Tolonen et al., 2014). Nevertheless, self-reported height and weight are generally considered valid measures (Hodge et al., 2020). Studies comparing self-reported GE with actual operator data have shown that individuals generally underreport their losses, although the self-reported figures still show a significant correlation with actual losses (Braverman et al., 2014; Auer & Griffiths, 2017). Individuals with higher gambling losses and those experiencing gambling problems tend to have greater difficulty accurately estimating their GE (Braverman et al., 2014; Auer & Griffiths, 2017).

Notably, the way questions are formulated and the instructions provided to participants can influence how they report their gambling behaviour (Blaszczynski et al., 2006; Wood & Williams, 2007). In the Gambling Harms Survey used in Sub-study I, participants were asked to estimate their GE based on the frequency of their own choosing. This approach may have contributed to the relatively low amount of missing data (Salonen & Raisamo, 2015; Salonen et al., 2020). It should also be noted that the instructions for the GE question did not specify whether participants were required to report their net spending (i.e., the amount spent on gambling minus any winnings). A study by Blaszczynski et al. (1997) demonstrated that only 32% to 64% of participants interpreted such questions as referring to net expenditure. Since participants in Sub-study I were asked how much they had *spent* on gambling, this may have biased them toward reporting losses rather than actual spending, potentially leading to inconsistencies in how expenditure was understood and reported (Williams & Wood, 2004).

A further limitation is that the questions related to HRBs, obesity, and health in Sub-study II used different time frames. For example, gambling, alcohol consumption, and physical activity were assessed over the past 12 months, whilst psychological distress was assessed over the past 4 weeks. The other questions, however, did not specify a time frame and instead focused more broadly on the current situation. This was because the time frames of the questions were based on the measures used (e.g., PGSI, MHI-5, and AUDIT-C) or were chosen based on the phenomenon being studied. As a result, this may have caused some confusion for participants regarding which time frame to follow for each question, although the questionnaire did provide clear and precise instructions. When interpreting the

results, it is also important to note that due to the varying time frames, HRBs, obesity, suboptimal self-rated health, and psychological distress may not have occurred at the same time as gambling or gambling problems of varying severity.

Sub-study III utilised unique, high-quality register-based data on diagnosed GD (ICD-10: F63.0) and comorbid somatic diseases and psychiatric disorders, covering the entire Finnish population residing on the mainland that had used social and healthcare services. Register data offer an excellent source for analysing the prevalence of somatic and psychiatric comorbidities amongst individuals with GD. Vulnerable population subgroups, as well as other hard-to-reach groups, can be difficult to study using population surveys due to non-response bias. Register data provide reliable information on diagnosed GD since they are not affected by the same recall bias as population-based surveys. Moreover, such data are also valuable for assessing somatic and psychiatric comorbidities. For example, individuals may be unaware of, or have difficulty recalling, the diagnoses they have received (Mäkelä et al., 2021).

However, register data provide only an indirect measure of GD prevalence since they really reflect service use (Mäkelä et al., 2021). A recent register-based study showed that the prevalence of diagnosed GD in Finland is notably low, whereas survey studies indicate a markedly higher prevalence of probable GD (Salonen et al., 2022; Salonen et al., 2020). This discrepancy suggests that GD may be underdiagnosed in Finland. Due to the low number of diagnosed cases, Sub-study III focused on a relatively small group of individuals with documented gambling problems. Therefore, the findings of this sub-study cannot be generalised to all Finnish individuals with GD, but only those who have received a formal diagnosis. It is possible that primarily individuals with the most severe gambling problems seek treatment and receive a GD diagnosis. Studies have shown that individuals with higher problem gambling severity are more likely to seek help (Bijker et al., 2022). These individuals may also have more frequent contact with healthcare services, increasing the likelihood that comorbid somatic and psychiatric conditions are identified and recorded compared to the general population. Future research should aim to link survey data with register-based diagnoses and examine comorbidities across the full spectrum of problem gambling severity to provide a more comprehensive understanding of associated health outcomes. In addition, since aggregated data was used in Sub-study III, it was not possible to take SEP into account in the analysis. However, this issue should be addressed in future research since clear SEP differences exist in both harmful gambling and health more broadly (e.g., Cowlishaw & Kessler, 2016; Sharman et al., 2019; Latvala et al., 2021).

Another limitation of Sub-study III was the exclusion of GD diagnoses amongst children and adolescents (n = 108; aged 4–17 years) since it is uncertain whether individuals under 18 years of age in these data fulfil the diagnostic criteria for GD. Some of these individuals may be addicted to gaming rather than gambling

(Håkansson et al., 2018). The Finnish translation of the GD diagnosis does not specify whether the disorder pertains to gaming or gambling (Castrén et al., 2014), which may cause confusion amongst clinicians with limited experience in behavioural disorders. Furthermore, the data indicated that some very young children had received a GD diagnosis, suggesting that this diagnosis may have been applied to symptoms related to gaming rather than gambling. In the revised ICD-11, gaming disorder has its own distinct diagnostic code (WHO, 2019). Therefore, future studies are likely to provide more accurate information on GD diagnoses amongst minors. It should also be noted that, since 2020, private service providers and occupational healthcare providers in Finland have contributed data to the primary care register more comprehensively than before. Since 2022, the coverage of occupational healthcare is considered fairly comprehensive, although some provider-specific gaps remain (Salonen et al., 2025).

8 Conclusions

This study focused on the associations between sociodemographic and health-related factors and harmful gambling. Harmful gambling was examined from three perspectives: high GE, problem gambling severity, and diagnosed GD. The study population in each sub-study consisted of Finnish adult residents, and the analyses were based on population surveys and register data. Overall, the findings strengthen previous evidence that harmful gambling is unevenly distributed across population groups, thereby potentially contributing to health inequalities. Moreover, the results provide new insight into health-related factors associated with harmful gambling, particularly HRBs and somatic comorbidities.

The results showed that only a small proportion of individuals accounted for half of the total GE. Notably, the majority of revenues within this group came from individuals engaging in at-risk or problem gambling. These individuals were more likely to have low education and to receive a disability pension or sickness allowance, suggesting that high GE is associated not only with social disadvantage but also with health-related problems. This interpretation is further supported by other findings of this study, which demonstrated that at-risk and problem gambling were associated with multiple HRBs, whilst GD was strongly related to psychiatric and somatic comorbidities. Thus, harmful gambling may be associated with an accumulation of various forms of disadvantage.

Whilst these results focus on individual-level factors, it is also important to interpret them in the context of broader, population-level influences. Like other health outcomes, harmful gambling is not solely a matter of individual choice but is shaped by complex social, economic, and environmental factors (Dahlgren & Whitehead, 1991; Abbott et al., 2018; Bartley & Kelly-Irving, 2025). One key factor is the availability and accessibility of gambling opportunities. Finland will replace its gambling monopoly with a licensing system in 2027, opening the online market to competition. Several new operators with financial interest are expected to enter the market, which is likely to expand the availability and accessibility of the most harmful gambling products. It is therefore essential to closely monitor how harmful gambling is distributed across different population groups in the coming years. The main aim of gambling policy should be to prevent and reduce harms from gambling, with particular attention to alleviating the disproportionate burden on disadvantaged groups.

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Appendices

Appendix 1.

Association between sociodemographic factors, gambling behaviour, and gambling expenditure (GE) groups amongst Finnish adults who had gambled in 2016. Multinomial logistic regression analysis.

	Highest vs. lowest GE			Intermediate vs. lowest GE		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Gender						
Men	2.5	1.7, 3.7	<0.001	1.8	1.6, 2.2	<0.001
Women	Ref.			Ref.		
Age						
65+	40.9	12.2, 137.3	<0.001	5.5	3.2, 9.7	<0.001
55–64	27.5	9.9, 75.9	<0.001	4.6	2.9, 7.3	<0.001
45–54	9.1	3.3, 25.0	<0.001	2.8	1.8, 3.0	<0.001
35–44	5.3	1.9, 14.3	0.001	1.9	1.2, 3.1	0.005
25–34	7.5	2.8, 20.1	<0.001	1.8	1.2, 2.8	0.010
18–24	Ref.			Ref.		
Education level						
Missing	2.5	1.2, 5.3	0.018	2.5	1.8, 3.5	<0.001
Upper secondary	2.3	1.1, 4.6	0.024	2.3	1.7, 3.1	<0.001
Short-cycle tertiary education	1.5	0.6, 3.5	0.347	1.5	1.0, 2.2	0.031
Bachelor's degree	1.3	0.5, 3.1	0.555	1.4	1.0, 2.1	0.068
Master's or doctoral degree	Ref.			Ref.		
Employment status						
Outside the labour force	1.6	0.6, 3.8	0.327	1.1	0.7, 1.7	0.730
Retired	1.1	0.5, 2.0	0.887	1.0	0.7, 1.4	0.922
Unemployed	1.4	0.7, 3.0	0.366	0.9	0.6, 1.4	0.749
Employed	Ref.			Ref.		
Net income tertiles						
T1 (low net income)	0.6	0.4, 1.0	0.049	0.8	0.6, 1.0	0.019
T2	Ref.			Ref.		
T3 (high net income)	2.0	1.3, 3.2	0.002	1.1	0.9, 1.3	0.575

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	Highest vs. lowest GE			Intermediate vs. lowest GE		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Income/unempl. benefit						
Yes	0.8	0.4, 1.4	0.788	0.8	0.6, 1.1	0.218
No	Ref.			Ref.		
Disab. pens./sick. all.						
Yes	2.0	1.1, 3.8	0.028	1.3	0.9, 1.9	0.128
No	Ref.			Ref.		
Gambling frequency						
Daily	224.8	104.4, 483.7	<0.001	24.9	16.4, 38.0	<0.001
Several times a week	76.3	37.7, 155.0	<0.001	15.2	11.4, 20.4	<0.001
Once a week	10.0	5.1, 19.8	<0.001	7.5	6.2, 9.0	<0.001
1–3 times a month or less	Ref.			Ref.		
Game types						
11–18 game types	18.5	9.0, 37.9	<0.001	3.9	2.4, 6.3	<0.001
6–10 game types	5.7	3.5, 9.2	<0.001	3.1	2.4, 4.0	<0.001
4–5 game types	1.4	0.9, 2.4	0.182	1.8	1.5, 2.2	<0.001
1–3 game types	Ref.			Ref.		
Gambling mode						
Multi-mode	1.4	0.9, 2.3	0.112	1.4	1.1, 1.7	0.007
Online	1.1	0.7, 1.9	0.692	1.2	1.0, 1.6	0.073
Land-based	Ref.			Ref.		
Do not know / missing	1.2	0.5, 2.9	0.685	1.2	0.8, 1.8	0.466
Gambling severity						
Problem gambling	29.5	15.4, 56.6	<0.001	3.7	2.2, 6.5	<0.001
At-risk gambling	3.4	2.3, 5.1	<0.001	1.8	1.4, 2.2	<0.001
Recreational gambling	Ref.	1.7, 3.7	<0.001	Ref.	1.6, 2.2	<0.001
R^2 (Nagelkerke)			0.53			

Weighted based on gender, age, education, and region of residence. OR = odds ratio; CI = confidence interval; Income/unempl. benefit = income support or unemployment benefit; Disab. pens./sick. all. = disability pension or sickness allowance. The GE groups are: 1) spends ≥40.0 euros per week and produces 50% of the total GE (highest), 2) spends 10.0–39.9 euros per week and produces 30% of the total GE (intermediate); 3) spends ≤9.9 euros per week and produces 20% of the total GE (lowest).

Appendix 2.

Association between health risk behaviours (HRBs), obesity, and the Problem Gambling Severity Index (PGSI) score amongst participants who gambled within the past 12 months. Negative binomial regression.

	Model I			Model II		
Characteristics	**IRR**	**95% CI**	**p-value**	**IRR**	**95% CI**	**p-value**
Gender						
Men	2.0	1.8, 2.3	<0.001	2.0	1.8, 2.3	<0.001
Women	Ref.			Ref.		
Age						
20–29	1.8	1.3, 2.4	<0.001	1.8	1.3, 2.4	<0.001
30–44	1.8	1.3, 2.3	<0.001	1.6	1.2, 2.2	<0.001
45–59	1.2	0.9, 1.5	0.300	1.2	0.9, 1.5	0.300
60–74	1.0	0.8, 1.3	0.900	1.0	0.8, 1.4	0.800
75+	Ref.			Ref.		
Net income						
15,000 € or less	2.6	2.1, 3.3	<0.001	2.3	1.9, 2.9	<0.001
15,001–35,000 €	1.9	1.6, 2.2	<0.001	1.8	1.6, 2.2	<0.001
35,001–55,000 €	1.3	1.1, 1.6	<0.001	1.3	1.1, 1.6	<0.001
55,001 € or more	Ref.			Ref.		
Education level						
Low	1.7	1.5, 2.0	<0.001	1.8	1.5, 2.1	<0.001
Intermediate	1.2	1.0, 1.5	0.015	1.2	1.0, 1.5	0.016
High	Ref.			Ref.		
Family structure						
Family with only adults	1.0	0.7, 1.1	0.800	1.1	0.9, 1.3	0.400
Family with children	0.9	0.7, 1.1	0.200	1.0	0.8, 1.2	0.900
Living alone	Ref.			Ref.		
Daily smoking						
Yes	2.1	1.8, 2.5	<0.001	2.1	1.7, 2.4	<0.001
No	Ref.			Ref.		
Excessive drinking						
Yes	1.5	1.4, 1.8	<0.001	1.4	1.2, 1.6	<0.001
No	Ref.			Ref.		

(Continues from the previous page)

	Model I			Model II		
Characteristics	**IRR**	**95% CI**	**p-value**	**IRR**	**95% CI**	**p-value**
Low F & V consumption						
Yes	1.3	1.2, 1.6	<0.001	1.3	1.2, 1.6	<0.001
No	Ref.			Ref.		
Insufficient sleep						
Yes	1.4	1.2, 1.6	<0.001	1.3	1.1, 1.5	0.003
No	Ref.			Ref.		
Low physical activity						
Yes	1.1	0.9, 1.2	0.300	1.0	0.9, 1.1	0.800
No	Ref.			Ref.		
Obesity						
Yes	1.4	1.2, 1.6	<0.001	1.4	1.2, 1.6	<0.001
No	Ref.			Ref.		
Suboptimal self-rated health						
Yes				1.3	1.1, 1.5	<0.001
No	-			Ref.		
Psychological distress						
Yes				1.7	1.4, 2.0	<0.001
No	-			Ref.		

IRR = incidence rate ratio; CI = confidence interval; F & V = fruit and vegetable. Adjusted for sociodemographic factors, suboptimal self-rated health, and psychological distress (Mental Health Inventory; MHI-5). Weighted data based on age, sex, marital status, education level, first language, and area of residence. The PGSI score is used as a continuous variable. Alcohol consumption was assessed using the Alcohol Use Disorder Identification Test for Consumption (AUDIT-C). Obesity was defined as body mass index (BMI) ≥ 30 kg/m^2.

Appendix 3.

Association between health risk behaviours (HRBs), obesity, and the Problem Gambling Severity Index (PGSI) score amongst women who gambled within the past 12 months. Negative binomial regression.

	Model I			Model II		
Characteristics	**IRR**	**95% CI**	**p-value**	**IRR**	**95% CI**	**p-value**
Age						
20–29	1.9	1.1, 3.1	0.016	1.9	1.1, 3.2	0.020
30–44	1.6	0.9, 2.6	0.072	1.5	0.9, 2.6	0.092
45–59	1.7	1.1, 2.7	0.026	1.8	1.1, 2.8	0.021
60–74	1.4	0.9, 2.1	0.200	1.5	0.9, 2.3	0.100
75+	Ref.			Ref.		
Net income						
15,000 € or less	3.4	2.3, 5.0	<0.001	3.3	2.3, 4.9	<0.001
15,001–35,000 €	2.4	1.8, 3.2	<0.001	2.3	1.7, 3.1	<0.001
35,001–55,000 €	1.7	1.2, 2.2	<0.001	1.7	1.3, 2.3	<0.001
55,001 € or more	Ref.			Ref.		
Education level						
Low	1.9	1.4, 2.5	<0.001	2.0	1.5, 2.6	<0.001
Intermediate	1.0	0.8, 1.4	0.800	1.0	0.8, 1.4	0.800
High	Ref.			Ref.		
Family structure						
Family with only adults	0.9	0.7, 1.2	0.300	0.9	0.7, 1.2	0.400
Family with children	0.7	0.5, 0.9	0.013	0.7	0.5, 1.0	0.051
Living alone	Ref.			Ref.		
Daily smoking						
Yes	3.0	2.3, 4.2	<0.001	2.8	2.1, 3.9	<0.001
No	Ref.			Ref.		
Excessive drinking						
Yes	1.5	1.2, 2.0	<0.001	1.5	1.2, 2.0	0.002
No	Ref.			Ref.		
Low F & V consumption						
Yes	1.4	1.1, 1.7	0.006	1.4	1.1, 1.8	0.007
No	Ref.			Ref.		

(Continues from the previous page)

	Model I			Model II		
Characteristics	**IRR**	**95% CI**	**p-value**	**IRR**	**95% CI**	**p-value**
Insufficient sleep						
Yes	1.3	1.0, 1.7	0.039	1.2	1.0, 1.6	0.110
No	Ref.			Ref.		
Low physical activity						
Yes	1.4	1.1, 1.7	0.007	1.3	1.0, 1.6	0.039
No	Ref.			Ref.		
Obesity						
Yes	1.5	1.2, 2.0	<0.001	1.5	1.2, 1.9	<0.001
No	Ref.			Ref.		
Suboptimal self-rated health						
Yes				1.3	1.0, 1.6	0.041
No	-			Ref.		
Psychological distress						
Yes				1.3	1.0, 1.8	0.032
No	-			Ref.		

IRR = incidence rate ratio; CI = confidence interval; F & V = fruit and vegetable. Adjusted for sociodemographic factors, suboptimal self-rated health, and psychological distress (Mental Health Inventory; MHI-5). Weighted data based on age, sex, marital status, education level, first language, and area of residence. The PGSI score is used as a continuous variable. Alcohol consumption was assessed using the Alcohol Use Disorder Identification Test for Consumption (AUDIT-C). Obesity was defined as body mass index (BMI) ≥ 30 kg/m^2.

Appendix 4.

Association between health risk behaviours (HRBs), obesity, and the Problem Gambling Severity Index (PGSI) score amongst men who gambled within the past 12 months. Negative binomial regression.

	Model I			Model II		
Characteristics	**IRR**	**95% CI**	**p-value**	**IRR**	**95% CI**	**p-value**
Age						
20–29	2.0	1.4, 2.9	<0.001	2.1	1.4, 3.1	<0.001
30–44	1.9	1.3, 2.7	<0.001	1.7	1.2, 2.4	0.002
45–59	0.9	0.6, 1.3	0.600	0.9	0.6, 1.3	0.500
60–74	0.9	0.6, 1.2	0.300	0.8	0.6, 1.1	0.200
75+	Ref.			Ref.		
Net income						
15,000 € or less	2.1	1.6, 2.8	<0.001	1.6	1.2, 2.2	0.001
15,001–35,000 €	1.8	1.5, 2.3	<0.001	1.8	1.5, 2.2	<0.001
35,001–55,000 €	1.2	1.0, 1.5	0.073	1.2	1.0, 1.4	0.110
55,001 € or more	Ref.			Ref.		
Education level						
Low	1.5	1.3, 1.9	<0.001	1.6	1.3, 1.9	<0.001
Intermediate	1.3	1.1, 1.6	0.016	1.3	1.0, 1.6	0.030
High	Ref.			Ref.		
Family structure						
Family with only adults	1.1	0.9, 1.3	0.500	1.3	1.0, 1.5	0.018
Family with children	1.1	0.9, 1.4	0.400	1.3	1.0, 1.6	0.037
Living alone	Ref.			Ref.		
Daily smoking						
Yes	1.8	1.5, 2.2	<0.001	1.8	1.5, 2.2	<0.001
No	Ref.			Ref.		
Excessive drinking						
Yes	1.7	1.5, 2.0	<0.001	1.5	1.3, 1.8	<0.001
No	Ref.			Ref.		
Low F & V consumption						
Yes	1.2	1.0, 1.5	0.100	1.2	1.0, 1.5	0.050
No	Ref.			Ref.		

(Continues from the previous page)

	Model I			Model II		
Characteristics	**IRR**	**95% CI**	**p-value**	**IRR**	**95% CI**	**p-value**
Insufficient sleep						
Yes	1.4	1.2, 1.7	<0.001	1.2	1.0, 1.5	0.030
No	Ref.			Ref.		
Low physical activity						
Yes	0.9	0.8, 1.1	0.300	0.8	0.7, 1.0	0.013
No	Ref.			Ref.		
Obesity						
Yes	1.3	1.1, 1.5	0.010	1.2	1.0, 1.5	0.017
No	Ref.			Ref.		
Suboptimal self-rated health						
Yes				1.4	1.2, 1.7	<0.001
No	-			Ref.		
Psychological distress						
Yes				2.0	1.7, 2.5	<0.001
No	-			Ref.		

IRR = incidence rate ratio; CI = confidence interval; F & V = fruit and vegetable. Adjusted for sociodemographic factors, suboptimal self-rated health, and psychological distress (Mental Health Inventory; MHI-5). Weighted data based on age, sex, marital status, education level, first language, and area of residence. The PGSI score is used as a continuous variable. Alcohol consumption was assessed using the Alcohol Use Disorder Identification Test for Consumption (AUDIT-C). Obesity was defined as body mass index (BMI) ≥ 30 kg/m^2.

Journal of Gambling Studies
https://doi.org/10.1007/s10899-021-10075-6

ORIGINAL PAPER

Socio-Demographic Factors, Gambling Behaviour, and the Level of Gambling Expenditure: A Population-Based Study

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Accepted: 9 September 2021
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Abstract

The aim of this study was to examine the relationship between socio-demographic factors, gambling behaviour, and the level of gambling expenditure. The data were drawn from the population-based Gambling Harms Survey 2016 and 2017 conducted in Finland. The data were linked to register-based variables. Past-year gamblers were included (Wave 1; n=5 805, both Waves; n=2 165). The study showed that of the 4.2% of gamblers that produced 50.0% of the total GE in 2016, 33.1% of the GE was produced by those with a gambling problem and 43.3% by those with at-risk gambling pattern. Compared to gamblers in the lowest GE group, those in the highest GE group were more likely to be men, aged 25 or older, with upper secondary education, have a high income, be on disability pension or sickness allowance, be frequent gamblers, gambling at least six game types, and showing at-risk and problem gambling patterns. Cumulative weekly GE by income tertiles remained fairly stable between the years. The results suggest that GE is highly concentrated. Among the small group of high-intensity consumers, the majority of the revenue comes from at-risk and problem gambling. Participants in the low GE group differ from those in the intermediate and high GE groups in terms of socio-demographics and gambling behaviour.

Keywords Gambling expenditure · Gambling · Longitudinal study · Population survey · Register data · Socio-demographic factors

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Published online: 04 October 2021

Introduction

Gambling environment has changed rapidly. Gambling is increasingly available and more advertised, and new gambling products are constantly being developed. People also spend more money on gambling than before (Statista 2020). Finland's per capita gambling expenditure (GE) rate is one of the highest in Europe (Economist 2017). Spending for gambling is highly concentrated (Salonen et al., 2017; Salonen et al., 2019; Salonen et al., 2020; Williams et al., 2011). This raises a question of how much of the gambling revenue is produced by individuals from different socio-demographic backgrounds and, especially, by those with a gambling problem.

Overall, men tend to spend more money on gambling than women (McCormack et al., 2014; Davidson et al., 2016; Castrén et al., 2018). This has been observed for both younger and older adults (Merkouris et al., 2016; Molinaro et al., 2018). GE increases with age (Tan et al., 1991), although some studies suggest that GE increases only until the middle age and starts to drop after that (Mikesell 1991; Scott & Garen 1994).

Moreover, low socio-economic status is associated with high GE (Davidson et al., 2016; Salonen et al., 2018a). To date, a limited number of studies have investigated the relationship between GE and receipt of social security benefits (Worthington 2001; MacDonald et al., 2004). A Canadian survey showed that households with income support were less likely to gamble. With the exception of one jurisdiction, households that received income support spend a lower proportion of their income on gambling. (MacDonald et al., 2004.) However, gambling problems are more common among those who receive income support or who are unemployed (McMillen et al., 2004). Moreover, gambling opportunities are concentrated in the socio-economically disadvantaged areas (Wardle et al., 2014; Raisamo et al., 2019).

Studies conducted in different countries have shown that although high income groups spend more on gambling, lower income groups contribute proportionally more (Beckert & Lutter 2009; Canale et al., 2016; Castrén et al., 2018; Roukka & Salonen 2020). In general, among those with low income, a large fraction of their income spent on gambling often leads to financial harm (Welte et al., 2004; Freund & Morris 2006), since they have fewer financial resources to cover up their losses. This may lead to debt taking (Sulkunen et al., 2019). A Finnish population survey showed that among help-seeking gamblers, 42 % had a debt problem or a debt spiral (Salonen et al., 2018b). Gambling-related harms (GRH) include financial consequences, such as over-indebtedness or losing funds intended for household expenses. In some cases, gamblers may lose all their assets, even their homes (Sulkunen et al., 2019). In addition, gambling may cause work-related problems and job loss; housing instability or homelessness; and criminal behaviour (Williams et al., 2011; Gattis & Cunninham-Williams 2011; Lind et al., 2015; Eby et al., 2016).

High gambling frequency is associated with high GE (LaPlante et al., 2009). The number of game types gambled affects GE, as those who gamble six or more game types spend the most. Furthermore, online gambling is associated with higher GE than land-based gambling (Salonen et al., 2017). Weekly gambling on horse races, online poker, EGMs and offshore games are linked with higher GE (Salonen et al., 2018b). EGMs cause more GRHs than other game types (Peluuri 2016; Binde et al., 2017).

High GE does not directly mean that a gambler experience GRH, but it is associated with GRH (Currie et al., 2006; Langham et al., 2016). A relatively large proportion of the gambling revenue comes from those with a gambling problem (e.g., Grinols & Omorov

1996; Lesieur 1998; Volberg et al., 1998; Volberg et al., 2011; Williams & Wood 2004; Wood & Williams 2007; Salonen et al., 2017; Fiedler et al., 2019). However, in previous studies, this proportion have ranged widely from 14% (Volberg et al., 2011) to 52% (Grinols & Omorov 1996). In addition to several methodological differences, the proportion of gambling revenue derived from those with a gambling problem depends on the game type, with lower proportions for lotteries and higher proportions for electronic gaming machines (EGM) (Volberg et al., 1998; Wood & Williams 2007).

Until 2016, the Finnish gambling policy was based on a three-party monopoly system. These operators were merged into a single state-owned company in 2017. Under the Lotteries Act, the country's gambling system's main objective is to prevent and reduce the gambling-related financial, health and social harm (Finlex 2011). Most of the Finnish gambling company's profits are channelled through the state or non-governmental organisations to promote the public good. The use of gambling revenues for good purposes is often used as a justification for the existence of this monopoly, in which all citizens are seen as beneficiaries.

As discussed above, previous studies have investigated the association between gambling expenditure, socio-demographic factors, and gambling behaviour. Nevertheless, very little is known about the small group of gamblers that produces the most of the gambling revenue. This study aims to investigate the relationship between socio-demographic factors (education, employment status, net income, and social security benefits), gambling behaviour (gambling frequency, number of game types gambled, gambling mode, and gambling severity), and the level of GE. The gamblers with the highest GE are compared to other gamblers.

Methods

Design and Participants

The data were drawn from the Gambling Harms Survey 2016–2017 conducted in Finland (Salonen et al., 2019). Finland is the only European Union country that still maintains a gambling monopoly; this makes Finland an interesting case. In addition, these data are longitudinal, which allows us to analyse individual-level changes. At Wave 1, a total of 20,000 permanent residents of selected areas were randomly selected from the national Population Information System. The inclusion criteria were: (1) age 18 or over; (2) Finnish or Swedish as first language; and (3) living in Uusimaa, Pirkanmaa or Kymenlaakso. At Wave 1, a total of 4 611 participants gave their permission to be re-contacted.

Data Collection

The study was conducted by the Finnish Institute for Health and Welfare in collaboration with the University of Helsinki. The data were collected by Statistics Finland between 9 January and 26 March 2017 (Wave 1) and between 15 January and 30 April 2018 (Wave 2) by using online and postal survey. The focus was on gambling in 2016 and 2017.

At Wave 1, a participant information sheet was sent to the potential participants. The first reminder was sent by mail. To 25–44-years-olds, the reminder was also sent by text mes-

sage. The third and fourth reminder included a postal survey. At Wave 2, the postal survey was sent to participants that had responded via postal survey at Wave 1. Similarly, an invitation with two reminders was sent to those participants that had answered to online survey at Wave 1. All invitations included a link to online survey.

At Wave 1, a total of 7 186 persons participated in the survey (response rate 36 %). At Wave 2, there were 2 624 participants, and the response rate was 57 % of eligible participants, who responded to Wave 1 survey and gave a permission for re-contact. At Wave 1, the response rate was lower in men than in women (Salonen et al., 2017); whereas at Wave 2 men responded more actively than women (Salonen et al., 2019). Overall, older and highly educated persons participated most actively.

Past-year gamblers were included (Wave 1; n = 5 805, both Waves; n = 2 165). Using national ID numbers, the survey data were linked to the Statistics Finland's register data on socio-demographic factors.

Measures

Gambling Expenditure GE was measured as follows: 'Think about the year 2016 (or 2017). Estimate the amount of money that you spent on gambling on average per week, per month or during the year (in Euros).' All GE figures were transformed into weekly GE. To categorise three groups, the cumulative distribution of total GE was created by sorting GE in descending order. Then, the cumulative distribution was explored to find the point where half of the total GE was cumulated. Lastly, based on the Pareto Principle (Juran 1975), which assumes that for many phenomena roughly 80 % of consequences are due to 20 % of the causes, the cumulative distribution was explored to find the point where 80 % of total GE was cumulated. Gamblers were divided into three groups as follows: (1) produces 50 % of the total GE and spend EUR ≥ 40.0 per week (i.e., the highest GE group), (2) produces 30 % of the total GE and spend EUR 10.0–39.9 per week (i.e., the intermediate GE group), and (3) produces 20 % of the total GE and spend EUR ≤ 9.9 per week (i.e., the lowest GE group).

The highest GE at Wave 2 was considered as an outlier and replaced as follows: firstly, all gamblers in both Waves with increased GE were selected from the dataset. Then, the average growth of GE between the waves was calculated for them. The outlier was replaced by multiplying the respondents' GE in Wave 1 by the average growth of GE.

Socio-Demographic Factors Socio-demographic factors were derived from Statistics Finland's registers and recoded (Table 1). They included gender, age, educational level, employment status, and personal net income tertiles. Furthermore, the amount of income support, unemployment benefit and sickness allowance were dichotomised (yes/no). In Finland, income support is a last-resort form of financial aid, which covers some of the basic necessities of life to individuals and families (Kela 2020). After that, income support and unemployment benefit variables were merged, while sickness allowance was merged with a disability pension variable.

Past-Year Gambling Behaviour Gambling frequency was asked for 18 game types. The list included games provided by the Finnish gambling monopoly company, but also offshore games and games offered in Åland and in ferries between Finland, Sweden and Estonia were included. The overall gambling frequency was calculated based on the game type in which

Table 1 The gambling expenditure (GE) groups by socio-demographic factors and gambling behaviour in 2016, n (%)

	Highest expenditure		Intermediate expenditure		Lowest expenditure		
	n=255 (4.2%)		n=1 179 (20.3%)		n=4 204 (75.5%)		P-value
Gender							<0.001
Men	203	(7.1)	779	(27.3)	1 867	(65.5)	
Women	52	(1.9)	399	(14.3)	2 338	(83.8)	
Age							<0.001
65+	55	(4.8)	330	(28.3)	762	(66.4)	
55–64	68	(7.1)	268	(28.1)	617	(64.7)	
45–54	43	(4.2)	220	(21.5)	758	(74.2)	
35–44	38	(3.9)	161	(16.4)	780	(79.7)	
25–34	40	(4.1)	139	(14.4)	789	(81.5)	
18–24	10	(1.8)	60	(10.6)	498	(87.7)	
Education level							<0.001
Missing	77	(6.6)	358	(30.7)	733	(62.8)	
Upper secondary	122	(5.2)	530	(22.5)	1 701	(72.3)	
Short-cycle tertiary education	23	(4.2)	111	(20.4)	411	(75.4)	
Bachelor or equivalent	17	(2.2)	105	(13.4)	662	(84.4)	
Master or doctoral degree or equivalent	15	(1.9)	74	(9.4)	698	(88.7)	
Employment status							<0.001
Outside the labour force	13	(2.9)	55	(12.2)	382	(84.9)	
Retired based on age or service years	84	(5.9)	416	(29.5)	912	(64.6)	
Unemployed	28	(6.6)	91	(21.4)	307	(72.1)	
Employed	130	(3.9)	615	(18.4)	2 604	(77.8)	
Net income tertiles							0.001
T1 (lowest net income)	67	(3.9)	331	(19.3)	1 321	(76.8)	
T2	90	(4.6)	462	(23.8)	1 387	(71.5)	
T3 (highest net income)	98	(5.0)	385	(19.8)	1 466	(75.2)	
Missing	0	(0)	2	(6.1)	31	(93.9)	
Income support or unemployment benefit							0.223
Yes	51	(5.3)	186	(19.3)	725	(75.4)	
No	204	(4.4)	992	(21.2)	3 479	(74.4)	
Disability pension or sickness allowance							<0.001
Yes	36	(9.5)	106	(28.0)	237	(62.5)	
No	219	(4.2)	1 073	(20.4)	3 968	(75.4)	
Gambling frequency, past-year							<0.001
Daily	96	(37.6)	123	(48.2)	36	(14.1)	
Several times a week	93	(21.2)	229	(52.3)	116	(26.5)	
Once a week	55	(3.4)	633	(39.6)	911	(57.0)	
1–3 times a month or less	11	(0.3)	192	(5.8)	3 131	(93.9)	
Game types gambled, past-year							<0.001
11–18 game types	46	(25.7)	64	(35.8)	69	(38.5)	
6–10 game types	117	(13.0)	335	(37.2)	449	(49.8)	
4–5 game types	41	(3.5)	310	(26.5)	818	(70.0)	
1–3 game types	50	(1.5)	465	(13.9)	2 830	(84.6)	

Table 1 (continued)	Highest expenditure		Intermediate expenditure		Lowest expenditure		
	n = 255 (4.2 %)		n = 1 179 (20.3 %)		n = 4 204 (75.5 %)		P-value
Gambling mode, past-year							< 0.001
Multi-mode	138	(8.4)	462	(28.2)	1 040	(63.4)	
Online only	38	(4.2)	222	(24.7)	639	(71.1)	
Land-based only	68	(2.4)	447	(15.5)	2 370	(82.1)	
Do not know / missing	12	(5.6)	47	(21.9)	156	(72.6)	
Gambling severity, past-year							< 0.001
Problem gambling	73	(45.9)	56	(35.2)	30	(18.9)	
At-risk gambling	91	(13.6)	277	(41.5)	299	(44.8)	
Recreational gambling	256	(4.6)	843	(17.6)	3 865	(80.5)	

The GE groups are categorised as follows: (1) spends EUR ≥ 40.0 per week and produces 50 % of the total GE (highest GE group), (2) spends EUR 10.0–39.9 per week and produces 30 % of the total GE (intermediate GE group), and (3) spends EUR ≤ 9.9 per week and produces 20 % of the total GE (lowest GE group)

Weighted based on gender, age, education, and region of residence. Statistical significance (p) was calculated using Pearson's chi-squared test. The GE groups are: (1) spends EUR ≥ 40.0 per week and produces 50 % of the total GE (highest GE group), (2) spends EUR 10.0–39.9 per week and produces 30 % of the total GE (intermediate GE group), and (3) spends EUR ≤ 9.9 per week and produces 20 % of the total GE (lowest GE group)

the gambler was the most active (Table 1). Gambling frequency, the number of game types gambled, and gambling mode were recoded into four categories.

Gambling severity was evaluated using the 14-item Problem and Pathological Gambling Measure (PPGM) (Williams & Volberg 2010). It was classified as: (1) problem gambling (incl. pathological gambling); (2) at-risk gambling; and (3) recreational gambling (incl. those gambling less than monthly). Cronbach's alpha for PPGM was 0.842.

Statistical Analysis

The data were weighted based on gender, age, education, and region of residence. Multinomial logistic regression analyses were used to estimate the association between the level of GE, socio-demographic factors, and gambling behaviour. The results are presented as odds ratios (ORs) and their 95 % confidence intervals (95 % CIs). The lowest GE group was used as the reference group. Multinomial logistic regression was conducted using IBM SPSS Statistic software version 27.0 (IBM Corp. Released 2020). The cumulative GE by PPGM and the cumulative GE by income tertiles were constructed using R software version 3.5.1 (R Core Team 2020). The respondents providing no GE information or PPGM information were excluded from the analyses.

Results

Of the total GE, 18.8 % was produced by those with a gambling problem, 32.2 % by those with at-risk gambling pattern and 49.0 % by recreational gambling (Fig. 1). 4.2 % of gamblers produced 50.0 % of the total GE. Among these high-intensity consumers, 33.1 % of GE was produced by those with a gambling problem and 43.3 % by those with at-risk gambling pattern.

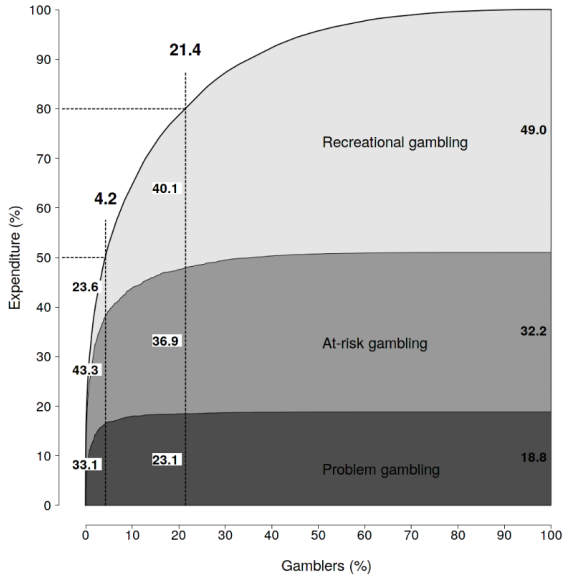

Fig. 1 Cumulative GE by PPGM in 2016

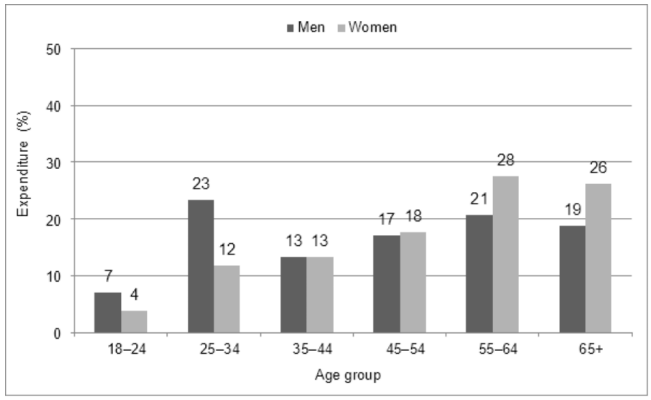

Fig. 2 The total GE of men and women gamblers by age group in 2016

21.4% of gamblers produced 80.0% of the total GE. In this group, 23.1% of GE was produced by those with a gambling problem, 36.9% of GE by those with at-risk gambling, and 40.1% by recreational gambling. The group with the lowest GE produced 20% of the total GE.

GE, Socio-Demographics and Gambling Behaviour In the highest GE group (n=255), the proportions of men and those aged 55 or older were higher compared with women and younger participants (Table 1). The intermediate GE group comprised of 20.3% of gamblers (n=1 179), and the lowest GE group of 75.5% of gamblers (n=4 204). In the lowest GE group, the proportion of 18–24-year-olds was the largest. GE differed between age groups (Fig. 2). Among men, 25–34-year-olds accounted for 23% of men's total GE, while the corresponding figure among women was only 12%. On the other hand, 55-year-old or older

women accounted for 54% of women's total GE, while the corresponding figure among men was 40%.

In the highest GE group, the proportions of those with upper secondary education, the unemployed or those on income support, those on statutory retirement, those with the lowest net income, and those who had received disability pension or sickness allowance were higher than of the proportions of the other groups (Table 1). The proportions of those gambling several times a week and gambling six or more game types were higher. The participants who gambled multi-mode or online were more often in the highest GE group compared to those who gambled only land-based. In addition, the proportion of at-risk or problem gambling (ARPG) was higher than the proportion of recreational gamblers. The corresponding figures for those in the intermediate GE group were fairly similar.

Multinomial Logistic Regression Compared to the lowest GE group, those in the highest GE group had higher odds of being male, aged 25 or older, having upper secondary education level or information of their education was missing, having high income, and receiving disability pension or sickness allowance (Table 2). In addition, they had higher odds of gambling at least once a week, at least six game types or more, and having an ARPG pattern.

Table 2 The association between gambling expenditure (GE) groups, socio-demographic factors and gambling behaviour in 2016: multinomial logistic regression

	Highest expenditure versus lowest expenditure			Intermediate expenditure versus lowest expenditure		
	OR	95% CI	P-value	OR	95% CI	P-value
Gender						
Men	*2.5*	*1.70, 3.73*	<0.001	*1.8*	*1.55, 2.18*	<0.001
Women	Ref.			Ref.		
Age						
65+	*40.9*	*12.20, 137.31*	<0.001	*5.5*	*3.15, 9.73*	<0.001
55–64	*27.5*	*9.94, 75.87*	<0.001	*4.6*	*2.90, 7.32*	<0.001
45–54	*9.1*	*3.32, 24.95*	<0.001	*2.8*	*1.79, 3.01*	<0.001
35–44	*5.3*	*1.94, 14.32*	0.001	*1.9*	*1.22, 3.05*	0.005
25–34	*7.5*	*2.81, 20.06*	<0.001	*1.8*	*1.15, 2.81*	0.010
18–24	Ref.			Ref.		
Education level						
Missing	*2.5*	*1.17, 5.31*	0.018	*2.5*	*1.76, 3.54*	<0.001
Upper secondary	*2.3*	*1.11, 4.58*	0.024	*2.3*	*1.66, 3.13*	<0.001
Short-cycle tertiary education	1.5	0.64, 3.54	0.347	*1.5*	*1.04, 2.22*	0.031
Bachelor or equivalent	1.3	0.54, 3.14	0.555	1.4	0.98, 2.05	0.068
Master or Doctoral or equivalent	Ref.			Ref.		
Employment status						
Outside the labour force	1.6	0.64, 3.76	0.327	1.1	0.70, 1.66	0.730
Retired based on age or service years	1.1	0.53, 2.01	0.887	1.0	0.67, 1.41	0.922
Unemployed	1.4	0.67, 3.01	0.366	0.9	0.63, 1.39	0.749
Employed	Ref.			Ref.		
Net income tertiles						
T1 (low net income)	*0.6*	*0.39, 1.00*	0.049	*0.8*	*0.61, 0.96*	0.019
T2	Ref.			Ref.		
T3 (high net income)	*2.0*	*1.30, 3.15*	0.002	1.1	0.86, 1.32	0.575

Table 2 (continued)

	Highest expenditure versus lowest expenditure			Intermediate expenditure versus lowest expenditure		
	OR	95% CI	P-value	OR	95% CI	P-value
Income support or unemployment benefit						
Yes	0.8	0.44, 1.40	0.788	0.8	0.63, 1.11	0.218
No	Ref.			Ref.		
Disability pension or sickness allowance						
Yes	*2.0*	*1.08, 3.83*	0.028	1.3	0.93, 1.86	0.128
No	Ref.			Ref.		
Gambling frequency, past-year						
Daily	*224.8*	*104.43, 483.67*	<0.001	*24.9*	*16.36, 37.99*	<0.001
Several times a week	*76.3*	*37.70, 155.00*	<0.001	*15.2*	*11.38, 20.41*	<0.001
Once a week	*10.0*	*5.05, 19.77*	<0.001	*7.5*	*6.16, 9.02*	<0.001
1–3 times a month or less	Ref.			Ref.		
Game types gambled, past-year						
11–18 game types	*18.5*	*9.01, 37.88*	<0.001	*3.9*	*2.44, 6.27*	<0.001
6–10 game types	*5.7*	*3.48, 9.23*	<0.001	*3.1*	*2.41, 3.98*	<0.001
4–5 game types	1.4	0.85, 2.35	0.182	*1.8*	*1.45, 2.21*	<0.001
1–3 game types	Ref.			Ref.		
Gambling mode, past-year						
Multi-mode	1.4	0.92, 2.26	0.112	*1.4*	*1.08, 1.68*	0.007
Online	1.1	0.67, 1.86	0.692	1.2	0.98, 1.55	0.073
Land-based	Ref.			Ref.		
Do not know / missing	1.2	0.50, 2.88	0.685	1.2	0.77, 1.78	0.466
Gambling severity, past-year						
Problem gambling	*29.5*	*15.38, 56.64*	<0.001	*3.7*	*2.16, 6.50*	<0.001
At-risk gambling	*3.4*	*2.31, 5.07*	<0.001	*1.8*	*1.42, 2.24*	<0.001
Recreational gambling	Ref.			Ref.		
R^2 (Nagelkerke)		0.53				
N		5 564				

The GE groups are: (1) spends EUR ≥40.0 per week and produces 50% of the total GE (highest GE group), (2) spends EUR 10.0–39.9 per week and produces 30% of the total GE (intermediate GE group), and (3) spends EUR ≤9.9 per week and produces 20% of the total GE (lowest GE group). The lowest GE group is the reference group

Weighted based on gender, age, education, and region of residence. Note: OR = odds ratio, CI = confidence interval. The reference group is gamblers that spend EUR ≤ 9.9 per week and produce 20% of the total GE. The GE groups are: (1) spends EUR ≥ 40.0 per week and produces 50% of the total GE (highest GE group), (2) spends EUR 10.0–39.9 per week and produces 30% of the total GE (intermediate GE group), and (3) spends EUR ≤ 9.9 per week and produces 20% of the total GE (lowest GE group)

Compared to the lowest GE group, those in the intermediate GE group had higher odds of being male, aged 25 or older and having upper secondary education, short-cycle tertiary education, or information of their education was missing. Low income indicated lower odds of being in the intermediate GE group. Furthermore, gambling at least once a week, gambling at least four game types, gambling multi-mode and having and ARPG pattern had higher odds of being in the intermediate GE group.

Cumulative Weekly GE by Income Tertiles

When cumulative weekly GE by income tertiles were examined, only past-year gamblers, those who had participated in both Waves and whose income information was available were included in the analysis (non-weighted). In 2016 (n=2 140), 20.6% of the total GE was produced by those with low net income (T1), 51.1% of the total GE by those with intermediate net income (T2) and 27.9% of the total GE by those with high net income (T3) (Fig. 3). In the group of 22.0% that produced 80.0% of the total GE, 19.2% of GE was produced by those with low income, 55.0% by those with intermediate income and 25.8% of GE by those with high income. In the group of 4.2% of gamblers that produced 50.0% of the total GE, 14.7% of GE was produced by those with low income, 65.4% by those with intermediate income and 19.8% by those with high income.

In 2017 (n=2 090), 22.7% of the total GE was produced by those with low income, 47.1% by those with intermediate income and 30.3% by those with high income (Fig. 4). In the group of 19.1% that produced 80.0% of the total GE, 21.9% of GE was produced by those with low income, 49.7% of GE by those with intermediate income and 28.4% of GE by those with high income. In the group of 2.3% that produced 50.0% of the total GE, 18.6% of GE was produced by those in with low income, 56.3% of GE by those with intermediate income and 25.2% of GE by those with high income.

Discussion

In the present study, a small group of gamblers (4.2%) produced half (50.0%) of the total GE in 2016. This result is in line with earlier research indicating that GE is highly concentrated (Salonen et al., 2017; Salonen et al., 2019; Salonen et al., 2020; Williams et al.,

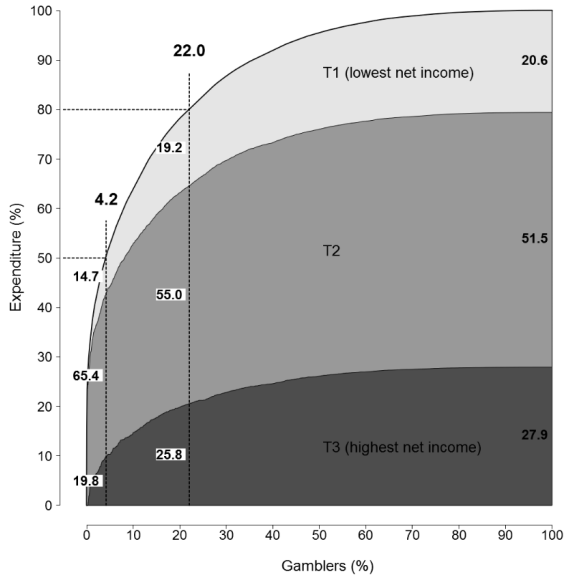

Fig. 3 Cumulative expenditure by income tertiles in 2016

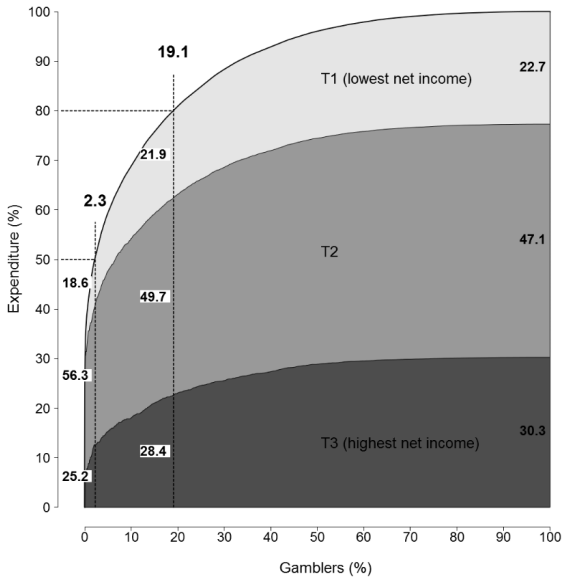

Fig. 4 Cumulative expenditure by income tertiles in 2017

2011). In Finland, corresponding figures have varied from 2.2 to 5.2% of gamblers that produce half of the gambling revenue (Salonen et al., 2017; Salonen et al., 2019; Salonen et al., 2020).

In this study, of the total GE, half of the money came from persons with ARPG. Among the small group of high-intensity consumers, 76.4% of the revenue came from ARPG. Gamblers with disordered gambling typically spend more money on gambling than they intended to, are unable to control their gambling, and take debts in order to continue gambling. In addition, they typically continue gambling to recover previous losses, often with increasing the size of bets (American Psychiatric Association 2013). Despite the fact that higher GE was clearly linked with ARPG, all GE groups had encountered ARPG. Among people with a low socio-economic status, even small losses can cause GRH.

Overall, respondents in the low GE group differed from those in the intermediate and high GE groups. Those in the highest or intermediate GE group were more likely to be male which is in accordance with earlier studies (McCormack et al., 2014; Roukka & Salonen 2020; Salonen et al., 2020). This may be related to the nature of the games men favour. While men tend to prefer strategic games such as poker and sport betting, particularly online (Wardle et al., 2011), women tend to prefer non-strategic games such as scratch cards (Salonen & Raisamo 2015). These strategic game types have fast gambling speed and high stakes, which expose men to higher GE than women.

Compared to the lowest GE group, those in the highest or intermediate GE group were less likely to be 18–24-year-old. Older adults (≥55 years) spent the most. Older adults still in employment may have more money to spend on gambling (Castrén et al., 2018). Among the retired adults, fixed incomes and limited prospects of future earnings make them a vulnerable group (Subramaniam et al., 2014). This is especially the case among older women, as they often face a higher poverty risk than older men (Nygård et al., 2017). In the present study, 55 years or older women accounted for 54% of women's total GE, while the corre-

sponding figure among men was 40 %. Opposite results have also been observed in terms of the association between age and GE. Previous studies have found that GE increases until the middle age and starts to drop after that (Mikesell 1991; Scott & Garen 1994).

Those in the highest or intermediate GE group had a lower education level than those in the lowest GE group. This finding is in line with prior research suggesting that low education is associated with higher GE (Worthington et al., 2003; Davidson et al., 2016; Salonen et al., 2017; Salonen et al., 2018a). According to a Finnish study conducted in 2017, 70.9 % of the total GE was produced by those with upper secondary or short-cycle tertiary education. Those with a bachelor's degree or higher produced 13.0 % of total GE. (Salonen et al., 2017.) An Australian study found that the difference of gambling spending between educational groups is particularly high in EGMs. Those with low education lost on average 6.5 times more on EGMs than those with a degree. (Davidson et al., 2016.) The density of EGMs is the highest in areas of socio-economic disadvantage (Wardle et al., 2014; Raisamo et al., 2019). Overall, EGM density and high GE are positively correlated (Vasiliadis et al., 2013), which highlights the need for further research taking into account the game types.

Those in the highest GE group had a higher net income than those in the lowest GE group. This is consistent with previous results (Williams et al., 2011; Salonen et al., 2020). However, studies have also shown that those with lower income spend more on gambling (Beckert & Lutter 2009; Bol et al., 2014). In relation to the gambler's net income, people with lower income have been found to spent more on gambling than those with higher net income (Castrén et al., 2018). Employment status and income support or unemployment benefit were not associated with the level of GE. Those who had received disability pension or sickness allowance had a higher GE than of those without these benefits. This result is supported by previous studies (Salonen et al., 2019; Roukka & Salonen 2020). Overall, poor health is shown to be associated with higher GE (Salonen et al., 2017).

Compared to the lowest GE group, those in the highest or intermediate GE group gamble more often, gamble more game types and more often engage in multi-mode gambling. These findings are consistent with what has been found in earlier studies (Salonen & Raisamo 2015; Salonen et al., 2017; Salonen et al., 2020). Gambling frequency has been shown to be the strongest indicator of high GE (Salonen et al., 2018a).

The proportion of intermediate income was higher in the group of gamblers that produced 50.0 % of the total GE than in the group of all gamblers that produced 100.0 % of the GE. It is noteworthy that the proportion of the first net income tertile is not considerably lower in the small group of gamblers that produced 50.0 % of the total GE than in the group of all gamblers that produced 100.0 % of the GE. This result was observed for both 2016 and 2017.

Strengths and Limitations Self-reported data were used as in most gambling studies (Shaffer et al., 2010). Studies evaluating the accuracy of self-reported data with actual data provided by gambling operator indicate that respondents tend to underestimate the amount spent on gambling (Braverman et al., 2014; Auer & Griffiths 2017), but self-reported loss still correlates with the actual loss (Auer & Griffiths 2017). Furthermore, the respondents did not consistently indicate a favourable distortion of their gambling losses or gains, as they underestimated or overestimated their gambling outcomes (Braverman et al., 2014). The format of the question being asked and how the respondents are instructed can affect the responses (Blaszczynski et al., 2006; Wood & Williams 2007). Herein, the participants were

asked to estimate their GE based on the frequency of their choice, which may have contributed into rather small amount of missing data (see Salonen & Raisamo 2015; Salonen et al., 2020). Finally, those with higher gambling losses and those experiencing GRHs have more difficulties estimating their spending on gambling accurately (Braverman et al., 2014; Auer & Griffiths 2017). Gambling severity was not based on medical diagnosis but was evaluated by using Problem and Pathological Gambling Measure (PPGM).

Conclusions

This study confirmed that GE is highly concentrated on the small group of gamblers. In the group of high-intensity consumers, the most of the GE was produced by those with ARPG patterns. In addition to the highest GE group, ARPG occurred in the lowest and intermediate GE group. It is noteworthy that those with ARPG often face other challenges as well, such as financial difficulties, substance abuse and mental health problems (Hodgins et al., 2011; Lorains et al., 2011; Castrén et al., 2013). These challenges are further aggravated by gambling. Participants in the lowest GE group differed from those in the intermediate and highest GE group in terms of their socio-demographic background and gambling behaviour. Cumulative weekly GE by income tertiles remained fairly stable between the two study years. In order to make gambling policy more responsible, the group of high-intensity consumers should be considered better in strategies to prevent and reduce the gambling-related financial, health-related, and social harm.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10899-021-10075-6.

Contributions TG, AK, JK and AHS conceived, designed, and planned the study. The data were analysed by TG and JK prepared the expenditure curves. TG, AK, JK and AHS interpreted the results. TG wrote the first draft of the article. TG, AK, JK and AHS critically revised the article for important intellectual content.

Role of Funding Sources Open access funding provided by Finnish Institute for Health and Welfare (THL). The Gambling Harms survey was funded by the Ministry of Social Affairs and Health, Finland, within the objectives of the § 52 Appropriation of the Lotteries Act. Daily work of the author TG (01.06.2019–31.08.2019), JK and AHS at the Finnish Institute for Health and Welfare, Finland, was also funded by the Ministry. Furthermore, doctoral thesis work of TG was supported by grants based on the funding from the Ministry but granted by the Finnish Foundation for Alcohol Studies. AK was supported by the Economic and Social Research Council (ESRC) (grant ES/S00744X/1). The funders have had no role in the study design, analysis, or interpretation of the results of the manuscript or any phase of the publication process. Future opportunities of the authors are not contingent upon the results of the research.

Availability of Data and Materials The Gambling Harms Survey 2016 and 2017 datasets are available from the Finnish Social Science Data Archive (https://www.fsd.tuni.fi/en/).

Ethical Approval The Ethics Committee of the Finnish Institute for Health and Welfare has approved the Gambling Harms Survey (THL/1390/6.02.01/2016). Potential participants were aware of the voluntary participation and gave verbal informed consent. In accordance with the national data protection regulations of the time, potential participants received information that participating the study involved the register-linkage. In the letter to potential participants, information about the registrars and their statutory right to disclose data for scientific purposes were described. The Ethics Committee of Statistics Finland has given approval (5/2016, 17.11.2016) to the use of socio-demographic data and an application for the licence has been approved (Dnro TK-53-1418-18). The results of the study are presented in such a way that the respondents cannot be identified on the basis of the results.

Conflict of Interest Declaration The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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European Journal of Public Health, 2025, ckaf216
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https://doi.org/10.1093/eurpub/ckaf216

Health risk behaviours, obesity, and gambling severity: findings from a nationwide population study

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Abstract

Prior research on the relationship between health risk behaviours (HRBs), obesity, and gambling has primarily focused on problem gambling, while studies focusing on lower severity levels are scarce. Moreover, this relationship has rarely been analysed separately for women and men. This study aimed to investigate the association between HRBs, obesity, and the full spectrum of gambling severity in women and men. Cross-sectional population-based data from Healthy Finland Survey 2022–23 was exploited, including adults aged 20+ years ($n = 28\,154$, response rate 46%, mean age 52 years). The Problem Gambling Severity Index (PGSI) was used as the dependent variable, both in continuous (score 0–27) and categorical (non-problem, low-risk, moderate-risk, and problem gambling) form. Independent variables included HRBs (daily smoking, excessive drinking, low fruit and vegetable (F & V) consumption, low physical activity, and insufficient sleep) and obesity. Sociodemographic factors, suboptimal self-rated health, and psychological distress were adjusted for. Daily smoking, excessive drinking, low F & V consumption, and insufficient sleep were less prevalent in the non-problem gambling category (PGSI score = 0) compared to the low-risk (score 1–2), moderate-risk (score 3–7), and problem gambling (score ≥8) categories. After adjusting for potential confounding variables, all HRBs and obesity, except for physical inactivity, were significantly associated with higher PGSI scores. These findings highlight the need for public health strategies that address gambling across the entire risk spectrum. Moreover, a holistic approach that considers the individual's broader life context could strengthen both research and prevention efforts.

Introduction

The global gambling industry is expanding rapidly, driven by digitalization, which has made gambling more accessible than ever through mobile phones and the internet. Alongside this, gambling is a crowing public health threat, causing a wide range of harm to an individual's health and well-being, but also to families, communities, and societies [1]. A recently published meta-analysis estimated that 1.4% of adults worldwide had engaged in problem gambling, an intermediate or subclinical form of gambling disorder [2]. However, this prevalence rate does not fully capture the extent of gambling-related harm experienced by people who gamble. Evidence suggests that most gambling-related harm occurs among individuals with low- and moderate-risk gambling, simply because they are more prevalent in the population than those with problem gambling, who still face a higher individual risk of harm [3]. This phenomenon is referred to as the 'prevention paradox' [4]. It is estimated that 9% of adults worldwide engage in low-risk, moderate-risk, or problem gambling [2], with the first two categories referring to gambling that causes some harm and often precedes the development of problem gambling.

Gambling often co-occurs with other health risk behaviours (HRBs). HRBs can be defined as any activity undertaken by individuals with a frequency or intensity that increases risk of disease or injury [5]. Prior research has shown that 19% of individuals with low-risk gambling and 31% of those with moderate-risk or problem gambling engage in at least two HRBs [6]. If multiple HRBs occur simultaneously, they can exacerbate one another. For example, excessive drinking may serve as a coping mechanism for anxiety related to gambling, but it can also trigger the urge to gamble. Moreover, co-occurring HRBs may further increase the risk of health problems or worsen the existing ones, leading to a lower quality of life, and, at the societal level, increased healthcare costs. Several studies have shown that gambling problems are strongly linked to various physical and mental health conditions [7, 8].

There is strong evidence that excessive drinking, smoking, and drug use are associated with gambling problems of varying severity [6, 9–12]. However, the relationship between gambling and other HRBs, such as an unhealthy diet, low physical activity, and insufficient sleep, has been less studied. Nonetheless, some evidence suggests that individuals with gambling problems have higher rates of these HRBs [6, 9–11, 13], as well as obesity [9].

To our knowledge, previous studies on the relationship between gambling, HRBs, and obesity have primarily focused on problem gambling and gambling disorder, rather than the full spectrum of risk severity. An exception to this, however, are studies examining gambling and substance use. This research gap has been due to the problem gambling measures used or sample sizes being too small to analyse different severity levels separately. To have more comprehensive understanding of the link between gambling, HRBs, and obesity, it is crucial to extend the analyses to lower severity levels [6]. Moreover, research on these aspects separately among men and

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women remains limited, despite the clear evidence that HRBs are gendered in the general population. Men are more likely than women to engage in HRBs [14], and gambling and gambling problems are no exception [2].

Study aims

This study aims to examine the associations between HRBs, obesity, and gambling severity among Finnish women and men, using a nationally representative population sample ($n = 28\ 154$). Gambling severity is assessed across non-problem, low-risk, moderate-risk, and problem gambling levels. The analysis controls for sociodemographic factors, suboptimal self-rated health, and psychological distress.

Methods

Data and sample

The data were drawn from the cross-sectional, population-based Healthy Finland survey, collected by the Finnish Institute for Health and Welfare (THL) between September 2022 and February 2023 [15]. A nationally representative sample of 61 600 permanent residents of Finland, aged 20+ years, was retrieved using a stratified random sample. Responses were collected via online and paper questionnaire in four languages: Finnish, Swedish, Russian, and English. A total of 28 154 (46%) individuals responded to the survey.

Measures

Problem gambling severity index

The problem gambling severity index (PGSI) [16], consisting of nine self-reported questions, was used in defining past-year gambling severity. The PGSI items have a four-point scale (0 = never, 1 = sometimes, 2 = most of the time, 3 = almost always). The total scores (range 0–27) were classified as non-problem gambling (score = 0), low-risk gambling (score = 1–2), moderate-risk gambling (score = 3–7), and problem gambling (score ≥8). The PGSI total score was also used as a continuous variable. The questionnaire included the following text before the gambling-related questions: 'Gambling refers to playing games for example lottery games, slot machines, scratch cards, sports and horse games, betting games which are also available online'. The Finnish and Swedish translations were finalized in collaboration with multiprofessional experts and have been used in several population studies in Finland; however, no separate validation study has been conducted.

Health risk behaviours

Daily use of tobacco or nicotine products was based on two questions: one on current smoking (cigarettes, cigars, or pipe) and another on the use of snus, e-cigarettes with nicotine, heated tobacco, or nicotine pouches. Response options were daily, occasionally, not at all, and never. Participants reporting 'daily' use to either question were classified as daily users. Alcohol consumption was assessed using the alcohol use disorder identification test for consumption (AUDIT-C), a three-item screening tool designed to identify hazardous drinking and potential alcohol use disorder [17]. The AUDIT-C uses a five-point Likert scale (range 0–4). Total scores were calculated by summing the points for each item. Excessive drinking was defined using the following cut-off points: ≥6 for men aged 20–64, ≥5 for women aged 20–64, and ≥4 for both men and women aged 65+ years [18]. Insufficient sleep was defined as rarely or hardly ever having enough sleep based on the question 'Do you feel that you get enough sleep?'. Low fruit and vegetable (F & V) consumption was defined as eating vegetables/root vegetables (excluding potatoes) or fruits/berries (excluding juices) less than daily, based on questions about usual consumption frequency [19]. Low physical activity, assessed using two sets of questions, was defined as (i) <2 h 30 min of moderate-intensity endurance training or 1 h 15 min of high-intensity endurance training per week, and (ii) two sessions of exercise maintaining or developing muscle health. Based on self-reported weight and height, obesity was defined as BMI ≥30 kg/m^2 [20].

Suboptimal self-rated health and psychological distress

Based on the question 'How would you describe your state of health at present?', participants who reported their health as average or below were categorized as having suboptimal self-rated health [21]. Psychological distress was assessed with the Mental Health Inventory (MHI-5), a five-item scale measuring anxiety, depression, and positive mood [22]. Response options ranged from 1 (all the time) to 6 (not at all). To calculate the final score, items c) and e) were reverse-coded, the scores were summed, and the raw scores were transformed to a scale ranging from 0 to 100. Psychological distress was defined as a score 52 or below [23].

Sociodemographic variables

Other variables used as covariates were age (20–29, 30–44, 45–59, 60–74, and 75+), sex (women/men), education level (low, intermediate, and high), household's annual income before taxes (€15 000 or less, €15 001–35 000, €35 001–55 000, and €55 001 or more), and family structure (living alone, family with children, family with only adults). The information on age and sex were obtained from the register of the Digital and Population Data Service Agency. Education level and household annual income was based on self-reported information.

Statistical analysis

Analyses used weights based on age, sex, marital status, education level, first language, and area of residence. These weights were created using the Inverse Probability Weighting method, which has been applied in various population surveys and is also shown to be suitable for correcting the non-response in the Finnish population [15]. Descriptive statistics of the study population are presented in Supplementary Table S1. The mean age of the participants was 52 years (standard deviation, SD = 19; women: 53 years, SD = 19; men: 51 years, SD = 18). For descriptive purposes, the proportions of HRBs and obesity across PGSI categories were analysed. Statistical differences were assessed using the Chi-squared test (Fig. 1; Supplementary Tables S3–S5). Negative binomial regression analysis was used to examine associations between HRBs, obesity, and gambling severity (Table 1), since there was overdispersion in the continuous dependent variable (PGSI score), but no zero-inflation. The negative binomial coefficients were reported as incidence rate ratios (IRRs) with their 95% confidence intervals (CIs). The models were adjusted for sex, age, net income, and education level, as well as for suboptimal self-rated health and psychological distress. A Wald test was used to evaluate whether sex interacted with HRBs or obesity. Analyses were conducted with IBM SPSS Statistics 29.0.2.0 and R 4.3.3.

Ethics

The necessary research permits were obtained for the Healthy Finland survey [15]. Potential participants received written study information, and the principles of voluntary participation. Completing the questionnaire was taken as consent. The Ethics committee of the THL approved the research protocol (THL/72/6.02.01/2022). The data underlying this article cannot be shared publicly due to confidentiality concerns that could compromise the participant privacy. However, the data may be shared upon reasonable request with collaborators, subject to a collaboration agreement [15]. The study results are presented in a manner that

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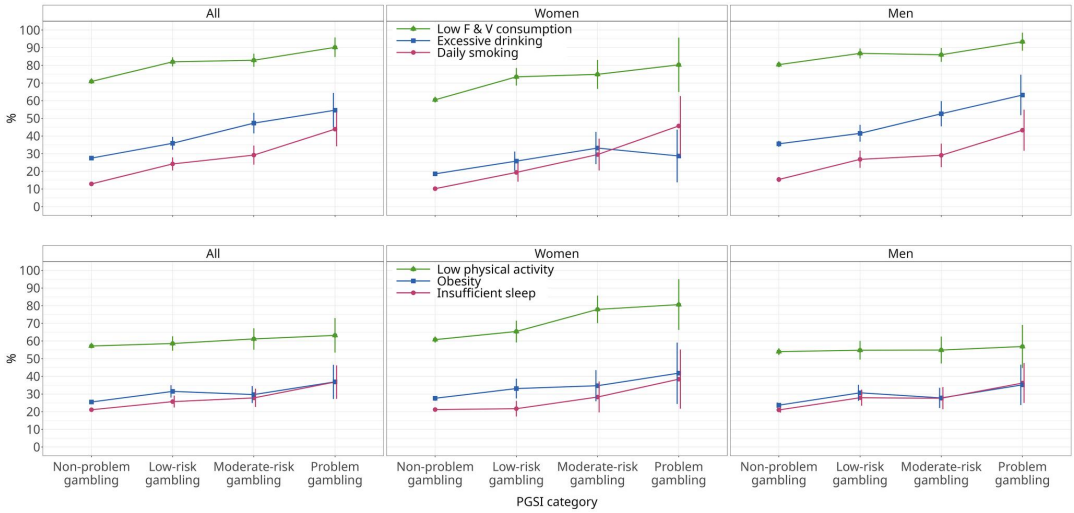

Figure 1. Prevalences of health risk behaviours (HRBs) and obesity by the problem gambling severity index (PGSI) category among women and men (%).

Table 1. Association between health risk behaviours (HRBs), obesity, and the problem gambling severity index (PGSI) score among participants who gambled within past 12 months.[a]

	All			Women			Men		
Characteristics	**IRR**	**95% CI**	***P***	**IRR**	**95% CI**	***P***	**IRR**	**95% CI**	***P***
Daily smoking									
Yes	2.1	1.7–2.4	<.001	2.8	2.1–3.9	<.001	1.8	1.5–2.2	<.001
No	Ref.			Ref.			Ref.		
Excessive drinking									
Yes	1.4	1.2–1.6	<.001	1.5	1.2–2.0	.002	1.5	1.3–1.8	<.001
No	Ref.			Ref.			Ref.		
Low F & V consumption									
Yes	1.3	1.2–1.6	<.001	1.4	1.1–1.8	.007	1.2	1.0–1.5	.050
No	Ref.			Ref.			Ref.		
Insufficient sleep									
Yes	1.3	1.1–1.5	.003	1.2	1.0–1.6	.11	1.2	1.0–1.5	.030
No	Ref.			Ref.			Ref.		
Low physical activity									
Yes	1.0	0.9–1.1	.8	1.3	1.0–1.6	.039	0.8	0.7–1.0	.013
No	Ref.			Ref.			Ref.		
Obesity									
Yes	1.4	1.2–1.6	<.001	1.5	1.2–1.9	<.001	1.2	1.0–1.5	.017
No	Ref.			Ref.			Ref.		

a: Negative binomial regression was used to examine associations between HRBs, obesity, and gambling severity. Adjusted for socio-demographic factors, suboptimal self-rated health, and psychological distress (MHI-5). Weighted data based on age, sex, marital status, education level, first language, and area of residence. The PGSI score was used as continuous variable. Alcohol consumption was assessed using the AUDIT-C. Obesity was defined as BMI ≥30 kg/m^2. CI = confidence interval; IRR = incidence rate ratio; low F & V consumption = low food and vegetable consumption.

the participants cannot be identified. The STROBE checklist was used to report the results (Supplementary Table S2).

Results

Prevalence of HRBs and obesity by gambling severity

Figure 1 presents the prevalence of HRBs and obesity by gambling severity (Supplementary Table S3). Daily smoking, excessive drinking, low F & V consumption, and insufficient sleep were clearly associated with gambling severity. Their prevalence was lower in the non-problem gambling category compared to low-risk, moderate-risk, and problem gambling categories. Additionally, daily smoking, excessive drinking, and low F & V consumption were more prevalent in the problem gambling group than in the low-risk group. For obesity, prevalence was higher in the low-risk category than in the non-problem category, but similar across moderate-risk and problem gambling groups.

Among both women and men, daily smoking and low F & V consumption were less prevalent in the non-problem gambling

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category compared to the low-risk, moderate-risk, and problem gambling categories (Fig. 1; Supplementary Tables S4 and S5). In addition, among women, low physical activity was less prevalent in the non-problem gambling category compared to the moderate-risk and problem gambling categories. Among men, excessive drinking was less prevalent in the non-problem gambling category compared to the moderate-risk and problem gambling categories.

Association between health risk behaviours, obesity, and PGSI score

After controlling for sociodemographic factors, suboptimal self-rated health, and psychological distress, each HRB and obesity were significantly associated with the PGSI score, apart from low physical activity (IRR = 1.0; 95% CI = 0.9–1.1) (Table 1; Supplementary Table S6). Daily smoking more than doubled the PGSI score (IRR = 2.1; 95% CI = 1.8–2.4), while excessive drinking (IRR = 1.4; 95% CI = 1.2–1.6), low F & V consumption (IRR = 1.3; 95% CI = 1.2–1.6), insufficient sleep (IRR = 1.3; 95% CI = 1.1–1.5), and obesity (IRR = 1.4; 95% CI = 1.2–1.6) also increased the score. The results were largely similar even when only sociodemographic factors were controlled for in the model (Supplementary Table S6). There were interactions between sex and daily smoking ($P = .012$), and between sex and low physical activity ($P = .001$).

Among women, after controlling for potential confounder, each HRB and obesity was associated with an increased PGSI score (Table 1; Supplementary Table S7), except for insufficient sleep. Among women, low physical activity slightly increased the PGSI score (IRR = 1.3; 95% CI = 1.0–1.6), whereas among men, it slightly decreased it (IRR = 0.8; 95% CI = 0.7–1.0). Among men, after controlling for potential confounders, all other HRBs and obesity increased the PGSI score (Table 1; Supplementary Table S8).

Discussion

Previous research on the relationship between HRBs, obesity, and gambling has mainly focused on problem gambling, with limited studies on lower levels of gambling severity. Moreover, few studies have examined this relationship separately for women and men. This study contributed to filling this gap by examining the relationship between HRBs, obesity, and the full spectrum of gambling severity in women and men using a large, nationally representative population sample. Compared to the participants with non-problem gambling, many HRBs were more prevalent not only among those with problem gambling but also among those with low- and moderate-risk gambling. Furthermore, nearly all HRBs and obesity were associated with higher PGSI score, even after controlling for potential confounders. Among women, all HRBs and obesity were associated with higher PGSI score, except for insufficient sleep. Among men, largely similar patterns were observed; however, low physical activity was associated with lower PGSI score, whereas insufficient sleep was associated with higher scores.

Our results support earlier research suggesting that the relationship between gambling and HRBs is not limited to severe gambling problems [6]. From a public health perspective, this is crucial, as individuals in the low- and moderate-risk categories represent far larger share of the population compared to those with problem gambling. Based on Healthy Finland survey used in this present study, 8% of adults engage in low- or moderate-risk gambling, while 1.1% engage in problem gambling. Consequently, the potential negative consequences of co-occurring HRBs may affect a broader portion of the population. Co-occurrence of multiple HRBs can elevate the risk of new or worsening health problems, increasing the burden on individuals and contributing to higher societal and healthcare costs. Moreover, individuals engaging in low- and moderate-risk gambling may progress to more severe gambling problems over time [24], a process that may be accelerated by the presence of other HRBs. This potential interaction between gambling and other HRBs warrants further investigation to better understand the compounding risks and to inform more integrated public health interventions.

This study also found that almost each HRB and obesity were significantly associated with a higher PGSI score. The results were largely similar even after controlling for potential confounders such as psychological distress. This was somewhat surprising, as stress is strongly associated with HRBs [25], possibly because individuals tend to cope with negative emotions by engaging in risky yet often pleasurable behaviours such as eating high-fat and sugary foods [26]. It is likely that a range of other underlying mechanisms also play a role in engaging in HRBs. For example, impulsivity have been identified as psychological trait that may underlie both gambling behaviours and HRBs [27]. In future research, linking national health registers with survey data would allow for the investigation of the relationship between gambling severity and other HRBs, while controlling for impulsivity-related variables. These results underline the importance of integrated interventions that address not only gambling but also co-occurring HRBs. Screening for HRBs in gambling treatment settings, and vice versa, could be a crucial step in identifying individuals at heightened risk and provide more holistic care.

Low physical activity was the only HRB that was not significantly associated with PGSI score, which aligns with previous research [6]. However, when analyses were stratified by sex, low physical activity was associated with slightly higher PGSI scores among women and slightly lower scores among men. It is likely that because of the opposite directions of the associations in men and women, the overall analysis combining both sexes did not reveal a significant relationship between low physical activity and PGSI score. Although low physical activity was a relatively weak risk factor compared to other HRBs and obesity among both sexes, it still represents a noteworthy finding. One possible explanation for the observed sex differences is that women are more likely than men to use gambling as a coping mechanism for negative emotions such as stress, anxiety, and depression, which have also been linked to lower levels of physical activity [28, 29]. Another point to consider is the role of age. Based on the Healthy Finland survey used in the present study, men with gambling problems are typically relatively young, whereas among women, gambling problems are more evenly distributed across different age groups. Young men are more likely than women to participate in competitive team sports, and participation is such sports has been associated with a higher likelihood of experiencing gambling problems [30]. This association may be partly explained by the desire to win, which serves as a motivational factor underlying both gambling and engagement in competitive team sports [31]. Overall, these contrasting findings underscore the importance of conducting sex-specific analyses; otherwise, important associations may remain undetected. The complex and potentially sex-specific relationship between physical activity and gambling problems also highlights the need for further research in this area.

The findings of the present study highlight the importance of preventive efforts that go beyond to individuals with severe gambling problems to address the broader population engaged in gambling at any risk level. The lower-risk gambling guidelines (LRGG) represent a population-level evidence-informed tool for primary prevention, aiming to reduce harm before it occurs by promoting clear, actionable limits. Finland is on track to implement national guidelines in 2025, following the model of like the ones that already established for alcohol use [32, 33]. These guidelines serve a public health function comparable to those in other domains and are most effective when integrated into broad health promotion strategies. Promoting guidelines for gambling, alcohol, and nutrition together may increase impact, as HRBs tend to cluster within individuals [12, 34]. Ensuring that such tools are perceived as relevant and accessible to the public will be key to their success.

Strengths and limitations

A large, high-quality, nationally representative data allowed us to examine HRBs and obesity across the full spectrum of gambling severity. Unlike prior research, which has largely focused only on

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problem gambling, our study investigated also low- and moderate-risk gambling. Furthermore, the survey achieved a satisfactory response rate (46%). There were notable differences in participation by age group, with the lowest response rate observed among men aged 20–39 years (22%) [15]. Low response rate among young men is particularly relevant, as gambling problems are especially prevalent among them [35], suggesting that the true extent of gambling-related harm in this high-risk group may be underestimated. However, survey weights were used to mitigate the bias caused by non-participation, as register-based information (e.g. sociodemographic factors) was available for the entire sample, including non-participants. This notion is supported by a recently published study that compared crude prevalences against weighted and non-response adjusted prevalences [36]. In that online and postal survey, non-response affected the estimated prevalence of problem gambling. Non-response bias must be addressed in population surveys; the use of administrative registers can improve reliability and adjust estimates, and future research should refine detection and correction methods.

Another limitation is the use of self-reported data on HRBs and obesity. Previous studies have shown that individuals often underreport their engagement in HRBs [37]. This may be due to recall difficulties or a tendency to provide socially acceptable answers [37], particularly among individuals with high engagement in HRBs [38]. It has also been argued that individuals with high levels of HRBs may be less likely to participate in population surveys [39]. Furthermore, individuals tend to slightly overreport their height and underreport weight, yet self-reported values are considered valid measures [40]. In this study, the low physical activity variable had 16% missing data, which may have introduced bias and affected the generalizability of the results. For the other HRB and obesity variables, missing values ranged from 3% to 5%.

This cross-sectional study does not allow for causal inference; thus, it remains unclear whether gambling problems precede HRBs and obesity or vice versa. However, gambling problems and HRBs may be bidirectionally associated. For example, gambling problems may lead to insufficient sleep due to negative emotions (e.g. shame, guilt, helplessness) related to gambling, whereas insufficient sleep may impair self-control and decision-making, which, in turn, can promote detrimental gambling behaviour [13].

Conclusions

Several HRBs were less prevalent among individuals with non-problem gambling compared to those with varying degrees of gambling problems. Notably, HRBs were present not only among individuals with problem gambling but also among those with low- and moderate-risk gambling. Even after controlling for sociodemographic factors, suboptimal self-rated health, and psychological distress, almost all HRBs and obesity were associated with an increased PGSI score. These findings highlight the need for public health strategies that address gambling across the entire risk spectrum, rather than focusing only on severe gambling problems. Moreover, a holistic approach that considers the individual's broader life context could strengthen both research and prevention efforts. Gambling is already recognized as a public health concern in many jurisdictions due to its wide-ranging health, social, and economic impacts. Addressing it at all levels of risk, including among those who do not currently meet clinical thresholds, is essential for early intervention and harm reduction. Such an approach ensures that preventive measures, including public awareness, guideline promotion, and integrated health messaging, reach the broader population and contribute to long-term reductions in gambling-related harms.

Author contributions

Tanja Grönroos conceived, designed, and planned the study. Tanja Grönroos, Anne H. Salonen, and Tiina A. Latvala prepared the data request. The data were analysed and interpreted by Tanja Grönroos and Jukka Kontto. Tanja Grönroos wrote the first draft of the article. Anne H. Salonen, Tiina A. Latvala, Anne Kouvonen, Annamari Lundqvist, and Jukka Kontto reviewed and edited the manuscript. Anne H. Salonen and Anne Kouvonen supervised the article. Tanja Grönroos organized project administration. All authors read and approved the final draft.

Supplementary data

Supplementary data are available at *EURPUB* online.

Conflicts of interest: None declared.

Funding

The study was funded by the Ministry of Social Affairs and Health, Finland, within the objectives of the §52 Appropriation of the Lotteries Act. Daily work of the authors Tanja Grönroos, Tiina A. Latvala, and Anne H. Salonen at the Finnish Institute for Health and Welfare, was also funded by the Ministry. The Ministry had no role in the study design, analysis, or interpretation of the results of the manuscript or any phase of the publication process.

Data availability

The data underlying this article cannot be shared publicly due to confidentiality concerns that could compromise the participant privacy. However, the data may be shared upon reasonable request with collaborators, subject to a collaboration agreement. More information on the survey data can be requested from the Healthy Finland research group (tervesuomi@thl.fi).

Key points

- Daily smoking, excessive drinking, low fruit and vegetable (F & V) consumption, and insufficient sleep were less prevalent among individuals with non-problem gambling compared to those with varying degrees of gambling problems.
- These HRBs were present not only among individuals with problem gambling but also among those with low- and moderate-risk gambling.
- After controlling for potential confounders, nearly all HRBs and obesity were associated with increased PGSI score.
- Low physical activity was the only exception, showing opposite associations by sex: it was linked to slightly higher PGSI scores in women and slightly lower scores in men.
- These findings highlight the need for public health strategies that address gambling across the entire risk spectrum, rather than focusing only on severe gambling problems.

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European Journal of Public Health, 2025, 00, 1–6
https://doi.org/10.1093/eurpub/ckaf216
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Check for updates

Received: 1 September 2023 | Accepted: 10 June 2024

DOI: 10.1111/add.16615

RESEARCH REPORT

ADDICTION SSA

Somatic and psychiatric comorbidity in people with diagnosed gambling disorder: A Finnish nation-wide register study

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Funding information
Ministry of Social Affairs and Health, Finland, Grant/Award Number: THL/5540/6.00.00/2023

Abstract

Background and aims: This is the first nation-wide register study based on a total population sample measuring the gender-specific incidences of chronic diseases and conditions among adults diagnosed with gambling disorder (GD).

Design, setting and participants: The study used aggregated data for 2011–22 retrieved from the Register of Primary Health Care visits, Care Register for Health Care and Care Register for Social Welfare, including specialized outpatient and inpatient health care, inpatient social care and institutional care and housing services with 24-hour or part-time assistance, set in mainland Finland. Participants comprised people aged 18–90+ years with GD diagnosis [corresponding to pathological gambling, International Classification of Diseases 10th revision (ICD-10) code F63.0, *n* = 3605; men *n* = 2574, women *n* = 1031] and the general population (*n* = 4 374 192).

Measurements: Incidences of somatic diseases and psychiatric disorders were calculated for the people with diagnosed GD and for the general population, separately for women and men.

Findings: After standardizing for age, the incidence of each diagnostic group was systematically higher for people with GD compared with the general population, except for cancer. The highest standardized incidence ratio (SIR) values were for psychiatric disorders [SIR = 234.2; 95% confidence interval (CI) = 226.1–242.4], memory disorders (SIR = 172.1; 95% CI = 119.1–234.8), nervous system diseases (SIR = 162.8; 95% CI = 152.8–173.1), chronic respiratory diseases (SIR = 150.6; 95% CI = 137.6–164.2), diabetes (SIR = 141.4; 95% CI = 127.9–155.5) and digestive diseases (SIR = 134.5; 95% CI = 127.1–142.2).

Conclusions: In Finland, the incidence of chronic diseases and conditions among people with gambling disorder is higher compared with the general population, apart from cancer.

KEYWORDS
Chronic diseases, comorbidity, gambling disorder, ICD-10, pathological gambling, register study, total population

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INTRODUCTION

Gambling disorder (GD) is an addictive disorder with repeated behaviour that can dominate a person's life with severe long-lasting consequences. To date, a large amount of research has linked several comorbidities to GD and problem gambling. However, previous studies on comorbidity have mainly been based on survey data or have been conducted in small-scale clinical settings, such as in individual clinics, which may cause non-representative sampling biases [1, 2]. To our knowledge, only a few studies utilizing register data have examined GD comorbidity in the total population [3, 4]. In this paper the term GD refers to a diagnosed disorder, while problem gambling is a broader term, also including survey-based measures and less severe problems.

Previous studies have described the high level of psychiatric comorbidity in GD and problem gambling [1–3]. In a Swedish register study 73% of people diagnosed with GD had at least one additional comorbid psychiatric disorder [3]. The most common comorbid psychiatric disorders were affective and anxiety disorders, as well as substance use disorders (SUD). Similar results have been observed in population surveys [1] and clinical studies [2]. In a Swedish register study, the risk of suicide attempts and suicide deaths were elevated among people with GD, particularly in the presence of SUD or other comorbid psychiatric disorder [5, 6]. Because of this significant influence on population health and on society at large, gambling can be considered as an important public health issue [7–10].

A substantial majority of the studies on comorbidity in GD and problem gambling has focused upon psychiatric comorbidity, whereas research on somatic comorbidities is scarce. A recent register-based case–control study of the association between cardiovascular disease, diabetes, respiratory disease and GD showed that all these aforementioned diseases and disorders were more common in GD patients than in controls [11]. In another register study on mortality, suicidality and associated comorbidity among people with GD, both somatic and psychiatric disorders were included [5]. However, most of the previous studies on somatic comorbidity are based on self-reported data, rather than diagnoses verified from health-care registers or medical records. In a population study, a life-time diagnosis of GD was associated with several self-reported medical conditions, including tachycardia, angina, cirrhosis and other liver diseases [12]. In another population study, problem gambling was linked to multiple pain and discomfort conditions in different parts of the body, such as pain in the back, neck or shoulders [13]. Furthermore, problem gambling has been associated with headache [13, 14] and, among women, with chronic bronchitis, fibromyalgia and migraine [15].

While the majority of people with GD are men [3, 16], comorbid disorders are significantly more common in women with GD [3, 11, 17]. In particular, mood and anxiety disorders are more prevalent in women with GD [3]. Women and men have some differences in their gambling behaviours and the development of gambling problem [18]. Women tend to start gambling at an older age than men, but they progress more quickly to problem gambling and they seek treatment sooner [19]. Women may use gambling as a way of coping with feelings of depression or anxiety more often than men, leading to over-involvement in gambling [20]. These findings highlight the need for further research on GD comorbidity separately in women and men.

TABLE 1 International Classification of Diseases 10th revision (ICD-10) codes and diagnostic groups.

ICD-10 code	Diagnostic group
D69.0, H10.1, J30, J39.3, K52.2, L20, L23, L25, L27, L50, M36.4, R68, T78, Z88	Allergies
C00–D48, N87.2	Cancer
I05–89, G45–46, O87.1, O88.2	Cardiovascular diseases
J40–46, J60–99	Chronic respiratory diseases
E10–14, O24	Diabetes
K20–93	Digestive diseases
F00–03, F05.1, G30	Memory disorders
M00–99, D86	Musculoskeletal diseases
G20, G35, G40–41, G43–44, G47, G81–82	Nervous system diseases
F04–99, excl. F05.1, F63.0	Psychiatric disorders

In this study, using nation-wide register data, the aim was to examine the gender-specific incidences of somatic and psychiatric disorders among Finnish adults with diagnosed GD. The corresponding incidences for the general population are presented as references.

METHODS

Design, participants and data collection

This is a nation-wide register study utilizing unique data of GD and comorbid chronic diseases from 2011 to 2022. The data were retrieved from the national health registers maintained by the Finnish Institute for Health and Welfare (THL): Register of Primary Health Care Visits, Care Register for Health Care and Care Register for Social Welfare [16]. The Register of Primary Health Care Visits covers all Finnish primary health-care centres, consisting of public, occupational and private health-care. The Care Register for Health Care includes specialized both outpatient and inpatient health-care and inpatient social care. The Care Register for Social Welfare contains registers of institutional care and housing services with 24-hour or part-time assistance.

The study included all individuals in the aforementioned national registries with the International Classification of Diseases 10th revision (ICD-10) pathological gambling diagnosis (ICD-10 code F63.0). The term gambling disorder (GD) is used in this study as it is the nomenclature chosen in the upcoming revised ICD-11 [21]. The data

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include the diagnosis of GD as a primary or as a secondary diagnosis. The same person could have received multiple GD diagnoses during the year, but in this case the diagnosis was counted only once. The diagnoses of underage people (n = 108, aged 4–17 years) and people living in Åland Island (n = 8) were excluded. This data set included a total of 3605 people with registered GD (men n = 2574; women n = 1031). Ages ranged between 18 and 90+ years at the time the of the GD diagnosis (mean = 35.4 years). The average population with the same age-range from the same national registries was used as the reference group (n = 4 374 192; mean = 50.4 years). The age of people with GD and the general population differed; therefore, we used estimates of the incidence of diseases/disorders in a population relative to what might be expected if people with GD had the same morbidity as the general population.

This study includes the most common chronic illnesses. They were categorized into diagnostic groups using their ICD-10 codes: diabetes, allergies, cardiovascular diseases, chronic respiratory diseases, cancer, musculoskeletal diseases, memory disorders, psychiatric disorders, digestive diseases and nervous system diseases (Table 1; Supporting information, Table S1). All comorbid disorders which were diagnosed before, after or at the same time that the diagnosis of GD was included in the data.

The data were obtained through a data request to the THL and the data request was implemented by the THL data managers. They used an individual-level health register data to produce the aggregated data set. The aggregated data set was then delivered to the research group and was used for the purposes of this report.

Statistical analysis

The incidences of somatic diseases and psychiatric disorders were calculated for individuals with diagnosed GD and for the general population separately for women and men. The expected number of cases of diseases/disorders was calculated as a sum of products of an age-specific expected number of cases, which were calculated by multiplying each age-specific population of the people with GD by each age-specific incidence rate of the Finnish general population. To calculate standardized incidence ratios (SIRs), the observed number of cases were divided by the expected number of cases multiplied by 100 [22]. The SIR of 100 indicates that the number of cases of the diseases/disorders observed among people with GD is equal to the number of such cases expected if people with GD had the same disease/disorder rate as the general population. In accordance with this, the SIR of 120 indicates 20% more cases than expected; the SIR of 80 indicates 20% fewer cases than expected. The 95% confidence interval (CI) for the SIR was calculated using a short-cut method [22]. Gender difference for each diagnostic group was tested by calculating CI for gender ratio, defined as the ratio of gender-specific SIRs [22]. Data were processed and analyzed using Microsoft Excel for Windows and the R epitools package [23, 24]. As the analyses described here were conducted without pre-registration, the results should be considered exploratory.

Ethics

The study procedures adhere to the Declaration of Helsinki and its amendments. In accordance with the Statutes of Finland, this study did not require separate approval from the ethics committee nor any procedure to obtain informed consent. This study utilized aggregated data. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist was used to report the results (Supporting information, Table S2) [25].

RESULTS

Incidence of comorbid illnesses among people with GD

The most common comorbid illnesses among people with GD were psychiatric disorders (88.2%), musculoskeletal diseases (66.7%), digestive diseases (33.6%), cardiovascular diseases (31.0%) and nervous system diseases (27.3%) (Table 2). Both women and men with GD had the same most common comorbid illnesses (Tables 3 and 4).

Standardized incidence of comorbid illnesses for GD and the general population

After standardizing for age, the incidence for each diagnostic group was systematically higher for people with GD compared to the general population, except for cancer (Figure 1). The highest standardized incidences were for psychiatric disorders (SIR = 234.2; CI = 226.1–242.4), memory disorders (SIR = 172.1; CI = 119.1–234.8), nervous system diseases (SIR = 162.8; CI = 152.8–173.1), chronic respiratory diseases (SIR = 150.6; CI = 137.6–164.2), diabetes (SIR = 141.4; CI = 127.9–155.5) and digestive diseases (SIR = 134.5; CI = 127.1–142.2).

Among men with GD, the incidence for each diagnostic group was higher compared to men in the general population, except for cancer and memory disorders (Figure 1). The highest standardized incidences were for psychiatric disorders (SIR = 246.1; CI = 236.0–256.4), nervous system diseases (SIR = 164.5; CI = 151.7–177.9), diabetes (SIR = 142.4; CI = 123.7–162.6), chronic respiratory diseases (SIR = 138.6; CI = 123.0–155.1) and digestive diseases (SIR = 129.0; CI = 120.0–138.4).

Among women with GD, the incidence for each diagnostic group was higher compared to women in the general population, except for allergies and cancer (Figure 1). The highest standardized incidences were for psychiatric disorders (SIR = 210.2; CI = 197.0–223.8), memory disorders (SIR = 182.5; CI = 112.8–268.8), chronic respiratory diseases (SIR = 171.2; CI = 148.6–195.5), nervous system diseases (SIR = 160.1; CI = 144.4–176.7), digestive diseases (SIR = 145.1; CI = 131.9–158.8) and diabetes (SIR = 140.3; CI = 121.5–160.4).

The SIRs of women and men for each diagnostic group were tested, resulting in significant differences only for chronic respiratory diseases (gender ratio = 0.81; CI = 0.68–0.97) and psychiatric disorders (gender ratio = 1.17; CI = 1.09–1.26).

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TABLE 2 Observed (Obs) and expected (Exp) number of cases of somatic diseases and psychiatric disorders and standardized incidence ratios (SIRs) with 95% confidence intervals (95% CI) among people with diagnosed gambling disorder (GD; F63.0) in 2011–22 (reference population: the Finnish general population).

	Finnish population (*n* = 4 374 192)		People with GD (*n* = 3605)				
Diagnostic group	**%**	***n***	**%**	***n* observed**	***n* expected**	**SIR**	**(95% CI)**
Allergies	13.0	567 276	16.2	584	512	114.2	(105.1–123.6)
Cancer	30.0	1 313 628	18.1	654	628	104.1	(96.2–112.2)
Cardiovascular diseases	49.2	2 153 782	31.0	1116	909	122.8	(115.7–130.1)
Chronic respiratory diseases	14.2	621 340	13.6	490	325	150.6	(137.6–164.2)
Diabetes	15.1	661 137	11.2	405	286	141.4	(127.9–155.5)
Digestive diseases	33.9	1 481 038	33.6	1210	899	134.5	(127.1–142.2)
Memory disorders	6.1	265 328	0.9	34	20	172.1	(119.1–234.8)
Musculoskeletal diseases	67.1	2 935 769	66.7	2405	2143	112.2	(107.8–116.8)
Nervous system diseases	19.6	857 842	27.3	983	604	162.8	(152.8–173.1)
Psychiatric disorders	34.1	1 491 035	88.2	3181	1358	234.2	(226.1–242.4)

TABLE 3 Observed (Obs) and expected (Exp) number of cases of somatic diseases and psychiatric disorders and standardized incidence ratios (SIRs) with 95% confidence intervals (95% CI) among men with diagnosed gambling disorder (GD; F63.0) in 2011–22 (reference population: men in the Finnish general population).

	Men in Finnish population (*n* = 2 142 986)		Men with GD (*n* = 2574)				
Diagnostic group	**%**	***n***	**%**	***n* observed**	***n* expected**	**SIR**	**(95% CI)**
Allergies	9.9	212 452	14.8	380	322	118.1	(106.5–130.3)
Cancer	25.2	540 490	14.1	363	327	111.0	(99.8–122.7)
Cardiovascular diseases	47.6	1 019 254	26.2	674	566	119.0	(110.2–128.2)
Chronic respiratory diseases	13.5	289 847	11.1	285	206	138.6	(123.0–155.1)
Diabetes	14.5	311 216	8.0	206	145	142.4	(123.7–162.6)
Digestive diseases	32.4	694 277	29.6	762	590	129.0	(120.0–138.4)
Memory disorders	5.0	106 201	0.5	13	8	157.7	(83.6–255.0)
Musculoskeletal diseases	62.0	1 327 770	61.1	1572	1437	109.4	(104.0–114.8)
Nervous system diseases	17.6	376 339	23.5	606	368	164.5	(151.7–177.9)
Psychiatric disorders	29.5	632 127	86.8	2234	908	246.1	(236.0–256.4)

TABLE 4 Observed (Obs) and expected (Exp) number of cases of somatic diseases and psychiatric disorders and standardized incidence ratios (SIRs) with 95% confidence intervals (95% CI) among women with diagnosed gambling disorder (GD; F63.0) in 2011–22 (reference population: women in the Finnish general population).

	Women in Finnish population (*n* = 2 231 206)		Women with GD (*n* = 1031)				
Diagnostic group	**%**	***n***	**%**	***n* observed**	***n* expected**	**SIR**	**(95% CI)**
Allergies	15.9	354 824	19.8	204	190	107.5	(93.2–122.7)
Cancer	34.7	773 138	28.2	291	301	96.6	(85.8–108.0)
Cardiovascular diseases	50.9	1 134 528	42.9	442	343	129.0	(117.2–141.3)
Chronic respiratory diseases	14.9	331 493	19.9	205	120	171.2	(148.6–195.5)
Diabetes	15.7	349 921	19.3	199	142	140.3	(121.5–160.4)
Digestive diseases	35.3	786 761	43.5	448	309	145.1	(131.9–158.8)
Memory disorders	7.1	159 127	2.0	21	12	182.5	(112.8–268.8)
Musculoskeletal diseases	72.1	1 607 999	80.8	833	705	118.1	(110.2–126.2)
Nervous system diseases	21.6	481 503	36.6	377	235	160.1	(144.4–176.7)
Psychiatric disorders	38.5	858 908	91.9	947	451	210.2	(197.0–223.8)

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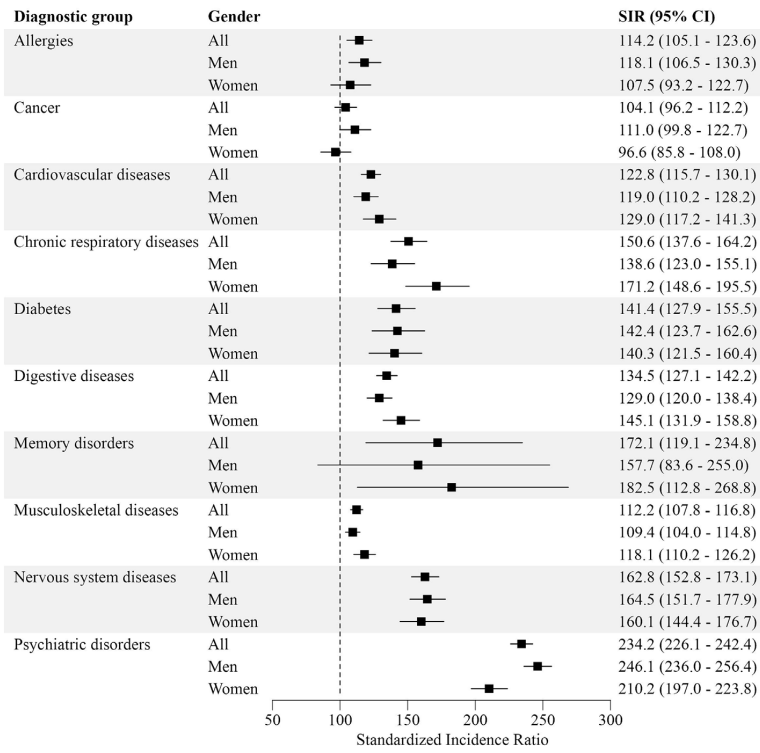

FIGURE 1 Somatic and psychiatric disorders and standardized incidence ratios (SIRs) with 95% confidence intervals (95% CI) among people with diagnosed gambling disorder (GD; F63.0) in 2011–22 (reference population: the Finnish general population).

DISCUSSION

To our knowledge, no previous nation-wide register-based study has been conducted on somatic comorbidity among people with GD compared to the general population. Prior studies have focused upon psychiatric comorbidity. This study contributed to filling this gap by examining the gender-specific incidence of both somatic and psychiatric comorbidity among Finnish adults with GD using national register data covering the total population. Overall, the incidence for each diagnostic group was higher for people with GD compared to the general population, except for cancer. The highest incidences were found for psychiatric disorders, memory disorders, nervous system diseases, chronic respiratory diseases, diabetes and digestive diseases. Both men and women with GD had a higher incidence for almost every diagnostic group compared to men and women in the general population.

The study found that the incidence of psychiatric disorders for people with GD was higher compared to the general population; this result is consistent with an earlier register-based study observing high psychiatric comorbidity among people with GD [3]. A novel finding in this study was that people with GD not only had diagnosed psychiatric disorders, but also several types of diagnosed somatic diseases. The incidence of nervous system diseases was higher among people with GD compared to the general population. In previous population studies problem gambling has been associated with migraines and headaches in general [13–15]. The high incidence of nervous system diseases and psychiatric diseases among people with GD may be partly explained by stress. As noted earlier, GD is particularly linked with stress-related disorders [3] and problem gambling has been associated with high perception of stress [13, 26]. Thus, illnesses with a stress-related component, such as some of the psychiatric disorders and nervous system diseases, may be more frequent in GD than in the general population. Studies have also shown that stress aggravates the symptoms of many somatic diseases, and complicates diseases accompanied by pain [27–29]. However, these considerations do not mean that stress is necessarily the actual cause of the disease.

The incidence of memory disorders among people with GD was particularly high compared to the general population. This was not a surprising result, as problems with money use are widely recognized as early indicators of memory disorders [30, 31]. However, the number of people with both diagnosed GD and memory disorders was low (n = 34), which should be considered when interpreting the result. Some forms of dementia, such as frontotemporal dementia (FTD), may be linked with GD [32]. FTD may cause people to lose control and to develop compulsive and impulsive behaviours, and therefore to become more prone to excessive gambling behaviour.

Another key finding was that the incidence of digestive diseases was higher compared to the general population. There is a shortage of research of the relationship between GD and digestive diseases.

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However, in an earlier population-based study, neither bowel syndrome nor stomach/intestinal ulcer was associated with problem gambling [15]; in another population study, stomach ulcer and gastritis were not associated with problem gambling [12]. It is noteworthy that our study examined all digestive diseases as an upper category, while the aforementioned studies involved specific diseases in more detail. Overall, comparability between these studies is limited due to differences in measures and samples. In a Swedish register study, 31% of people with diagnosed GD had a comorbid digestive disease [5], which is in line with the corresponding figure in our study (33.6%).

We also found that the incidence of chronic respiratory diseases among people with GD was higher compared to the general population. A few population studies have observed that problem gambling was associated with chronic bronchitis [15], but not with bronchial asthma or chronic lung diseases [14]. Furthermore, in this study the incidence of cardiovascular diseases for people with GD was higher compared to the general population. In population-based studies, self-reported cardiovascular diseases have been associated with at-risk and problem gambling [12, 33]. Moreover, cardiovascular diseases and older age were observed to predict general mortality among people with GD [5]. The incidence of diabetes was higher for people with GD compared to the general population. These findings are consistent with a previous register-based case–control study showing a higher prevalence of respiratory disease, cardiovascular disease and diabetes in patients with GD than in controls [11].

Importantly, all the somatic diseases and psychiatric disorders included in this study are common chronic diseases: conditions in Finland that are important public health issues. Well-known risk factors for several chronic diseases and conditions are insufficient sleep, unhealthy diet, low physical activity, smoking, high-risk alcohol consumption and obesity [34]. It is noteworthy that all these have been linked to problem gambling, as has been the use of illicit drugs [35]. Managing these factors can help to prevent the onset of somatic diseases and psychiatric disorders. Our results highlight, in addition to previous knowledge of the link between unhealthy behaviour and problem gambling, that healthy life-style management should be promoted among people with GD. More research is needed to gain a clearer understanding of these risk factors among people with GD as well as gender differences. Findings based on the Conceptual Framework of Gambling Related Harm [18, 36, 37] also emphasize the need to deepen the understanding regarding health harms including, for example, smoking, high alcohol consumption, poor nutrition, poor sleep practices, non-compliance with medication and reduced personal hygiene.

Strengths and limitations

The strengths of the present study deserve mention. To our knowledge, this is the first study to examine comorbid somatic diseases among people with a diagnosis of GD compared to the general population based on nation-wide register data. Another strength is that the high-quality register data used in this study include the entire Finnish population living in the mainland of Finland. However, this study has some limitations. A recent register-based study showed that the prevalence of diagnosed GD is notably low in Finland [16], while the prevalence of probable GD is markedly higher in the Finnish survey studies [38]. Because of this discrepancy, it is suggested that GD is under-diagnosed in Finland [16, 39]. Due to the low number of diagnosed GDs, this study focused upon a very small group of those with actual gambling problems. Therefore, in future studies, surveys should be linked to register-based diagnoses, and both somatic and psychiatric comorbidities should be investigated among those with at-risk or problem gambling to provide a broader picture of the comorbidity.

It should be noted that GD is also treated in social welfare services in Finland, where the recording of ICD-10 diagnoses is still limited [40]. However, the national knowledge base and recording of social welfare will be developed under the implementation programme for knowledge-orientated leadership, steering and supervision in social welfare and health-care [41] and the social welfare register reform. Under-registration can also be caused by occupational health service visits in the private sector, as not all occupational health-care records are yet visible in the pooled health registers.

Our data did not include individual-level information on the number and frequency of visits to health-care services. Those who have more visits to the health services may be more likely to be diagnosed with another condition than those who have less contact with such services. In other words, if the GD population has more visits to health services than the general population, they may be more likely to be diagnosed with another condition. This could inflate the SIRs. All Finnish citizens have access to public health and social care. Occupational health-care is also widely available. However, among the working-age population, those with a lower socio-economic status use less health-care than those with a higher socio-economic status [42].

As we used aggregated data, it was not possible to tell which condition was diagnosed first: GD or the comorbid disorder. For example, both affective and anxiety disorders are common among people with GD [3]. Gambling may be used as a mechanism to deal with symptoms of affective or anxiety disorders but problem gambling may also lead to mental health issues due to the excessive loss of money. Moreover, physical ill-health and poor physical functioning may predispose to gambling because this may be seen as a form of recreation requiring minimal physical activity. Conversely, gambling may lead to health problems due to long-lasting low levels of physical activity. In fact, sedentary life-style has been linked to problem gambling [35]. In future studies it would be important to have individual-level register data to examine more closely the different trajectories of health issues among people with problem gambling. Moreover, the use of individual-level data would allow socio-economic factors to be taken into account in analyses. It may be that GD and comorbidity with respect to certain diseases are clustered in certain lower socio-economic groups. Previous studies have observed differences in the number and types of gambling harms in the different social groups [43].

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A further limitation was that the diagnoses of children and adolescents (n = 108) were excluded from the data, because it is uncertain whether those under 18 years of age included in these data fulfil the diagnostic criteria for GD. As noted by Håkansson *et al.* [3], some of them may be addicted to gaming rather than to gambling. The Finnish translation of GD diagnosis does not indicate whether it is gaming or gambling that may cause confusion in clinicians with short experience in behavioural disorders. Furthermore, the data showed that some very young children had a diagnosis of GD, implying that the diagnosis of GD among minors is also used for symptoms which are related to gaming, not gambling. In the revised ICD-11 [21], gaming disorder has its own diagnostic code. Thus, in future studies, more accurate information on GD diagnoses of underage people can probably be obtained.

CONCLUSIONS

To our knowledge, this was the first study to examine both somatic diseases and psychiatric disorders among adults with GD compared to the general population based on nation-wide register data. The results showed that the incidence for each group of the somatic diseases and psychiatric disorders among people with GD was higher compared to the general population, apart from cancer. The highest incidences were found for psychiatric disorders, memory disorders, nervous system diseases, chronic respiratory diseases, diabetes and digestive diseases. Overall, these results highlight the need of health and social care professionals to be aware of the potential presence of various comorbidities when working with people with GD, although people with GD are young people on average. Future studies, particularly those using longitudinal individual-level health register data, would provide useful information not only on the trajectories of GD and comorbidity in different socio-economic groups, but also on the use of health and social care services among people with GD.

AUTHOR CONTRIBUTIONS

Tanja Grönroos: Conceptualization (equal); formal analysis (lead); methodology (equal); project administration (lead); visualization (lead); writing—original draft (lead); writing—review and editing (equal). **Jukka Kontto:** Formal analysis (supporting); methodology (equal); supervision (supporting); visualization (equal); writing—review and editing (equal). **Anne Kouvonen:** Supervision (equal); writing—review and editing (equal). **Tiina A Latvala:** Methodology (supporting); supervision (supporting); writing—review and editing (equal). **Timo Partonen:** Supervision (supporting); writing—review and editing (equal). **Anne H Salonen:** Conceptualization (equal); supervision (equal); visualization (equal); writing—review and editing (equal).

ACKNOWLEDGEMENTS

This study was funded by the Ministry of Social Affairs and Health, Finland (THL/5540/6.00.00/2023), within the objectives of the §52 Appropriation of the Lotteries Act. Daily work of the authors T.G., J.K., T.A.L. and A.H.S. at the Finnish Institute for Health and Welfare was also funded by the Ministry. The Ministry had no role in the study design, analysis or interpretation of the results of the manuscript or any phase of the publication process. We wish to thank Senior Planning Officer Topias Kuosmanen, Statistician Jokke Häsä and Senior Researcher Antti Impinen for implementing the data request and Research Professor Pekka Jousilahti for consulting help while classifying chronic diseases and conditions for the data request.

DECLARATION OF INTERESTS

None.

DATA AVAILABILITY STATEMENT

No data available.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Grönroos T, Kontto J, Kouvonen A, Latvala TA, Partonen T, Salonen AH. Somatic and psychiatric comorbidity in people with diagnosed gambling disorder: A Finnish nation-wide register study. Addiction. 2024. https://doi.org/10.1111/add.16615

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