Sociodemographic Risk Factors for Risky and Disordered Gambling – Investigations through Registry Data

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Thesis for the degree of Philosophiae Doctor (PhD)
University of Bergen, Norway
2023

UNIVERSITY OF BERGEN

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Date of defense: 11.12.2023

Year: 2023

Title: Sociodemographic Risk Factors for Risky and Disordered Gambling – Investigations through Registry Data

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Print: Skipnes Kommunikasjon / University of Bergen

Scientific environment

This thesis was completed at the Department of Psychosocial Science, Faculty of Psychology at the University of Bergen. I have been affiliated with the Graduate School of Clinical and Developmental Psychology. I have been a member of Bergen Addiction Research Group and Norwegian Competence Center for Gambling and Gaming Research. The included studies form part of the 'Using REGistry-based Studies to Alleviate the Burden of GAMbling problems (REGGAM)' project which was funded by the Research Council of Norway (project number 273718). My main supervisors have been Professor Eilin Kristine Erevik and Associate Professor Rune Aune Mentzoni, with Professor Ståle Pallesen as co-supervisor.

Acknowledgements

First and foremost, I am deeply grateful for the advice, support, and encouragement that my supervisors Prof. Eilin Kristine Erevik, Assoc. Prof. Rune Aune Mentzoni, and Prof. Ståle Pallesen have given me. Prof. Erevik's work and accomplishments as a young researcher have been inspiring to me, and I am thankful for the care you have shown for my work and personal welfare as a PhD candidate. Assoc. Prof. Mentzoni has provided me with support and encouragement for 10 years. I approached Assoc. Prof. Mentzoni one evening in 2013 when he had delivered an engaging talk on gaming, no doubt encouraged by his warm and welcoming nature. His positive response to my wish to work as a research assistant for the Bergen Addiction Research Group and his subsequent mentorship, including his role as supervisor on my master's thesis, has unmistakably played a critical part in my career path focusing on gambling problems and other addictive behaviors. I want to thank Prof. Ståle Pallesen for his wisdom, supervision, and leadership during the REGGAM project. Ever since I approached Prof. Pallesen to act as supervisor during my student scholarship, I have felt encouraged to develop and carry out my own research ideas. Prof. Pallesen contributes ambition and inspiration to the Norwegian Competence Center for Gambling and Gaming Research and his support of its members' own research ideas has also made my PhD period more educative still.

I want to thank Dr. Tony Leino for his guidance, his important data curation work during the REGGAM project, and our talks on all things methods and R. I also want to thank Dr. Robert Smith whose expertise was invaluable in helping me navigate the statistics jungle and the rich data sets in my PhD.

Finally, I want to extend my gratitude to my family. My parents Nada and Asle have given me unconditional love and have been the longest and strongest supporters of my endeavors, academic or otherwise. My brothers Christian and Daniel have shown keen

interest in my work, and I am thankful of all our talks. My partner Sunniva has shown me love, enthusiasm, support, and patience. I am grateful for all our illuminating discussions on addictions and having a partner that shares a strong interest in mental health.

Abstract

Age, gender, and marital status are robust predictors of disordered gambling. Men and younger individuals generally report more disordered gambling, while women appear to develop disordered gambling faster (the 'telescoping effect'). Further, divorce and unmarried status appears overrepresented among those with disordered gambling. However, there are still gaps in our understanding of these sociodemographic variables in relation to disordered gambling. For age and gender, studies are needed combining wide age ranges and longer time periods to elucidate trends in disordered gambling for different age and gender groups over time. For gender, the 'telescoping effect' remains to be replicated with prospective data from non-clinical samples. For marital status, studies are needed to investigate the directionality between marital status and disordered gambling.

The current thesis presents three studies that aimed to alleviate previous limitations by leveraging registry data. Behavioral tracking data allows for automatic and non-intrusive recording of objective gambling behavior, giving rise to large longitudinal datasets that are rich in detail. Health registry data allows for access to large samples of individuals with psychiatric diagnoses such as gambling disorder (GD), that are nationally representative of the treatment-seeking population, and whose data can be linked with other registries containing similar high-quality recordings of health and social information.

The first study of this thesis used behavioral tracking data to investigate how annual trends in theoretical loss (a measure of risk propensity in gambling) varied according to age and gender groups for a population of electronic gaming machine (EGM) players over six years. The second study used the same data to the examine a variant of the 'telescoping effect': Women were hypothesized to be older than men when initiating EGM gambling, and their time between first playing EGM to reaching first loss limit would be shorter compared to men. The third study made use of health and social welfare registries across an 11-year period

to examine if getting divorced was associated with increased odds for future GD, and if getting married was associated with reduced odds for future GD.

Results from the first study showed that higher theoretical loss at various parts of the distribution (25th, 50th [median], and 90th percentile) was associated with older age and being a woman. Age-related differences in theoretical loss were also stronger among men compared to women. Finally, yearly theoretical loss decreased among the most intense gamblers (90th percentile) across the examined years for all age- and gender groups except men aged 18-29 years. Results from the second study indicated a 'telescoping effect' as women were on average 6 years older than men when first gambling on EGMs, and women reached their first monthly loss limit on average 9 months before men (out of 70 total study months). Results from the third study showed that getting divorced was associated with increased risk for future GD compared to illness controls (2.45 odds ratio) and general population controls (2.41 odds ratio). Results also showed that getting married was associated with reduced odds for future GD compared to illness controls (0.62 odds ratio) and general population controls (0.57 odds ratio).

The changing gambling landscape and established theories of disordered gambling might explain the present findings on land-based EGM gambling. EGM gambling appears to be decreasing, although women and older adults show stronger preference for EGM gambling compared to men and younger adults. This could increase exposure to reinforcement factors and maintain cognitive biases that facilitate disordered gambling. Regarding marital status and risk for GD: Divorced individuals might develop GD as gambling becomes a coping strategy following such a stress-full life event. Married individuals might benefit from social control and support from spouses that buffer against overinvolvement in gambling. The benefits and limitations of using registry data for achieving the study aims are discussed, as are implications for intervention and future research.

Sammendrag (Norwegian abstract)

Alder, kjønn, og sivilstatus er robuste prediktorer for problematisk pengespilling. Menn og yngre rapporterer generelt mer problematisk pengespilling, mens kvinner virker å utvikle problematisk pengespilling raskere (såkalt teleskop-effekt). Videre er skilte og ugifte overrepresentert blant de med problematisk pengespilling. Det er allikevel flere kunnskapshull i vår forståelse av disse sosiodemografiske variablene og deres betydning for problematisk pengespilling. For alder og kjønn så er det behov for studier som kombinerer større aldersspenn og lengre oppfølgningsperioder for å klargjøre trender i problematisk pengespilling for ulike alders- og kjønnsgrupper over tid. For kjønn så gjenstår det å replisere teleskop-effekten med prospektive data fra ikke-kliniske utvalg. For sivilstatus så er det behov for studier som undersøker retningen på forholdet mellom sivilstatus og problematisk pengespilling.

Denne avhandlingen presenterer tre studier som har målsetting å imøtekomme tidligere begrensninger ved å benytte registerdata. Sporingsdata på pengespilling muliggjør automatisk og ikke-invaderende innsamling av objektiv spillatferd som gir opphav til store og detaljerte longitudinelle utvalg. Helseregisterdata gir tilgang til store utvalg av individer med diagnoser for psykiske lidelser slik som pengespillidelse ("gambling disorder", GD), som er nasjonalt representative for den behandlingssøkende populasjonen og der dataen kan kobles med andre registre som har liknende høy kvalitet på helse og sosial informasjon.

Den første studien i denne avhandlingen brukte sporingsdata for å undersøke hvordan årlige trender i teoretisk tap (et mål på tilbøyelighet til å ta risiko i pengespilling) varierte etter alders- og kjønnsgrupper for en populasjon av spillautomatspillere ("electronic gaming machines", EGM) over seks år. Den andre studien brukte samme data for å undersøke en variant av teleskop-effekten: Kvinner ble antatt å være eldre enn menn når de begynte EGM-spilling og tiden det gikk fra de begynte EGM-spilling til de møtte sin første tapsgrense ble

antatt å være kortere sammenlignet med menn. Den tredje studien brukte helse- og sosialregistre over en 11-års periode for å undersøke hvorvidt å skille seg var assosiert økt odds for fremtidig GD og hvorvidt å gifte seg var assosiert redusert odds for fremtidig GD.

Resultater fra den første studien viste at høyere teoretisk tap på flere deler av fordelingen (25., 50. [medianen], og 90. persentil) var assosiert med høyere alder og å være kvinne. Aldersrelaterte forskjeller i teoretisk tap var også sterkere hos menn sammenlignet med kvinner. Til slutt, årlig teoretisk tap falt blant de mest intense pengespillerne (90. persentil) på tvers av de undersøkte årene for alle alders- og kjønnsgrupper utenom menn i alderen 18-29 år. Resultater fra den andre studien ga støtte for en teleskop-effekt ettersom kvinner var i gjennomsnitt 6 år yngre enn menn da de begynte sin EGM-spilling og kvinner møtte sin første månedlige tapsgrense i median 9 måneder før menn (av totalt 70 måneder i studien). Resultater fra den tredje studien viste at å skille seg var assosiert økt odds for fremtidig GD sammenlignet med kontroller som har psykisk eller somatisk sykdom (2,45 odds ratio) og kontroller fra generelle befolkningen (2,41 odds ratio). Resultatene viste også at å gifte seg var assosiert redusert odds for fremtidig GD sammenlignet med kontroller som har psykisk eller somatisk sykdom (0,62 odds ratio) og kontroller fra generelle befolkningen (0,57 odds ratio).

Endringer i pengespillmarkedet og etablerte teorier for problematisk pengespilling kan være med å forklare de aktuelle funnene på landbasert EGM-spilling. EGM-spilling virker å være synkende generelt, men kvinner og eldre voksne viser en sterkere preferanse for EGM-spilling sammenlignet med menn og yngre voksne. Dette kan styrke forsterkning fra EGM og medføre opprettholdelse av kognitive skjevheter som fremmer problematisk pengespilling. Angående sivilstatus og risiko for GD: Skilte personer kan muligens utvikle GD ved at pengespillingen blir en mestringsstrategi i møte med slik belastende livshendelse. Gifte personer vil muligens dra fordel av sosial kontroll og støtte fra deres ektefeller som beskytter

mot overinvolvering i pengespill. Fordeler og ulemper ved bruk av registerdata for å oppnå målsettingene i studiene blir diskutert samt implikasjoner for intervensjoner og fremtidig forskning.

List of Publications

1. Syvertsen, A., Leino, T., Pallesen, S., Smith, O. R. F., Mentzoni, R. A., Griffiths, M. D., & Erevik, E. K. (2023). Age and gender differences in gambling intensity in a Norwegian population of electronic gaming machine players. *International Gambling Studies,* https://doi.org/10.1080/14459795.2023.2199051

2. Syvertsen, A., Leino, T., Pallesen, S., Smith, O. R. F., Mentzoni, R. A., & Erevik, E. K. (2022). Telescoping and gender differences in high-risk gambling: Loss limit behavior in a population of electronic gaming machine players. *Psychology of Addictive Behaviors*. https://doi.org/10.1037/adb0000844

3. Syvertsen, A., Leino, T., Pallesen, S., Smith, O. R. F., Sivertsen, B., Griffiths, M. D., & Mentzoni, R. A. (2023). Marital status and gambling disorder: A longitudinal study based on national registry data. *BMC Psychiatry*, *23*(1), 199. https://doi.org/10.1186/s12888-023-04697-w

Contents

1. Introduction

Gambling is the "the wager of any type of item or possession of value upon a game or event of uncertain outcome in which chance, of variable degree, determines such outcome" (Bolen, 1968, p. 619). Most gambling presents little harm for the gambler and others, rather providing positive experiences such as intellectual challenge, social rewards, and positive mood change (Binde, 2013). In Norway, approximately two thirds of the adult population gamble at least once yearly (Pallesen et al., 2020). Scratch cards and lottery games are the most popular overall, while certain game types also find higher popularity among specific age- and gender groups. For instance, young men show a higher preference for online games compared to women and older adults, older men prefer horse racing to a larger degree than younger men and women, and women engage more with paper-based scratch cards compared to men.

Gambling can also entail negative consequences such as causing dependence, financial harm, work-related harm, mental/physical harm, emotional harm, relationship harm, and other harms such as gambling-related crime (Li et al., 2017; Pallesen et al., 2020). The prevention and minimization of such negative consequences from gambling is a chief concern for society at large. In Norway, the current governmental action plan against gambling problems identifies areas of research and innovation that are seen as necessary for achieving such ends (Ministry of Culture and Equality, 2022). The need for continued research on risk factors for disordered gambling constitutes one such area. The current thesis contributes to this by presenting three studies that aim to contribute to our understanding of age, gender, and marital status as risk factors for risky and disordered gambling by using registry data.

1.1 Disordered gambling and associated definitions

Gambling can involve different levels of loss of control and negative consequences for the gambler, which may be placed on a continuum (Shaffer & Korn, 2002; Shaffer & Martin, 2011). This thesis will use the term disordered gambling to refer to more severe negative consequences and loss of control that is varying but nevertheless lie at the latter parts of this continuum, and the term risky gambling to refer to earlier parts of the continuum which reflect (probable) milder/moderate consequences. On an individual level, gamblers with high expenditure and frequency experience the most severe harm. Still, on a societal level, most gambling related harm is concentrated among those with moderate to low levels of gambling expenditure and frequency (Browne & Rockloff, 2018; Canale et al., 2016). A public health approach involves taking the full spectrum of gambling behavior into account and minimizing gambling harm overall (Latvala et al., 2019). Prevention efforts targeting those with lower levels of gambling behavior may result in the most harm reduction, which has been termed the 'prevention paradox' (Browne & Rockloff, 2018).

The term disordered gambling also subsumes more categorical understandings of gambling harm and behavioral characteristics related to gambling. These categories that use clear separation in presence/absence of pre-defined criteria will be presented in the following to provide a fuller understanding of the different conceptualizations of disordered gambling that exist. These categories can be placed at the far end of the continuum of disordered gambling.

Gambling that is persistent and recurring and that causes substantial distress or impairment may qualify for the psychiatric diagnosis gambling disorder, as specified in the eleventh edition of the International Classification of Diseases (ICD-11; World Health Organization, 2019) and the fifth version of Diagnostic and Statistical Manual for Mental Disorders (DSM-5; American Psychiatric Association, 2013). Within ICD-11, the individual's

gambling behavior must be characterized by a set of essential features/symptoms within a 12-month period to qualify for the disorder. This includes a persistent pattern of gambling characterized by impaired control over gambling (loss of control), increasing priority to gambling (pre-occupation), and continuation or escalation of gambling despite negative consequences (tolerance and harm). Gambling disorder is characterized similarly within the DSM-5, although by specifying 9 more isolated criteria that qualify towards the disorder and with different degrees of severity based on cut-offs: Mild = 4/5 out 9, moderate = 6/7 out 9, and severe = 8/9 out 9. Example criteria include needing to gamble with increasing amounts of money to achieve the desired excitement, making repeated unsuccessful attempt to control, cut back, or stop gambling, and lying to conceal the extent of involvement with gambling. These psychiatric diagnoses of disordered gambling were reclassified from being an impulse-control disorder in ICD-10 and DSM-IV to being an addictive disorder within ICD-11 and DSM-5. This was done because disordered gambling was understood to have more in common with substance use disorders (i.e., addictions) in terms of behavioral characteristics (e.g., loss of control, pre-occupation, tolerance) and possibly underlying mechanisms, compared to other impulse control disorders such as obsessive-compulsive disorder (Potenza et al., 2019). This also involved changing the diagnostic term from pathological gambling to gambling disorder. However, description/criteria have remained largely the same between transitions in the diagnostic systems.

The psychiatric diagnoses gambling disorder and pathological gambling form the basis for clinical care, but the term problem gambling is often used in prevalence studies on disordered gambling (Hodgins et al., 2011). One definition of problem gambling is: “having difficulties limiting money and/or time spent on gambling which leads to adverse consequences for the gambler, others, or for the community” (Williams et al., 2012, p. 8). This definition is very similar to the description of disordered gambling presented above,

although the term problem gambling is typically used in conjunction with a categorical understanding also including less severe cases. For instance, using the Problem Gambling Severity Index (PGSI), individuals are often categorized as having problem gambling if they have a composite score of 8+ across 9 items scored on a 0 (“never”) – 3 (“always”) scale that assess problematic gambling behavior or negative consequences from gambling, whereas moderate risk gambling is defined as having a composite score ranging between 3 and 7 (Ferris & Wynne, 2001).

Beyond the usefulness of a continuum-based understanding of disordered gambling in a public health perspective, the use of the terms disordered and risky gambling in the present thesis is also informed by the studies that are included in the thesis. Study 1 and Study 2 rely upon using behavioral indicators that approximate, but not directly measure, disordered gambling (see section 1.3.1 “Behavioral tracking data in gambling” for discussion of the literature on this) thus it is arguably more meaningful to refer to the more inclusive term in that context. Study 3 uses health registry data and the diagnosis F63.0 pathological gambling from ICD-10. However, in cases when the categorical understanding is specified, the term gambling disorder (GD) will be used when discussing this study and other studies with clinical samples because GD is the term most often used in studies with clinical samples, there is significant overlap in both conceptualization and clinical practice when it comes to GD and pathological gambling (as discussed above), and the most recent clinical classification of gambling problems in ICD-11 and DSM-5 is now converging on GD as a term.

1.2 Theories of disordered gambling

Disordered gambling, and all the terms discussed above, are atheoretical concepts in that they only refer to behavioral characteristics and negative consequences from gambling

without reference to cause or mechanism. Still, there are different theories about the cause (etiology), development, and maintenance of disordered gambling that can be applied to further its understanding (Blaszczynski & Nower, 2007; Griffiths & Calado, 2022).

1.2.1 *Psychoanalytic and psychodynamic theory*

Psychoanalytic and psychodynamic theories represent the earliest formal theories offered on disordered gambling, albeit largely based on case material and lacking empirical testing of proposed ideas (Blaszczynski & Nower, 2007). Early psychoanalytic theory emphasized regression to pregenital psychosexual phases, such as the anal phase where defecation was pleasurable but denied unless conducted in a controlled manner, as a cause of different disorders/problems (Harris, 1964). Conflict and resulting fixation at this phase could result in ongoing unconscious guilt that is sought to be relieved by (self-)punishment. In terms of gambling, winning and losing was suggested to act as a way of reenacting the conflict between forbidden impulses and punishment for indulging. The inherent risk of gambling is eroticized, winning is pleasurable and losing becomes a form of necessary self-punishment (i.e., gambling becomes masochistic, joining both sexual/libidinal and aggressive impulses). Thus, disordered gambling is caused by early developmental experience, an unresolved Oedipal conflict, and it is maintained because the repeated reenactment through gambling does not resolve the conflict.

After the early focus on psychosexual theory, psychoanalytic and psychodynamic perspectives on disordered gambling have emphasized how disordered gambling may result from unconscious seeking of love, acceptance, and experiences of absolute control (omnipotence) through gambling (Rosenthal & Rugle, 1994). The understanding of disordered gambling within psychodynamic theory also coincides with how other mental distress is conceptualized within this approach. That is, maladaptive coping styles (such as gambling in this case) and associated defenses develop as reaction to intolerable affect,

previous relationship experiences, and efforts to fulfill wishes/goals that are not readily available for the patient, unspoken, or irrational (Rosenthal, 2008). For example, disordered gambling may develop as a way of handling intolerable grief following the loss of a parent. Similarly, the exacerbation and maintenance of disordered gambling can also be influenced by affect regulation: Chasing losses can be seen as a way of counteracting feelings of guilt as the gambler believes winning money back can not only alleviate the financial losses incurred but even 'erase' the existence of the gambling problem (an undoing defense mechanism; Rosenthal, 2008). Thus, what is overtly irrational behavior (chasing losses exacerbates gambling problems) becomes understandable within the perspective of unconscious affect regulation (attempts to alleviate intolerable guilt). Within psychodynamic theory it becomes crucial to foster self-awareness of such patterns and eventual replacement with more adaptive coping styles in order to achieve long-term recovery.

Recently, psychodynamic perspectives on addictions, including gambling, has further emphasized a relational focus such as on the role of attachment (Mooney et al., 2019). In terms of etiology of disordered gambling, early experiences that result in insecure attachment are understood as predisposing for attachment to drugs/gambling which then act as a substitution for healthy attachment to others. Individuals with disordered gambling report history of worse parental bonding and higher rates of insecure attachment style (Grant & Kim, 2002; Keough et al., 2018).

Psychodynamic theory of disordered gambling informs psychodynamic therapy of this condition, although critics have pointed to the lack of systematic outcome studies on psychodynamic therapy of disordered gambling (Blaszczynski & Nower, 2007). While acknowledging this point, Rosenthal (2008) reviews and argues how efficacious treatment programs have in large part integrated psychodynamic theory and thus can be taken as some support of its associated tenets. Regardless, there is still a need for more directed efforts of

empirically testing psychodynamic conceptions of disordered gambling and targeted interventions.

1.2.2 *Behavioral theory*

Behavioral theory of disordered gambling is based on learning theory and especially the role of operant and classical conditioning which conceptualizes disordered gambling as a learned maladaptive behavior (Blaszczynski & Nower, 2007; Griffiths & Calado, 2022). Within classical conditioning, learning occurs as adjustment to events in the environment which are outside of the individual's control: A neutral stimulus becomes associated with a valued stimulus, making the neutral stimulus elicit a response previously only elicited by the valued stimulus alone (Domjan, 2014). Within operant conditioning, the individual's behavior is instrumental: Behavior that produces a gratifying outcome or that eliminates or prevents an aversive outcome will increase the rate of the associated behavior during similar circumstances (Domjan, 2014). These learning principles are termed positive reinforcement and negative reinforcement, respectively. In contrast, behavior that produces an aversive outcome or eliminates or prevents a gratifying outcome will decrease the rate of the associated behavior in similar contexts. These learning principles are termed positive punishment and negative punishment, respectively. The rate at which behaviors produce outcome is also of key importance within operant conditioning, termed schedules of reinforcement. Fundamentally, an outcome can happen after a fixed number of behavior responses or time interval, or after a variable number of behavior responses or time interval. These are termed fixed or variable reinforcement schedules, respectively.

Gambling has been conceptualized as driven particularly by positive reinforcements through winning and associated arousal, reflecting operant conditioning (Blaszczynski & Nower, 2007; Griffiths & Calado, 2022). Audio-visual stimulation while gambling reflects milder but frequent reinforcement, and wins reflect stronger reinforcement albeit variable and

unpredictable. Negative reinforcement can also occur when gambling alleviates boredom, stress, anxiety, or other aversive emotional states. Variable reinforcement schedules are especially effective in maintaining behavior long-term. Winning can also reinforce the association between contextual cues (e.g., sounds, imagery, visual aspects in the gambling environment etc.) and excitement from winning, reflecting both operant and classical conditioning (Rickwood et al., 2010). Notably, this results in contextual cues being sufficient in eliciting excitement and motivation to gambling. Contextual cues are important in eliciting gambling urges among individuals with disordered gambling (Brevers et al., 2019). Further, arousal and excitement can become so strongly associated with gambling over time that not being involved with gambling elicits boredom and restlessness which means that gambling becomes negatively reinforced (again reflecting a combination of operant and classical conditioning; Griffiths & Calado, 2022). Within behavioral theory, structural characteristics of gambling products become especially important because they reflect the system for reinforcement and source for contextual cues that drive development and maintenance of disordered gambling (Yücel et al., 2018).

Cue-exposure is one example of a treatment technique based primarily on behavioral theory: Gamblers repeatedly place themselves in a situation with gambling-related contextual cues (e.g., enters the casino) while withholding response (i.e., refrains from gambling) which weakens the learned association fostering extinction and reduction in cue-elicited urges (Tolchard, 2017).

Gambling also involves punishment such as the occurrence of financial losses and other negative consequences. Indeed, such negative consequences are characteristic of disordered gambling (as described earlier) and behavioral theory faces a challenge in explaining how persistence in gambling is maintained in the face of such negative consequences (Blaszczynski & Nower, 2007). The effect of punishment factors can be

negated to some degree by the negative consequences being delayed such as, for instance, severe debt or relationship difficulties due to gambling only happening after longer gambling engagement. However, acute consequences are also present in the form of immediate losses and associated negative emotional reactions. Behavioral theory of disordered gambling has also been criticized by its' inability to explain why only a minority of gamblers develop disordered gambling and the downplaying of factors such as motivation, thought, and emotion (Griffiths & Calado, 2022). The latter limitation can be alleviated by viewing behavioral theory in combination with other theories of disordered gambling, such as cognitive theory.

1.2.3 *Cognitive theory*

The cognitive perspective emphasizes the role of irrational beliefs in the development and maintenance of disordered gambling. Gambling is assumed to be motivated by financial gain but expected return is less than the sum staked, and the existence of irrational beliefs among gamblers represents one explanation to how gamblers reconcile this (Ladouceur et al., 1998). The existence of such irrational beliefs among gamblers and their increased severity among those with disordered gambling finds support in early and more recent studies (Ladouceur et al., 1988; Orlowski et al., 2020; Schluter et al., 2019; Tabri et al., 2023).

Toneatto (1999, 2002) has presented a framework of irrational beliefs in disordered gambling. It is proposed that individuals with disordered gambling are motivated by the core belief of "the ability to predict or control the outcome of a future event which is, by definition, either randomly determined (e.g., slot machines, roulette, lotteries) or about which insufficient knowledge is available to make accurate predictions (e.g., sport lotteries, race tracks, card games)" (Toneatto, 2002, p. 192). Notably, this focus on illusion of control is also related to earlier theoretical work within psychodynamic theory with the emphasis of the gambler experiencing absolute control (omnipotence; Rosenthal & Rugle, 1994). Within cognitive theory, more specific irrational beliefs result from the core belief detailed above and can be

categorized in groups. Categories include for example beliefs about superstitious behavior (e.g., believing certain objects, rituals, or mental states confer higher probability of winning), attribution biases (e.g., wins reflect dispositional factor and losses situational factors), and control over luck (e.g., luck can be associated to specific games, machines, individuals). This cognitive theory is tied heavily to cognitive therapy of disordered gambling (Toneatto, 2002). Within this perspective it becomes essential to guide the individual with disordered gambling to become attentive to irrational beliefs, engage skeptically with them, and ultimately replace them with more adaptive beliefs regarding gambling and its' function.

More recently, the metacognitive perspective on disordered gambling represents an alternative way of conceptualizing how cognition plays a role in the development and maintenance of disordered gambling (Caselli et al., 2018; Spada et al., 2015). Proponents of this perspective have argued that it is mental processes such as worry, rumination, fantasizing about gambling that drives disordered development rather than specific content of beliefs, such as the aforementioned irrational beliefs (Caselli et al., 2018). Rather, these mental processes are seen as causative of the irrational beliefs, meaning that long-term recovery of disordered gambling requires changing such metacognitive processes. These metacognitive processes are themselves underpinned by metacognitive beliefs that can be broadly categorized into negative metacognitions that concern the uncontrollability of gambling and thoughts about gambling, positive metacognitions concerning the perceived usefulness of gambling to reduce worry, and metacognitions about consequences of gambling (e.g., gambling will make one lose one's mind, gambling thoughts should be repressed). While the metacognitive perspective represents a useful expansion or alternative conceptualization of traditional cognitive theory, it remains to investigated if targeted intervention of its constructs will result in recovery from disordered gambling.

Cognitive theory faces similar critique as behavioral theory in that it is unclear how the transition to severe disordered gambling (i.e., fulfilling criteria for GD) takes place (Griffiths & Calado, 2022). Further, it is unclear whether cognitive distortions cause disordered gambling, disordered gambling cause cognitive distortions, disordered gambling and cognitive distortions exhibit bidirectional causation, or disordered gambling and cognitive distortions simply develop alongside disordered gambling. Cognitive theory is now frequently combined with behavioral theory in CBT which is also considered the gold-standard treatment of disordered gambling (Cowlishaw et al., 2012; Oei et al., 2010; Raylu & Oei, 2010). Thus, CBT can include both the cue-exposure technique from behavioral therapy and the cognitive restructuring from cognitive therapy, described earlier.

1.2.4 *The pathways model*

Theories or aspects of theories of disordered gambling may complement each other and can be combined into more holistic frameworks. The pathways model represents one such effort and attempts to explain both the development and maintenance of disordered gambling (Blaszczynski & Nower, 2002; Nower et al., 2022). The pathways model draws on behavioral and cognitive theories of disordered gambling and asserts that individuals with disordered gambling can be grouped into three distinct categories that differ in terms of problem development and individual characteristics. The first pathway describes individuals that follow a pathway to disordered gambling driven by behavioral conditioning and irrational beliefs (i.e., mechanisms detailed within behavioral and cognitive theory, respectively). These gamblers do not have pre-existing psychopathology and initially start gambling for social and recreational reasons which gradually progress to disordered gambling through behavioral and cognitive learning. The second pathway describes individuals who are more likely to have pre-existing traumatic life events and comorbid mood disorders that would motivate gambling to regulate mood states. The third pathway describes individuals who have personality traits

that predispose them towards disordered gambling, including impulsiveness and anti-social personality traits which exacerbate sensation seeking and binge episodes of gambling. Like those within the second pathway, individuals within the third pathway also gamble to regulate mood states and the pathway was originally understood as a sub-group of the second pathway. Recent work with latent class analysis of a large number of treatment seekers have revised this view and now pathway 3 is considered an independent pathway within the revised pathways model (Nower et al., 2022). Some factors are understood as applicable across pathways. Notably, the model incorporates the contextual factors of availability and access to gambling opportunities as important pre-requisites to problem development. The model also emphasizes irrational beliefs (cognitive theory) as important in the maintenance of disordered gambling. The model is developed based on clinical samples where individuals tend to have more severe gambling problems (Loy et al., 2018). In reference to the previous discussion regarding terms for gambling problems, the model can be said to be applicable to those with GD, with pathological gambling, and/or at the far end of the continuum for disordered gambling.

The theories of disordered gambling covered so far have mostly focused on individual factors. Individual biological, psychological, and social factors are important in development and maintenance of mental problems, including disordered gambling, but these also act within broader contextual influences from the local community, culture, norms, and policies (Abbott et al., 2013; Lehman et al., 2017). The gambling environment with structural characteristics of gambling products can affect the development of disordered gambling as discussed in relation to behavioral theory mentioned above. The gambling environment is influenced by technological developments and governmental policies that affect the access and availability of gambling. This broader dynamic interplay can be illustrated by the case of Norway and electronic gaming machines (EGMs).

1.3 A brief history of gambling regulation and electronic gaming machines in Norway

Gambling in Norway has gone through periods of both strict regulation and liberalization since it first became legal in 1912 with the introduction of a state-owned lottery (Götestam & Johansson, 2009). Income from legal gambling in Norway has since its inception been granted to humanitarian efforts, sports, and research. Indeed, the Norwegian red cross was given a permit for mechanical gambling machines in Norway as early as 1938. Multiple gambling products were introduced across the 20th century, including horse racing (1927), sports betting (1948), and bingo halls (1960s), although stakes were modest and time between stakes and results were relatively long for most games (i.e., low event frequency) throughout this early period (Rossow & Hansen, 2016). The 1980s and 1990s represented a period of liberalization as horse race bets could be placed outside racing tracks (i.e., increasing gambling availability) and age limits and limits to winnings were removed from scratch cards and lotteries. Liberalization can be said to have peaked in the 1990s when EGMs were introduced and private companies could eventually run EGMs on behalf of organizations that were deemed to have public utility (e.g., local sports clubs; Rossow & Hansen, 2016). In contrast to earlier mechanical gambling machines, these EGMs introduced structural characteristics in gambling that have since been linked to higher risk for disordered gambling development, such as high event frequency, variable reinforcement schedules, audio-visual reinforcement, and high winnings (Yücel et al., 2018). While Norway has never had land-based casinos, EGMs became so ubiquitous in kiosks, supermarkets, bars etc., that Norway had the 3rd highest number of EGMs per capita in the world (Rossow & Hansen, 2016). Turnover from gambling increased massively between the mid-1980s and mid-2000s and this was predominantly because of EGMs (Götestam & Johansson, 2009).

These EGMs then became banned in 2007 as they were understood as contributing to disordered gambling. The relationship between EGMs and disordered gambling was also investigated empirically with studies examining disordered gambling rates before and after the ban. The results have been mixed as to whether the ban reduced disordered gambling, with some indications suggesting reduced gambling frequency and problems after the ban (Lund, 2009; Rossow et al., 2013), but also some findings suggesting no change (Bakken & Weggeberg, 2008). However, gambling turnover decreased drastically after the ban to EGMs, but has since then increased and has now surpassed estimates before the ban (Pallesen et al., 2020). Technological developments have continued and the 2010s have seen the expansion of online gambling so that Norwegians may now gamble online through the monopoly operators Norsk Tipping (lotteries, sports betting, online casino) and Norsk Rikstoto (horse racing), as well as through unregulated providers of gambling abroad (Pallesen et al., 2021; Rossow & Hansen, 2016).

The original EGMs that were banned in 2007 became replaced by another type of EGMs in 2009 named Multix (Rossow & Hansen, 2016). Multix EGMs are run by Norsk Tipping and are multigame terminals that were developed to be less likely to lead to disordered gambling by having less audio-visual stimulation, no cash deposit or payout, personal gambling cards that enable registered play, the introduction of loss limits, and opportunities to self-exclude oneself from the machine. Registered play involves the use of player cards and checking individuals date of birth and personal ID against the population registry, this was introduced for Norsk Tipping in 2009 and Norsk Rikstoto in 2020 and serves as an overarching tool for maintaining other responsible gambling tools such as global and game-specific loss limits and self-exclusion possibilities (Hamar, 2017; Norsk Rikstoto, 2021).

Previous studies have investigated player behavior at Multix (Leino et al., 2015, 2016, 2017; Sagoe et al., 2018). Leino et al. (2015) examined the effect of structural characteristics in Multix' games and found that playing games with higher payback percentage, lower average win size, and higher hit frequency (i.e., more bets must be placed to win) was associated with more bets placed. Relatedly, getting 'losses disguised as wins', meaning placing a bet and winning an amount less than staked, has been found to increase likelihood of continuing betting during a session compared to losing a full stake (Leino et al., 2016). Another repeated-measures study found that gambling on Multix terminals placed at alcohol-serving venues was associated with staking less money per bet but losing more money overall, compared to gambling at terminals placed at non-alcohol-serving venues (Leino et al., 2017). However, this pattern was not observed for individuals that met their monthly loss limit. This suggests that the people with less risky gambling behavior overall (non-limit reaching players) are more susceptible to the contextual effect of alcohol-serving. Finally, players have been found to place more bets and spend more time and money in places with multiple Multix terminals present (Sagoe et al., 2018).

1.4 Sociodemographic risk factors for disordered gambling

A risk factor can be defined as a "measurable characterization of each subject in a specified population that precedes the outcome of interest and which can be used to divide the population into 2 groups (the high-risk and the low-risk groups that comprise the total population)" (Kraemer, 1997, p. 338). Risk factors may be fixed (e.g., biological sex, birth year, ethnicity) or variable (e.g., income, age, marital status). Variable risk factors must occur prior to the outcome, rather than only appearing simultaneously or consequently, to fulfill the definition of a risk factor. Variable characterizations that only satisfies these alternative conditions, or when the temporal relationship is unknown, are better termed correlates

(Kraemer, 1997). Variable risk factors can be manipulated or not, and if the manipulation is shown to influence the outcome, then it can be termed a causal risk factor. Protective factors are the opposite of risk factors, they imply reduced risk for the future outcome, while sharing all other definitional conditions with risk factors (Kazdin et al., 1997).

It follows from the above definition of risk factors that only specific study designs can demonstrate the presence of risk factors. Cross-sectional studies, such as general population prevalence studies on disordered gambling and correlates, can only demonstrate the presence of fixed risk factors. Longitudinal studies are necessary to meet the precedence requirement of variable risk factors.

Accurate labeling of risk factors is important for correctly informing prevention and treatment efforts. Fixed risk factors are not relevant for intervention directly but may inform the search for causal risk factors and can be relevant for targeting of interventions. For instance, male sex has consistently been found to be positively associated with disordered gambling and can be termed a fixed risk factor (Allami et al., 2021). It is not meaningful to modify sex to prevent or treat disordered gambling, but knowledge about such variables can help the search for possible mechanisms in disordered gambling and it is possible to specifically target subgroups within fixed risk factors with prevention interventions.

Several sociodemographic (i.e., social and demographic) correlates of disordered gambling have been identified (Allami et al., 2021; Johansson et al., 2009). There appears to be a lack of a formal definition of ‘sociodemographic’ in most psychological studies, although the following correlates have been identified as positively associated with disordered gambling and are typically categorized under the sociodemographic umbrella term: Male sex, young age, belonging to minority ethnic groups, being single/divorced, lower education, and lower income (Allami et al., 2021).

The strength of association between disordered gambling and sociodemographic variables is lower than the association between disordered gambling and other categories of variables such as gambling activity variables (e.g., whether the individual engages in EGM gambling, poker, or internet gambling), psychosocial variables (e.g., anxiety, suicidal thoughts), or substance use variables (e.g., alcohol problems, tobacco use, cocaine use; Allami et al., 2021). However, sociodemographic variables hold special value in that they often concern more fundamental aspects in which all individuals vary and thus offer more practical utility in terms of prevention and minimization of disordered gambling. For instance, prevention targeting based on sex related differences in gamblers makes the intervention applicable to a larger group of individuals compared to targeting based on tobacco use in gamblers, a narrower sub-population. Thus, the potential total prevention impact can be greater (assuming the relevant causal mechanisms for disordered gambling are acted upon).

The current thesis focuses on the role of the sociodemographic variables age, gender, and marital status in disordered gambling. Age and gender constitute special cases of sociodemographic variables as other factors in psychopathology are often understood in relation to these. For age, this is perhaps best illustrated by the field of developmental psychopathology which seeks to understand causes and mechanisms of mental disorders through the perspective of developmental processes (Rutter & Sroufe, 2000). For gender, there are increasing efforts to not only control for gender in the study of mental disorders but to understand mental health through a gender perspective (Heidari et al., 2016; Riecher-Rössler, 2017). The latter refers to an attempt to examine the why and how of gender differences. For instance, depression is more common among women and one review took a gendered perceptive by understanding depression in women through women's higher tendency for rumination, higher exposure to abuse, and influence of sex hormones (Kuehner,

2017). There are similar calls for taking gendered perspectives in studies on disordered gambling as well (McCarthy et al., 2019; Venne et al., 2020).

Marital status represents a key structural indicator of social connection (i.e., the ways individuals connect to others emotionally, behaviorally, and physically; Holt-Lunstad, 2018). Marriage can provide a social connection that benefits physical and mental health whereas divorce constitutes a stressful life-event that can negatively impact physical and mental health (Booth & Amato, 1991; Holt-Lunstad, 2018; Saeri et al., 2018). The following sub-sections review the role of age, sex and gender, and marital status as correlates and risk factors of disordered gambling.

1.4.1 Age

Adolescents and young adults appear to be at increased risk for developing disordered gambling compared to older adults (Hodgins et al., 2011; Shaffer & Martin, 2011). Cross-sectional studies show increased prevalence among younger individuals: One systematic review and meta-analysis found worldwide problem gambling rates ranging between 0.12 – 5.8 % for the general population, with higher prevalence among younger individuals (Calado & Griffiths, 2016). Specific examination of those aged 10 to 24 show prevalence rates ranging between 0.2–12.3 % (Calado et al., 2017). These ranges in prevalence estimates show considerable variability which may partly be due to different problem gambling screening instruments and cut-off ranges (Derevensky & Gupta, 2000; Gambino, 2006; Ladouceur et al., 2000). Regardless, with lower age generally being associated with higher prevalence rates, it has been suggested that younger individuals are more likely to develop problem gambling because of their general tendency for risk-seeking behavior coupled with increased normalization of gambling in society (Arnett, 1992; Volberg et al., 2010).

Adolescents have higher impulsivity and increased risk taking compared to adults, which could predispose them towards gambling as well. This partly reflects ongoing brain

maturation, particularly within the frontostriatal system (DePasque & Galván, 2017). Further, peer influence and positive attitudes towards gambling within the family positively predicts disordered gambling among adolescents (Derevensky & Gilbeau, 2015). Established theories of disordered gambling can help us understand these lines of research. Behavioral theory and the pathways model emphasize reinforcement factors in the development of disordered gambling (Nower et al., 2022). Ongoing maturation of the frontostriatal system leads to a hyper-responsivity to rewards which consequently facilitates reinforcement of risky behaviors such as gambling (pathway 1). Additionally, the presence of peers promotes risk taking by sensitizing these reward pathways further (Chein et al., 2011). Finally, adolescents appear less responsive to negative feedback during risky decision making which can hinder harm avoidance learning (Cauffman et al., 2010). Thus, behavioral conditioning of (disordered) gambling might be facilitated among adolescents.

Cultural changes in high-income countries in the US, Europe and Japan may have contributed to a distinct period of maturation among young adults; a phase between 18 and 29 termed emerging adulthood that represents a continuation of social influences that characterized adolescence (Arnett et al., 2014; Sussman & Arnett, 2014). Emerging adulthood is characterized by identity development, self-focus, low stability in jobs and relationships, as well as optimism. Notably, this phase also includes increased tendency towards risk-taking behavior. This period of persistent experimentation can also extend to disordered gambling: One study followed individuals from adolescence to young adulthood and found that participants typically manifested their gambling problems at 15 years and these gambling problems were then moderately stable from 15 to 22 years old until showing a decrease at 30 years old (Carbonneau et al., 2015).

The higher prevalence of disordered gambling among adolescents and young adults compared to other age groups does not negate the importance of understanding disordered

gambling among older adults as well. Disordered gambling in older age can represent a continuation of disordered gambling developed earlier in life, or it can be newly developed in late life. Life-time disordered gambling among older adults (60+) has been estimated to affect between 0.01%-10.6% and there is a similar wide variation of 0%-11% for estimates of past 12-months disordered gambling (Subramaniam et al., 2015). Estimates are typically lower in general population samples compared to community samples and samples from gambling venues.

Older adults develop disordered gambling for a variety of reasons, including reasons that are more unique to these age groups. Stressful life events such as financial and sexual problems can increase the risk for disordered gambling in older adults, while some may turn to gambling as a coping mechanism for the loss of a partner or to alleviate feelings of loneliness (Elton-Marshall et al., 2018; Granero et al., 2020). Some may resort to drawing on savings to fund their gambling when their regular income and pensions are not sufficient (Southwell et al., 2008). Older aged adults with disordered gambling often experience more physical and mental health problems compared to other same aged individuals (Erickson et al., 2005; Pietrzak et al., 2007). Additionally, disordered gambling might be perceived differently among older adults as they may be more hesitant to admit to gambling problems due to stigma and might view the negative consequences as purely financial rather than a manifestation of disordered gambling per se (McKay, 2005).

A review by Tirachaimongkol (2010) analyzed disordered gambling among older adults in regard to the pathways model (Blaszczynski & Nower, 2002). The review suggested that pathways 1 and 2 are the most applicable in the development of late-life disordered gambling among older adults. This is because gambling as an escape from stress and negative emotions is a common motivation for older adults (pathway 2: emotionally vulnerable) and such gambling becomes reinforced through engagement with more continuous gambling

forms such as EGMs, and the lack of other sources of satisfaction (pathway 1: behavioral conditioning). However, pathway 3, which involves neurochemical and dispositional vulnerabilities, is also relevant in specific cases such as when older adults have health issues that increase their susceptibility to disordered gambling. This can include conditions such as stroke, dementia, and co-morbid substance abuse, which may cause abnormal brain changes that can lead to impulsive and compulsive behavior. In the case of Parkinson's disease, the use of dopamine agonists can also contribute to the development of disordered gambling (van Eimeren et al., 2009).

There is a dearth of studies investigating age in disordered gambling over time (For exceptions, see Abbott, 2020; Bilt et al., 2004; Carbonneau et al., 2015). Furthermore, longitudinal studies have typically examined age groups in isolation, such as adolescents and emerging adults (Allami et al., 2017; Carbonneau et al., 2015; Edgerton et al., 2015) or older adults (Bilt et al., 2004; Martin et al., 2011). While it is possible to review age-related findings across studies assessing different age groups, there might be aspects related to specific samples, jurisdictions, or timeframes that impact the pattern of results. Studies with multiple assessment points and with samples containing a wider range in participant ages would enable identification of potential age differences while holding such factors constant. The relationship between age and disordered gambling might also be further nuanced by taking gambling types into account. Gambling type preference varies by age, younger individuals prefer online gambling and games with skill-element, while older individuals tend to prefer land-based gambling and gambling types such as lotteries, casino, and horse racing (Ariyabuddhiphongs, 2012; Pallesen et al., 2021; Subramaniam et al., 2015; Welte et al., 2007). Differences in age-related gambling preferences might lead to different distributions of disordered gambling depending on the gambling type population. That is, it is possible that the inverse association between age and disordered gambling is stronger among online

gamblers and skill-element gamblers (e.g., poker and sports betting populations), and/or that this association is weaker or reversed among land-based EGM gamblers for instance (a preferred gambling type among older individuals).

1.4.2 Gender

Sex refers to male and female biological differences in sex hormones, external genitalia, internal reproductive organs, and chromosomal cellular and molecular differences (Clayton & Tannenbaum, 2016). Gender refers to socially constructed roles, norms, and relationships that influence how a person perceives and present themselves (self-identity). Gender can take on a spectrum of identities and expressions that go beyond a binary male/female distinction (Heidari et al., 2016). The terms sex and gender are often used interchangeably within the gambling literature (Kairouz et al., 2022). The current thesis uses the term gender unless referring to biological characteristics specifically, as gender is seen as the most inclusive term.

Men consistently report higher rates of disordered gambling compared to women (Allami et al., 2021; Johansson et al., 2009). This also includes estimates from studies that assess older age groups (i.e., 60+; Subramaniam, Wang, et al., 2015). Multiple sex and gender differences, including a combination of the two, could be driving differences in prevalence rates for disordered gambling. For instance, men are also more impulsive which could explain men's higher rates of disordered gambling and other externalizing disorders such as alcohol and substance abuse disorder (Eaton et al., 2015; González-Ortega et al., 2013; Nower et al., 2022). This can be interpreted in terms of biological and/or social factors. For instance, a suggested biological sex effect would be the unsupported idea that men show higher prevalence of disordered gambling due to higher testosterone levels driving impulsivity (Blanco et al., 2001). Social factors can also interact with biological factors. Men and boys have earlier gambling onset compared to women and girls, which in itself is associated with higher rates of disordered gambling (Ladd & Petry, 2002; Sundqvist & Rosendahl, 2019;

Tavares et al., 2002). If boys/men start gambling during adolescence and emerging adulthood more often than girls/women, then they would also be more exposed to the age-related factors discussed above, such as increased risk-seeking and ongoing brain maturation. Additionally, interpreted within the pathways model, men and boys would thus be exposed to longer periods of behavioral conditioning which also facilitates disordered gambling development (Blaszczynski & Nower, 2002).

While disordered gambling is more prevalent among men compared to women overall, there is more nuance to sex and gender differences in disordered gambling. In addition to having a later gambling onset, women typically progress faster from gambling onset to disordered gambling compared to men (e.g., González-Ortega et al., 2013; Grant et al., 2012; Ronzitti et al., 2016). This effect of accelerated progression from starting a potentially addictive behavior to developing an addiction has been termed 'telescoping'. It is currently unknown what causes this effect, although several potential explanations have been suggested and some have been evaluated empirically (Zakiniaeiz et al., 2017). The telescoping effect could be caused by unique gambling motivations, comorbidity, gambling type preference, or social norms affecting women that gamble.

Women are more motivated to gamble to escape negative emotional states compared to men, a type of motivation which is associated with more disordered gambling compared to other gambling motivations (Sacco et al., 2011). Further, this type of gambling motivation might be facilitated by comorbid mood and anxiety disorders, which appears more frequently among women compared to men (Blanco et al., 2006; Desai & Potenza, 2008). Alternatively, women might develop disordered gambling because of their preference for EGMs, a type of gambling associated with higher rates of disordered gambling compared to other gambling types (Blanco et al., 2006; Dowling et al., 2005; Leino et al., 2015). However, the telescoping

effect has been observed when controlling for both psychiatric comorbidity and game type preference (Grant et al., 2012).

Social norms can also influence women to start gambling later in life, although this does not explain the accelerated progression following gambling debut. The gender difference in gambling onset appears to be changing, however, which could mean that gender differences in disordered gambling could also shrink in the future, including the telescoping effect. Gambling onset appears to be influenced by social norms; the gender gap in gambling onset has been shortening in more recent birth cohorts alongside increasing public acceptance of girls and women gambling (Richmond-Rakerd et al., 2013). Indeed, the understanding of gambling and disordered gambling among girls and women should consider broader theories of gender differences and similarities. For example, sociocultural theory posits that gender differences are ultimately driven by historic division of labor, emphasizing both biological and cultural determinants. Women have traditionally taken roles that emphasize nurture and relationships, while men have had access to more power and wealth that enabled increased access and expectation of agency (Hyde, 2014; Wood & Eagly, 2012). The tendency for women to have higher neuroticism and rates of mood and anxiety disorders than men, may be understood because of women's lack of power. Women risk social costs by showing dominance/increased agency as it runs counter to gender norms. Neuroticism could then reinforce a tendency for emotion regulation motivation in gambling and thus faster progression to disordered gambling. Differences in division of labor, notably lower income among women, could also explain the telescoping effect as women have less money to lose and thus faster experience the negative consequences of gambling (Brown & Coventry, 1997). Heritability studies of disordered gambling suggest a larger impact from environmental factors for women compared to men (Xuan et al., 2017), attesting to a stronger role played by external factors, possibly including gender related norms and wage gap.

Studies on gender and disordered gambling mostly include gender as a control in multivariate analyses, rather than an attempt to understand disordered gambling through a gender perspective (McCarthy et al., 2019). The research on the telescoping effect and associated proposed explanations represents an exception to this (Zakiniaeiz et al., 2017). However, there are still limitations regarding research on the telescoping effect. Most studies on telescoping have used clinical samples, and individuals seeking treatment for gambling problems represent a unique population characterized by more severe gambling problems (Loy et al., 2018). Notably, one study based on a general population sample did not find support for the telescoping effect (Slutske et al., 2015). Previous studies have also relied on participants' retroactive recall of gambling onset and disordered gambling development, rather than prospectively following participants. Finally, one previous study has also suggested that differences in progression time from gambling onset to disordered gambling was due to age differences at gambling onset rather than gender itself, as the gender differences disappeared when controlling for age at gambling onset (Nelson et al., 2006).

Like with age, there is gender-related variation in gambling type preference and taking this into account might nuance the understanding of gender and disordered gambling. Women show stronger preference for EGM gambling compared to men, and disordered gambling among women have been found to be associated with their engagement with EGMs in particular (Baggio et al., 2018; Husky et al., 2015). Gender differences should be examined in relation to specific gambling type populations, both alone and in interaction with age (as this is another predictor of gambling preference, as reviewed above).

1.4.3 Marital status

Individuals with disordered gambling are more likely to be single or divorced, which has been suggested to be due to the relationship harm that disordered gambling can cause (Allami et al., 2021; Black et al., 2012; Kalischuk et al., 2006). Indeed, disordered gambling is defined in

part by gambling causing relational difficulties, reflected for instance in the GD criteria of concealment of gambling involvement, jeopardizing or losing relationships because of gambling, and using others to fund gambling (American Psychiatric Association, 2013).

Knowing someone with disordered gambling, being a concerned significant other (CSO), is relatively common. One Finnish general population survey found that 19.3% of participants could be classified as CSOs, with more than half of these reporting experiencing harms themselves due to that other person's disordered gambling, including worry, emotional distress, and interpersonal problems (Salonen et al., 2016). Spouses and family members typically report the most distress as CSOs and relationship difficulties are associated with severity of gambling problems (Dowling et al., 2014; Hodgins et al., 2007; Salonen et al., 2016). Prolonged disordered gambling is associated with higher risk for divorce among spouses (Svensson et al., 2013).

The understanding that disordered gambling increases the risk for relationship difficulties or divorce reflects an idea of mental health influencing marital status. This understanding is inherent when researching and providing treatment for partners/spouses of those with disordered gambling (i.e., targeting CSOs as such). Alternatively, one can examine how marital status influences mental health. Using risk factor terminology, this is the difference between disordered gambling being a risk factor for marital status and marital status being a risk factor for disordered gambling. There appears to be a lack of studies taking the latter approach to studying marital status and disordered gambling, such as by studying if divorce increases the risk for disordered gambling. However, these ways of understanding the relationship between marital status and mental health appear more commonly within the literature that covers psychopathology broadly (Amato, 2000; Whisman et al., 2022). Within such models, divorce is understood as causing short-term negative impact on mental health as an acute stressor (a 'crisis model') and/or long-term negative impact on mental health by

divorce leading to deprivation of the social, psychological, or material resources associated with marriage (a 'resource model'; Amato, 2000; Raley & Sweeney, 2020; Whisman et al., 2022). Relatedly then, marriage also holds implication for mental health, but rather in the way of being a potential protective factor.

Marriage is associated with better physical and mental health, including reduced risk for future alcohol use disorder (Hsu & Barrett, 2020; Kendler et al., 2016; Kiecolt-Glaser, 2018; Leonard & Rothbard, 1999). It has not been investigated whether marriage confers a similar protective effect against disordered gambling, although this appears plausible. Marriage constitutes a structural indicator of social connection, indicating that on average, marriage provides individuals with opportunities to connect with others emotionally, socially, and physically (Holt-Lunstad, 2018). This may buffer against disordered gambling development: Lack of social support has been shown to be associated with more severe gambling problems (Petry & Weiss, 2009). Further, loneliness has been found to mediate the positive association between being unmarried/divorced and disordered gambling among men (Botterill et al., 2016). The pathways model also posits that gambling to regulate mood states is a pathway towards disordered gambling development, of which marriage can provide an alternative source for coping resources and might make the individual less emotionally vulnerable overall (Blaszczynski & Nower, 2002; Nower et al., 2022). It should be noted that in cases of severe marital discord, marriage can have deleterious effects on mental health and divorce can result in improved well-being (Bourassa et al., 2015; Gustavson et al., 2014). Positive effects of marriage can stem from what is termed positive social control which includes using positive reinforcement and modeling to encourage healthy behaviors and discourage less risky behaviors (such as gambling), while avoiding the use of pressuring and restriction (Craddock et al., 2015).

Currently, the study of marital status and disordered gambling face several limitations. Associations between marital status such as divorce and disordered gambling are mostly based on cross-sectional studies that makes it impossible to conclude on directionality (Allami et al., 2021). When causality is assumed, it is predominantly based on spouses and partners self-reporting that they experience relationship discord and divorce *because of* their partners disordered gambling (e.g., Jeffrey et al., 2019; Lorenz & Yaffee, 1988). While this is very likely given the nature of disordered gambling, longitudinal studies could increase our knowledge of the magnitude of effects and provide more nuance to the trajectories of gambling harm and changes in marital status. Further, there is a need to examine the reverse route of influence as well, the potential association between marital status and future risk for disordered gambling. As reviewed above, this type of influence (i.e., marital status influencing mental health) has garnered empirical support among studies on psychopathology broadly. Thus, it appears plausible that one will observe similar effects for disordered gambling. Finally, as most studies on marital status and disordered gambling are based on general population surveys, the current knowledge base concerns individuals with less severe disordered gambling. Groups of individuals with moderate gambling risk and problem gambling are often collapsed to increase statistical power in such studies, and studies that include people with the more severe GD diagnosis are typically limited to small studies with convenience samples (Black et al., 2012).

1.5 Registry data and gambling

A registry can be defined as a "systematic collection of unit-level data organized in such a way that updating is possible" (United Nations Economic Commission for Europe, 2007, p. 15). Registries should have (near) complete data on a target population based on predefined rules. One example would be all individuals who have been in contact with

Norwegian specialist health services (Bakken et al., 2020). The unit must be uniquely identified. Identification is typically done by a unique person identification number, although a combination of other personally identifiable information may suffice (United Nations Economic Commission for Europe, 2007). Registry data can also be termed archival data, which includes any type of data that has been stored for purposes other than academic research (Heng et al., 2018). As such, behavioral tracking data in gambling, which is objective records of gambling behavior may also be seen as a form of registry/archival data.

Registry data allows for investigation of a whole population rather than a sample of said population. There are several strengths to using registry data in epidemiological research (Thygesen & Ersbøll, 2014). The high number of participants provides high statistical power. Access to complete populations can be especially valuable when the exposure factor or outcome of interest is rare. There is no selection bias, all participants in the target population are included. Further, there is often no recall bias as information is often collected independent of the individual. Registries typically allow for very long follow-up times which makes it possible to identify any relationships where the effect of the exposure factor manifests itself after a long time. Some limitations are also typical of registry data, however (Thygesen & Ersbøll, 2014). Registries can lack information needed to investigate specific study aims, typically because the primary aim of the registry is not to aid research. For instance: A researcher might be interested in investigating the role of marital status in relation to some illness/disease. The FD-Trygd registry is handled by Statistics Norway and contains detailed information about marital status/changes including marriage, divorce, and widowhood, but not cohabitation status which researchers could also be interested in (Statistics Norway, 2021). This is not a limitation of the registry itself because the variables are included in the registry based on relevance to judicial law, more specifically The Marriage Act (1991), rather than research aims. Lack of specific variables could also lead to issues of

confounding— the observed relationship between exposure and outcome can be partly or fully explained by another set of variables not available (Schneeweiss et al., 2005). Issues of data quality may arise such as lower completeness or missingness which may bias results. Completeness refers to the extent that the relevant information has actually been reported to the registry (Bakken et al., 2020). Missingness in registry studies can be hard to interpret in some cases, it could reflect true missingness or convey specific information (Thygesen & Ersbøll, 2014). Finally, data availability is naturally restricted to the start of the registry leading to left truncation. Failure to account for this can lead to issues such as immortal time bias in survival analysis, for example (Shariff et al., 2008).

1.5.1 Behavioral tracking data and the identification of disordered gambling

There have been several lines of research within the gambling field to identify behavioral patterns that can indicate risky and disordered gambling (Delfabbro et al., 2012). Such indicators are useful in circumstances where more direct assessment of disordered gambling is unavailable. Categorical conceptualizations of disordered gambling, including GD and problem gambling, is typically assessed through clinical interviews based on diagnostic criteria or screening instruments such as the PGSI (Ferris & Wynne, 2001). Alternative methods based on behavioral indicators include self-report of gambling behavior, observations in land-based venues, and, especially in more recent times, objective data on gambling behavior which is termed behavioral tracking data (Delfabbro et al., 2012; Gainsbury, 2011). Behavioral tracking data can be seen as a type of registry data and identifying behavioral indicators for risky and disordered gambling can aid health professionals and gambling operators to prevent or intervene with the development of gambling problems and associated harms (Auer et al., 2021). Notably, established indicators can also be used to further understand different groups/factors associated with risky and

disordered gambling, such as age, gender, game type and personality (Boldero et al., 2010; Dufour et al., 2015; Lloyd et al., 2010; Tackett et al., 2015).

Behavioral tracking data has been used in several studies aiming to identify risky and disordered gambling (Adami et al., 2013; Braverman & Shaffer, 2012; Dragicevic et al., 2011; Philander, 2014). One strength with behavioral tracking data is that it is not subject to failures in recall or social desirability bias, in contrast to self-report data. In terms of self-report data gamblers have been shown to overestimate their wins or underestimate their losses, and this tendency is greater among those with higher losses and self-reported gambling problem (Auer & Griffiths, 2017; Braverman et al., 2014). Furthermore, behavioral tracking data is ecologically valid as they are collected from real-world gambling contexts in a non-invasive manner. Further, behavioral tracking datasets are typically large (e.g., $n > 20{,}000$) and include detailed information regarding gambling behavior such as play duration, deposits, and wagers. Collected over time, behavioral tracking data allows for rich analysis of change.

One line of research using behavioral tracking data has attempted to predict risky and disordered gambling by combinations of different gambling behavior variables. Braverman and Shaffer (2012) conducted an influential study using behavioral tracking data of online sports-bettors who ended up closing their account within a 2-year period with a provided reason. The authors used theoretically informed measures of risky gambling behavior examined during participants' first 30 days of play; including frequency (total number of active days gambling), gambling intensity (total number of bets divided by frequency), variability (standard deviation of wagers), and trajectory (increasing/decreasing bets for first month). They identified four clusters of gamblers through k-clustering technique. Among these clusters, there was one cluster exhibiting low values on all risk indicators and one cluster exhibiting positive values on all risk indicators—reflecting groups of low and high-risk players respectively. Notably, gamblers that self-excluded due to self-perceived gambling

problems were overrepresented within the high-risk group, supporting the notion that these gambling patterns were associated with (self-reported) gambling problems.

The study by Braverman and Shaffer (2012) influenced several subsequent studies predicting self-exclusion using behavioral tracking data (Adami et al., 2013; Dragicevic et al., 2011; Philander, 2014). Dragicevic et al. (2011) also applied k-clustering and the same behavioral indicators, examining gambling patterns among a sample of casino gamblers. Their results revealed four clusters, although the clusters did not differentiate in the clear manner found by Braverman and Shaffer (2012). Adami et al. (2013) relied upon the same data-set and statistical technique as Braverman and Shaffer (2012), seeking to replicate their findings while also expanding on them by including two new indicators that may aid in the identification of disordered gambling. This included the "saw-tooth" marker and a marker of number of game types engaged in. A "saw-tooth" pattern consists of alternating between increasing wager sizes and the rapidly dropping them, suggesting that the gamblers exceeded their economic ability and were forced to restrict their own gambling behavior, indicating a form of over-involvement and loss of control. The authors replicated Braverman and Shaffer (2012) high-risk cluster with positive values on the original markers and they conducted a precision-recall curve for segmenting gamblers according to risk categories that indicated that the added markers provided greater detection of problem gamblers. Philander (2014) investigated the same data, while varying regression and classification approaches and found that artificial neural networks performed the best out of nine different analytic approaches. More recently, Ukhov et al. (2021) found support for a predictive model with 40 explanatory variables including demographic information such as age and gender, and numerous gambling behavior variables (gambling frequency, size of deposits etc.) to predict self-exclusion due to self-perceived gambling problems among casino and sports bettors.

Common behavioral indicators for risky and disordered gambling have also failed to receive support in some studies, including gambling frequency (Dragicevic, Percy, Kudic, & Parke, 2015; Gray, LaPlante, & Shaffer, 2012) and gambling involvement, the latter being a measure of number of different types of games played during a given period (Dragicevic et al., 2015). Different results may emerge as different studies assess different game types and populations of gamblers (Chagas & Gomes, 2017). Consequently, researchers may currently benefit from including several behavioral indicators when assessing risky and disordered gambling.

In terms of different analytic approaches underlying the identification process, machine learning approaches such as artificial neural networks may perform well in a predictive sense, but the resulting models can be harder to interpret. That is, harder to explain how and to what degree different variables contribute to identifying risky and disordered gambling (Ukhov et al., 2021). This may not concern those looking for reliable identification to aid in responsible gambling measures. However, researchers may be interested in theory building and being able to explain how different risk factors contribute to risky and disordered gambling. Regression-based approaches may fit better in these latter cases as they are easier to interpret.

Most of the studies reviewed above relied on access to many variables, but there is arguably a benefit to be able to approximate risky and disordered gambling by a single variable. The tradeoff to accuracy may be offset by ease of interpretation and convenience. Limit setting behavior represents one such possibility. Gamblers are sometimes being offered to control their gambling behavior by setting limits for time and money spent (Delfabbro & King, 2021). Limits can be personal and independent, or they may be tied to a specific gambling product/gambling provider. The limits can be voluntary by the gambler or mandatory limits set by the provider. For instance, Multix has mandatory daily loss limits of

650 NOK (10 NOK ≈ 1 €) and monthly loss limits of 2700 NOK. Gamblers may also enforce voluntary loss limits below the mandatory ones.

Lalande and Ladouceur (2011) studied the personal limit-setting behavior of disordered and non-disordered EGM gamblers. They found that most of the gamblers, regardless of disordered status, reported setting personal loss limits for themselves before beginning an EGM gambling session. However, disordered gamblers set higher loss limits relative to their income and were also more likely to exceed their own limits. The disordered gamblers were also more likely to be dependent on external measures such as the gambling venue closing or depleting all their funds to stop a gambling session. The authors suggest that limit setting behavior can act as a measure of (lack of) self-control and thus be informative of disordered status.

Self-exclusion can be understood as another "red flag" for disordered gambling. The option to self-exclude from gambling operators has become increasingly available in recent years — a study of 50 different online gambling sites found that 86% provided the option to do so (Bonello & Griffiths, 2017). Voluntary self-exclusion has been used as an indicator of disordered gambling (Haefeli et al., 2011; Haeusler, 2016). Other behavioral indicators for disordered gambling have also been evaluated/validated against it (as discussed previously). A key limitation to self-exclusion as an indicator of disordered gambling is the fact that gamblers may choose to self-exclude from gambling operators for reasons other than experiencing gambling problems, such as annoyance with a gambling operator (Hayer & Meyer, 2011). Catania and Griffiths (2021) found that most online gamblers that chose to self-exclude did so within 7 days and had minimal gambling activity at the gambling site in question. Individuals that self-excluded due to gambling problems had markedly higher expenditure. This suggests that gamblers that choose to voluntary self-exclude themselves

constitute a heterogeneous group and self-exclusion should be traced to (self-perceived) gambling problems or high spending to be a reliable indicator of disordered gambling.

Monetary expenditure, as well as wins and losses by extension, reflect key features of gambling. These features are also types of gambling activity that can be associated with risky and disordered gambling. Financial harm is the most prevalent type of harm resulting from gambling (Browne & Rockloff, 2018) and continued gambling involvement despite substantial financial losses is reflective of disordered gambling (Potenza et al., 2019). Money lost due to gambling has been found to be positively associated with disordered gambling (Fiedler et al., 2019). It follows from this that measures of monetary expenditure and/or money lost can be used as a proxy for risky and disordered gambling. However, measures of losses are influenced by individual extreme win/loss events which could biases analyses that focus on aggregate measures and group level data. Analyzing money spent can serve as an alternative, but this approach can be limited by the fact that house advantage differs across games (i.e., the size of bets can result in substantially different losses/wins depending on which game is played) which can distort aggregate measures.

Theoretical loss reflects the risk propensity that a person takes when gambling and has been argued by Auer and Griffiths (2014) to be the most robust and stable measure of gambling intensity. Theoretical loss is calculated as a product of total bet size and house advantage, specific to each game type. Theoretical loss addresses limitations associated with the impact of extreme individual win/loss events and house advantage differences between games impact on group level data and aggregate measures. Further, in cases of one or a few bets, theoretical loss reflects the level of risk the individual is willing to take independent of the actual win or loss result. Individuals' propensity for risk taking is arguably more relevant for research into disordered gambling rather than win or loss itself, which is a result of chance to a varying degree. Gamblers have for example been classified as high-risk gamblers by

belonging to the group with the 10% (Auer & Griffiths, 2013) or the 0.5% highest theoretical loss (Jonsson et al., 2019, 2020). Interestingly, there does not appear to be any studies that have demonstrated a direct positive association between theoretical loss and disordered gambling, a point of criticism that has been raised by others as well (Tom & Shaffer, 2016). Such a link appears plausible, however, given that research support the association between money spent on gambling broadly and disordered gambling (Fiedler et al., 2019).

Finally, it is important to note that behavioral tracking data in addition to its strengths, also has key limitations that should be acknowledged when evaluating this type of research, including the uncertainty regarding the usefulness of certain behavioral indicators as proxies for disordered gambling (Griffiths, 2014). Researchers using behavioral tracking data can only study participants' gambling behavior on the gambling site/operator they have access to, typically one or a few. Participants may however gamble at several gambling sites/operators, leading to issues of representativeness. Furthermore, gamblers may also share their player card with others which can confound analyses that assume independence. Often when using behavioral tracking data one might also lack accompanying information that has been shown to relate to disordered gambling, including data on personality traits, demographic information, income, other risky behaviors (e.g., drinking and smoking), and cognitive variables (Johansson, Grant, Kim, Odlaug, & Götestam, 2009). Behavioral indicators for disordered gambling might be moderated by these variables as well. Research using self-report data has its own set of limitations, but this type of research avoids some of the mentioned limitations in behavioral tracking data research. Participants may report on total gambling across all gambling sites and land-based venues, as well as provide additional information on variables such as personality and demographics. Consequently, the emergence of behavioral tracking data with all its benefits does not preclude the continued usefulness of research using self-report data.

1.5.2 The Norwegian Patient Registry (NPR)

The Norwegian Patient Registry (NPR) is one of several national health registries in Norway tracking individuals' contact with public specialist health services (Bakken et al., 2020; Health data, n.d.). The main goal of the registry is to aid administration and quality control of specialist health services, including financing (Norwegian patient registry regulation, 2007). Additionally, the registry should enable health research that may facilitate the understanding of health services, treatment effect, illness diagnosis, illness etiology, illness epidemiology, illness prevalence, illness development, and preventive interventions. The registry has included personal identification numbers (PIN) since 2008 which enables linking with other national registries at the individual level. As of 2018, there had been over 200 articles published based on data from the NPR with the rate of published articles increasing yearly (Bakken et al., 2020). The psychiatric diagnosis in NPR that reflects gambling disorder is the ICD-10 code F63.0 for pathological gambling (World Health Organization, 1993). Patients mainly receive this diagnosis through their contact with mental health care sectors and within specialized interdisciplinary addiction treatment. Data that has been registered at these institutions also include information such as referral type (treatment, assessment etc.), place of referral, patient ability to consent, waiting time before treatment was started and more (Health data, n.d.).

Access to diagnostic data from NPR allows for access to a large population of nationally representative treatment-seeking individuals with GD. As discussed in section 1.4.3, general population studies often include moderate risk categories and studies that do include GD are typically small and lack representativeness. Previously, studies using Nordic health registry data on GD have found that between 15% (Norway) and 25% (Sweden) of treatment-seekers with GD also suffer from comorbid substance use disorders, psychiatric comorbidity is more common among women with GD, and suicide is leading cause of death

among individuals with GD (Håkansson et al., 2018; Karlsson & Håkansson, 2018; Pallesen et al., 2019). However, there are also limitations to using health registry data (beyond the general limitations to registry data covered in section 1.5). Notably, findings will be limited to the far end of the disordered gambling spectrum with reduced generalizability of findings beyond this selective group. Treatment-seekers with GD have been found to have more severe disordered gambling, more comorbidity, financial harms from gambling, and relationship difficulties compared to individuals with disordered gambling in the general population (Loy et al., 2018). Further, any errors or biases present in the health registry will affect validity of resulting health registry studies. Data quality and accuracy is estimated to be high for NPR, although errors are more likely when researchers rely upon specific diagnostic codes rather than broader groups of related diagnostic codes (Bakken et al., 2020). This can also affect research on GD based on NPR data (which relies on the F63.0 code specifically). For example, inaccuracy can emerge because Norwegian clinicians also use the diagnostic code F63.0 for gaming disorder because there is currently no separate code for gaming disorder (Torvund et al., 2018).

1.5.3 National Welfare Database

The National Welfare Database registry ([Forløpsdatabasen Trygd, FD-Trygd]) stores data about work status, social benefits, and demographic information. Examples include information on whether the individual is receiving child benefits, retirement pension, or has employment-seeking status (Statistics Norway, 2021). Demographic information includes such variables as age and gender (based on an individual's birth number), citizenship, municipality, and marital status. Information is registered on all persons that are classified as "residents" which is defined as having provisional or permanent residence permit in Norway and that the individual is planning on staying in Norway for at least 6 months (Espeland et al., 2013).

The FD-Trygd registry has been used in combination with other national registries and surveys to study the relationship between health and factors such as welfare benefits, income, and marital status. For instance, such studies have demonstrated that psychiatric illness is a more common cause of disability benefits compared to somatic illness, that lower income levels are associated with increased risk for cancer, and that unmarried status and being divorced is associated with increased risk for suicide (Larsen et al., 2020; Mykletun & Øverland, 2010; Øien-Ødegaard et al., 2021).

1.6 Aims

1.6.1 Overall thesis aim

The current literature review indicates that previous studies have revealed much about the relationship between risky and disordered gambling and sociodemographic variables such as age, gender, and marital status. However, several knowledge gaps remain to be addressed. There is currently a dearth of studies combining wide age ranges and longer time spans meaning there is limited knowledge about how trends in risky and disordered gambling might vary between age groups over time. In the case of the telescoping effect, there is a need for prospective studies on non-clinical samples. For marital status, there is a need for studies examining the directionality between disordered gambling and marital status, and for studies including clinical samples.

The use of registry data, including health/social registries and behavioral tracking data, carries with it unique strengths that can also benefit the study of these sociodemographic risk factors of risky and disordered gambling. Notably, the automatic and non-invasive data collection makes it possible to avoid non-response or biases in self-report. This ensures objective reporting of gambling behavior across levels of gambling activity and for different demographic groups. This is important as previous research suggests people with disordered

gambling are more likely to overestimate their wins and underestimate their losses (Auer & Griffiths, 2017; Braverman et al., 2014). Some studies also indicate that men and younger individuals have been less likely to respond to gambling surveys, meaning inferences about men and younger individuals from survey studies could have some inherent biases (Fridberg & Birkelund, 2016; Pallesen et al., 2020; Scholes et al., 2008).

This thesis predominantly focuses on EGM gamblers, making use of a population dataset on Norsk Tipping's Multix players (Study 1 and 2). EGMs are consistently associated with higher levels of disordered gambling compared to other gambling types which underscores the importance of better understanding the role of age and gender among individuals playing EGMs (Allami et al., 2021; Dowling et al., 2005). The findings from Study 3 are not limited to EGM gamblers as that study made use of NPR data on all adults receiving GD diagnosis in a specific period regardless of game type participation.

The main aim of this thesis is to extend the understanding of age, gender, and marital status as risk factors for risky and disordered gambling. A secondary aim is to evaluate the benefits and limitations of using registry data for achieving the aims of the three studies. It should be clarified that the thesis does not aim to evaluate the use of registry data in general (e.g., how accurate behavioral tracking data is in predicting risky and disordered gambling, degree of errors in health registry data on GD, etc.).

1.6.2 Aim of Study 1

Study 1 used behavioral tracking data to investigate annual trends in theoretical loss (a measure of risk propensity in gambling) for a population of 195,318 Multix EGM players. The study aimed to assess how theoretical loss varied by age and gender groups. The study was guided by a public health approach in that it investigated a wider spectrum of theoretical loss, including the low (25^{th} percentile), medium (50^{th} percentile), and high (90^{th} percentile) parts of the theoretical loss distribution. The latter end of the disordered gambling continuum

is associated with the most severe harms, but the early and middle parts are associated with the most harm on aggregate, hence it was deemed important to examine the role of age and gender across wide levels of gambling (Browne & Rockloff, 2018; Canale et al., 2016). The direction or strength of the association between age or gender and theoretical loss could also differ at various quantiles, which is ultimately relevant for targeting of prevention efforts (e.g., if gender variation is greater at 90th percentile theoretical loss compared to 50th percentile theoretical loss, then tailoring interventions for gender is more important among high-intensity gamblers compared to average-intensity gamblers).

1.6.3 Aim of Study 2

Study 2 used the same behavioral tracking data set as Study 1 to investigate a specific gender-related topic within risky and disordered gambling development—the telescoping effect. Age at first month gambling on Multix and time from first month gambling on Multix to meeting first monthly loss limit was investigated and related to gender and age groups. In line with the telescoping effect, it was hypothesized that women would be older when they started gambling on Multix and show shorter time between gambling onset and meeting loss limit (the proxy measure for disordered gambling). An interaction effect of age groups on this time-to-event measure was also investigated.

1.6.4 Aim of Study 3

Study 3 used health registry data to investigate how transitions in marital status were associated with risk for future GD diagnosis. The aim was to investigate if transitioning from being unmarried to married was associated with reduced odds for future GD, and to investigate if transitioning from being married to divorced was associated with increased odds for GD. The study also investigated if individuals that would go on to receive GD were more likely to be unmarried or divorced at baseline when compared to individuals that had

previously received a somatic or psychiatric diagnosis, or were sampled from the general population.

2. Methods

2.1 Measures

2.1.1 Measures of Study 1 and Study 2

Study 1 and Study 2 utilized the same behavioral tracking dataset which comprises the population of Norsk Tipping Multix EGM players from March 2013 to December 2018. In 2009 registered play was made mandatory for all Norsk Tipping products, excluding paper-based scratch cards. Customers are required to use a personalized player card which is linked to national identity numbers, which enables complete records of gambling behavior.

Age and gender

Age and gender information was based on information from Norsk Tipping which in turn collects this from customers' national identity numbers. Gender is coded based on sex assigned at birth, although individuals can legally change this to reflect their gender identity from age 16 onwards. The gender change will be reflected in their new national identity number.

Proxy for risky and disordered gambling in Study 1

The main proxy measure of disordered gambling in Study 1 was theoretical loss (stated in NOK). Individuals' monthly bet amount was available for each of the 33 to 44 different Multix games that were available between 2013 and 2018. Norsk Tipping provided information on house advantage associated with each game, based on optimal play or average house advantage when optimal play was unknown (games that involved a skill-element). Theoretical loss was then calculated by multiplying game-specific bet amount with game-specific house advantage (Auer et al., 2012). Theoretical loss was adjusted for inflation up to

the average 2021 NOK value[1]. The choice of theoretical loss as a proxy is based on studies consistently observing a positive association between gambling expenditure/losses and disordered gambling/gambling harm (Braverman & Shaffer, 2012; Deng et al., 2021; Fiedler et al., 2019; Grönroos et al., 2021). Theoretical loss reflects gambling expenditure, while simultaneously incorporating information about the risk in specific games.

A secondary proxy measure of disordered gambling (used in sensitivity analyses, see below) was days played on Multix (gambling frequency). Days played have been found to have a positive association with disordered gambling (Braverman & Shaffer, 2012; Brosowski et al., 2021; LaPlante et al., 2014).

Proxy for risky and disordered gambling in Study 2

The proxy measure for disordered gambling in Study 2 was meeting the monthly loss limit on Multix. Given the study aim was to assess a variant of the telescoping effect, a categorical proxy measure was preferred instead of a continuous proxy measure such as theoretical loss. Loss limits denote how much money can be lost to gambling before further play is stopped for that month. There are both voluntary and mandatory loss limits, the mandatory limit was 2,500 NOK in 2013 which was adjusted to 2,700 NOK from 2016 onwards. When starting play at Multix, players must specify a voluntary limit that is below or equal to the mandatory limit. The choice of loss limit as a proxy measure for disordered gambling is based on studies finding a positive association between meeting loss limits and disordered gambling (Hing et al., 2015; Lalande & Ladouceur, 2011).

Other gambling behavior

A complete list of gambling behavior variables that were available in the Multix dataset is contained in the appendix.

[1] https://www.norges-bank.no/en/topics/Statistics/Price-calculator-/.

For Study 1, gambling behavior information also included frequency of individuals that had participated at Multix for each study year.

For Study 2, gambling behavior also included mean/median on the following: Bet total amount, time spent in minutes, number of sessions played, time from first active month to first monthly loss limit.

2.1.2 Measures of Study 3

Age and gender

Age and gender information was based on national identity numbers.

Gambling disorder

Information on month and year for first GD diagnosis was based on NPR and the diagnostic code for pathological gambling (F63.0). A survey of Norwegian clinics offering treatment for gambling problems revealed that the most prevalent assessment tool for gambling problems was the South Oaks Gambling Screen (SOGS) which is based on the DSM-III criteria of pathological gambling and the National Opinion Research Center DSM-IV Screen for Gambling Problems (NODS; Torvund et al., 2018). Thus, in practice, use of the diagnostic code for pathological gambling is likely to be informed by an understanding of gambling problems as reflected in the DSM system as well.

Marital status

Information on marital status was based on information from the FD-Trygd registry. Information on marital status and/or changes from January 2008 to December 2018 was included. The FD-Trygd registry includes the following marital statuses: Unmarried, married, widow/widower, divorced, separated, registered partner, separated partner, divorced partner, and surviving partner. Registered partnership between two individuals of the same sex has been possible in Norway since 1993. More information on coding and registration of

demographic variables in the FD-Trygd registry is available in a report by Statistics Norway (Espeland et al., 2013). For study 3, marital status was categorized into unmarried, married (including registered partnership), separated/divorced, and widowed.

2.2 Design and statistical procedure

2.2.1 Design and statistical procedure in Study 1

Study 1 used data on the full population of Multix players between March 2013 to December 2018 (70 months total; n = 195,318, 26.5% women, age range 18 to 103 years [M = 40, SD = 16]) which was supplied by Norsk Tipping. All gambling behavior measures were aggregated on a yearly level and values for 2013 were multiplied by 1.2 to better compare 2013 values to other study year values (i.e., to adjust for missing data in January and February in 2013). Gambling expenditure was first adjusted for inflation to 2021 value before being used in calculation of theoretical loss. Given that the study aim was to investigate how annual trends in theoretical loss varied at the level of age groups and gender, rather than examining how age and gender predicted individual trajectories, it was chosen to include participants in the analyses at the time they started playing Multix during the study period (e.g., an individual that first played Multix in 2015 was included from 2015 onwards). Age was categorized into six groups: 18-29, 30-39, 40-49, 50-59, 60-69, and 70+. Age grouping was done to make it easier to interpret the findings in relation to different parts of adult life and to uncover potential non-linear effects. The broader 70+ age group was made to make this group comparable in size to the others. Age was treated as a variable factor (i.e., individuals could age into a new age group during the study period). The study aim informed the statistical procedure: Quantile regression enables analyzing variation at different parts of the distribution and providing specific estimates for predictors (Koenker & Hallock, 2001). This made it possible to analyze age groups, gender, and years as predictors of low (25th percentile),

medium (50th percentile [median]), and high (90th percentile) theoretical loss. Models with main effects only and models that included two-way interactions between predictor variables were estimated. Quantile regression was a good fit for the aim of Study 1 because it can handle heteroscedasticity, is robust to outliers, and can uncover non-linear effects (predictors which have different influence at different parts of the distribution). This was important because the distribution of gambling behavior tends to be heavily skewed and age has been found to show stronger association with gambling expenditure at lower and higher ends of the distribution compared to the middle (Koenker & Hallock, 2001; Roukka & Salonen, 2020). The quantile regressions were also repeated for yearly days played as a sensitivity analysis. Theoretical loss is a function of money spent and financial ability varies by age, thus days played was also chosen because this variable is relatively less contingent on money (Statistics Norway, 2023).

2.2.2 Design and statistical procedure in Study 2

Study 2 also used the population data on Multix players, but excluded participants that would be less than 18 years old in 2013 (first study year). This decision was to accommodate the statistical approach (see below). The analytic sample comprised n = 184,113 individuals, 27.0% women, and age ranged 18 to 103 years (M = 41, SD = 16). Study aims involved investigating the telescoping effect which is constituted by two aspects, each requiring its own investigation. One of the aims was to investigate age differences at gambling onset between men and women and was done by conducting a Welch two-sample t-test comparing men and women's mean age at first active gambling month on Multix during the study period. The other aim was to investigate gender variation in individuals' time-to-event data, specifically the time between the first active gambling month on Multix and meeting the first monthly loss limit on Multix. This was done with Kaplan-Meier estimate of survival function and individuals that did not meet a monthly loss limit during the study period were treated as right

censored from their last active gambling month and onwards. The study also investigated if gender differences in time-to-event were dependent on age (interaction effect). This was done by conducting Cox proportional hazards regression on time-to-loss-limit and included age groups, gender, and their interaction as predictor variables. Cox regression involves estimating the probability of meeting a monthly loss limit within the time points in the study period (1-70 months) given that this has not occurred at a previous time point, with probabilities expressed as *hazard ratios* (*HR*). Age was categorized into six groups as in Study 1 for this analysis but was also treated as a fixed variable reflecting age at first active gambling month on Multix (meaning individuals could not age into a new age group). We opted for a robust variant of Cox regression as there were influential outliers in the data, although this meant age could not be treated as a variable factor (Bednarski, 1993; Minder & Bednarski, 1996)[2]. Finally, a set of sensitivity analyses were conducted to account for a potential limitation related to gambling onset on Multix. Participants could have gambled on Multix before the study start and if the degree to which participants did so differ between age and gender groups then this could potentially affect study conclusions. Thus, the Welch two-sample *t*-test, Kaplan-Meier estimate, and Cox regression was repeated for a subsample of participants that had their first active gambling month on Multix after month 12 or later into the study period (n = 76,182, 28.9% women). It was assumed that this would reduce the proportion of individuals with gambling onset on Multix before the study start.

2.2.3 Design and statistical procedure in Study 3

Study 3 used a population-based case-control design comparing individuals aged 18 years or older who received their first GD diagnosis in Norwegian specialist health services between January 2008 and December 2018 (n = 5,121) to individuals that had previously

[2] There exist solutions for adding time-varying covariates to Cox regression models which would accommodate for aging into new age categories. However, at the time of the study, we were not able to combine these solutions with a solution that was robust against outliers.

received a psychiatric or somatic diagnosis (NPR illness control, *n* = 27,826), or were part of the general population (FD-Trygd general control, *n* = 26,695). Individuals in the GD case group were frequency matched on age and gender characteristics for each of the control groups. Information on psychiatric or somatic diagnoses were taken from NPR and information on marital statuses were taken from FD-Trygd and this information was linked using participants' national identity number. The main study aims were to investigate (1) if going through a divorce was associated with increased odds of future GD diagnosis compared to remaining married, and (2) if getting married was associated with reduced odds of future GD diagnosis compared to remaining unmarried. Additionally, potential interaction effects between the marital status transitions and gender were examined. These main aims were achieved by conducting unconditional logistic regressions on odds for receiving GD diagnosis within subsamples of participants that were (1) married at baseline or (2) unmarried at baseline. Separate logistic regressions were conducted when using each of the control groups (illness control and general control). A two-step approach was used in which a main-effect only model was first estimated with the predictor variables marital status transition, age, and gender, and secondly a model including an interaction effect between gender and marital status transition. A secondary aim of the study was to examine if there were differences in the proportion of unmarried and separated/divorced at baseline between those who would receive their first GD diagnosis and those do who did not (the control groups). This was examined with chi-squared tests that compared proportions who were unmarried, married, separated/divorced, and widowed in January 2008 between GD cases, illness controls, and general controls.

2.3 Ethical considerations

2.3.1 Ethical considerations in Study 1 and Study 2

Studies 1 and 2 used secondary data that was de-identified by Norsk Tipping before access (i.e., data was made anonymous). This behavioral tracking data set constituted customer data, not health data. While the studies involve constructing proxy measures of disordered gambling, these indicators are approximations at the group level and do not equate classification of GD at the individual level. Studies 1 and 2 were exempted from ethical approval and from seeking individual informed consent in accordance with guidelines of Sikt (previously Norwegian Centre for Research Data) for anonymous data. Norsk Tipping ensured participant anonymity by providing each participant with a constructed (i.e., not backwards identifiable) and unique identification number and aggregated the individual tracking data to a monthly level.

2.3.2 Ethical considerations in Study 3

Study 3 used registry data from NPR and FD-Trygd registries and the study received ethical approval from the Regional Committee for Medical and Health Related Research Ethics in Western Norway (no. 30393). The data from the registries were linked and anonymized before the authors got access to it. Informed consent from participants was not required as is common in health registry research (Ludvigsson et al., 2015). A Data Protection Impact Assessment (DPIA) has also been made in collaboration with the University of Bergen and approved by the Department of Psychosocial Science, University of Bergen.

3. Results

3.1.1 Results in Study 1

The main effects quantile regressions on 25th, 50th, and 90th percentile theoretical loss showed that belonging to older age categories and being a woman was associated with higher yearly theoretical loss. For instance, for the 25th percentile yearly theoretical loss, the highest estimates were for the 70+ years age category at 500 NOK (95% CI [473, 527]) and women at 26 NOK (95% CI [23, 29]). For the 50th percentile (median) yearly theoretical loss, the highest estimates were for the 70+ years age category at 5,280 NOK (95% CI [5,111, 5,449]) and women at 334 NOK (95% CI [302, 367]). For the 90th percentile yearly theoretical loss, the highest estimates were for the 60-69 years age category at 15,343 NOK (95% CI [15,067, 15,620]) and women at 1,658 NOK (95% CI [1,478, 1,838]). Theoretical loss was stable or decreased by a small amount over the study years, with year estimates 0.15 NOK (95% CI [-0.24, 0.53]) at 25th percentile, -35 NOK (95% CI [-38, -32]) at the 50th percentile, and -1,061 NOK (95% CI [-1,109, -1,012]) at the 90th percentile.

The quantile regressions with two-way interactions on 25th, 50th, and 90th percentile theoretical loss showed that there was an interaction effect between age categories and gender: The positive association between age and yearly theoretical loss was stronger for men compared to women. This can be shown by contrasting the 2013 theoretical loss estimates for men and women at the youngest and oldest age groups, for instance. The following results are calculated with combinations of regression estimates to aid interpretability (see Table 3 in Paper 1 for 95% CIs of individual regression estimates). Contrasting men and women at 18-29 years: Men had theoretical loss of 20 NOK (25th percentile), 135 NOK (50th percentile), and 10,196 NOK (90th percentile). Women had theoretical loss of 47 NOK (25th percentile), 720 NOK (50th percentile), and 20,217 NOK (90th percentile). Contrasting men and women at 70+ years: Men had theoretical loss of 718 NOK (25th percentile), 8,068 NOK (50th percentile),

and 30,753 NOK (90th percentile). Women had theoretical loss of 439 NOK (25th percentile), 5,687 NOK (50th percentile), and 28,957 NOK (90th percentile). Thus, women aged 18-29 years had more theoretical loss than men aged 18-29 years old, but women aged 70+ years had less theoretical loss than men aged 70+ years.

The sensitivity analysis with quantile regressions on yearly days played showed similar pattern of results as the quantile regressions on theoretical loss (see appendix in Paper 1), although quantile regression was not possible for the 25th percentile of days played because of low variability for the predictors at that quantile. The main effects quantile regression on 50th and 90th percentile yearly days played showed that belonging to older age groups was associated with more yearly days played. For example, for the 90th percentile, the highest estimate was for the 70+ years age category estimate at 100.92 days played. Gender was only weakly associated with days played in the main effects models (50th percentile women: 0.40, 90th percentile women: -0.92). However, gender differences emerged more strongly in the model with interaction effects (50th percentile women estimate: 3.20 days played, 90th percentile women estimate: 25.00 days played). The positive association between age and yearly days played was also stronger for men compared to women. For example, at the 90th percentile, men aged 18-29 years had 54.00 days played and women aged 18-29 years had 79 days played. Men aged 70+ had 180 days played and women aged 70+ had 139,25 days played.

Finally, the number of individuals playing Multix during each year was examined (see Table 1 in Paper 1). The results showed that there was a decrease in participation across the study years. Information was only available from March onwards in 2013 (i.e., 10 months), although the number of individuals participating on Multix in 2013 was nearly identical to the full 2014 year (101,695 in 2013 versus 102,626 in 2014) and then decreased to 80,607 individuals in 2018 (final year). Men participated more frequently than women (For 2018:

59,318 men versus 21,289 women) and men aged 18-29 years had the highest number participating compared to all other gender- and age groups across all study years.

3.1.2 Results in Study 2

The results were in support of a telescoping effect for women gamblers at Multix. Women were older than men at their first active month on Multix by a mean age difference of 6 years (Women $M = 46$ ($SD = 17$), Men $M = 40$ ($SD = 15$); $t(80{,}779) = -66.52$, $p < .001$, Cohen's $d = -0.36$). The Kaplan-Meier survival estimate showed that the time to first monthly loss limit met was lower for women compared to men: The median survival time was 46 months, 95% CI [45, 47], for women and 55 months, 95% CI [54, 56], for men, out of the total 70 study months. The Cox regression showed that, when controlling for age categories, women had a 22% higher probability (*HR*: 1.22, 95% CI [1.20, 1.25]) of meeting a monthly loss limit at any time point in the study compared to men. The probability of meeting a monthly loss limit increased with older age categories up to the 60-69 years category which was associated with 93% higher probability (*HR*: 1.93, 95% CI [1.86, 2.00]) of meeting a monthly loss limit compared to the 18-29 years category. The interaction term between age categories and gender was statistically significant (Wald test = 3,156, 11 *df*, $p < .001$), so Cox regressions were stratified by gender to further investigate gender as a moderator of age category effects. The gender-stratified Cox regressions showed that the probability of meeting a monthly loss limit among men increased with older age categories up to the 60-69 years category which was associated with 152% higher probability (*HR*: 2.52, 95% CI [2.41, 2.63]) of meeting a monthly loss limit compared to the men in the 18-29 years category. The pattern between gender and age categories was associated with smaller effects and was less linear among women: The highest age-related probability of meeting a monthly loss limit among women was for those 40-49 years with 15% higher probability (*HR*: 1.15, 95% CI [1.09, 1.22]) compared to women 18-29 years.

The sensitivity analyses results mirrored the main analyses results. Women were older than men at their first active month on Multix by a mean age difference of 5 years (Women M = 44 (SD = 17), Men M = 39 (SD = 15); t(36,260) = -43.18, p < .001, Cohen's d = -0.36). The Kaplan-Meier survival estimate showed that the median survival time was 36 months, 95% CI [35, 38], for women and 47 months, 95% CI [46, 48], for men. Cox regression showed that, when controlling for age categories, women had a 28% higher probability (*HR*: 1.28, 95% CI [1.23, 1.33]) of meeting a monthly loss limit at any time point in the study compared to men.

3.1.3 Results in Study 3[3]

The logistic regression with interaction term between gender and divorce status was statistically insignificant using either control groups (illness control: OR = 1.11, 95% CI [0.74, 1.66]; general control: OR = 1.15, 95% CI [0.76, 1.72]), so only results from main effects models are presented. The results showed that going through divorce was associated with higher odds of receiving a GD diagnosis compared to remaining married. Specifically, those who got divorced had 2.45 (95% CI [2.06, 2.92]) times the odds of getting a GD diagnosis in the analysis with illness controls, and 2.41 (95% CI [2.02, 2.87]) times the odds of getting a GD diagnosis in the analysis with general controls.

The logistic regression with interaction term between gender and getting married was also statistically insignificant using either control groups (illness control: OR = 0.91, 95% CI [0.64, 1.27]; general control: OR = 0.80, 95% CI [0.56, 1.11]), so only results from main effects models are presented. The results showed that getting married was associated with reduced odds of receiving a GD diagnosis compared to remaining unmarried. Specifically, those who got married had 0.62 (95% CI [0.55, 0.70]) times the odds of getting a GD

[3] All logistic regressions were conducted as adjusted and unadjusted variants (i.e., the effect of each predictor when controlling for other predictors versus not controlling for other predictors). The ORs were similar between the adjusted and unadjusted analyses so only results from adjusted analyses are reported here. See Paper 3 for details on unadjusted analyses.

diagnosis in the analysis with illness controls, and 0.57 (95% CI [0.50, 0.64]) times the odds of getting a GD diagnosis in the analysis with general controls.

There were statistically significant differences in the proportion of unmarried and separated/divorced individuals at baseline between those who would receive their first GD diagnosis and those who did not (χ^2 [df = 6, n = 59,642] = 129.61, p < .001). Being unmarried or separated/divorced was more frequent among those that would go on to receive their first GD diagnosis compared to the control groups. The proportion of unmarried individuals within each group was 71.7% for those with GD, 64.1% for illness controls, and 63.0% for general controls. The proportion of separated/divorced individuals within each group was 10.0% for those with GD, 5.4% for illness controls, and 5.4% for general controls.

4. Discussion

4.1 Discussion on results regarding sociodemographic risk factors

The results from Study 1 and Study 2 contribute to our understanding of the role of age and gender for the distribution and development of risky and disordered gambling. While previous research indicates that younger men have the highest risk for disordered gambling (Allami et al., 2021), the results from Study 1 suggest that the pattern between age, gender, and risky and disordered gambling might depend on the type of gambling population examined. Results from Study 1 show that, when using theoretical loss or days played as proxy measures of disordered gambling, older individuals and women emerge as the most vulnerable groups in a land-based EGM population. Further, the interaction analysis indicated that the positive association between age and theoretical loss was stronger for men compared to women, particularly at 90th percentile theoretical loss. The aim of Study 1 was to investigate wider levels of gambling because gambling harm is distributed along the full spectrum of gambling activity (Browne & Rockloff, 2018; Canale et al., 2016). If the relationship between theoretical loss and gambling harm follows a previously found relationship between gambling risk/gambling activity and gambling harm, then lower (25th percentile) and average (50th percentile) theoretical loss could be associated with the most gambling harm overall and high theoretical loss (90th percentile) could be associated with the most severe types of gambling harm. The differences in the strength of association between age and gender and theoretical loss depending on quantile examined could also hold implications for the relationship between age, gender, and gambling harm then. Study implications for prevention are discussed in more detail in a separate sub-section below.

Results from Study 2 contribute to the understanding of risky and disordered gambling development. Women were older than men when they had their first active month gambling

on Multix, and women reached their first monthly loss limit faster than men with median difference of 9 months. This pattern of results is in line with the telescoping effect and reflects a common observation on disordered gambling development, although previously observed mostly in smaller clinical samples (Zakiniaeiz et al., 2017). There was also a positive association between age and probability of meeting a monthly loss limit in Study 2. Gender-stratified analyses revealed that this age effect mostly applied to men, indicating that women were more homogenous across age groups compared to men (like what was found for theoretical loss in Study 1).

The age and gender-related results in Study 1 and Study 2 can be interpreted as a reflection of the changing gambling landscape and related to established theories on disordered gambling. Gambling is increasingly taking place online in Norway and internationally, and younger individuals and men appear to more frequently gamble online (Gainsbury, 2012; Pallesen et al., 2021). Multix constitutes land-based gambling which might be becoming less attractive for younger and male audiences. Indeed, analyses on the yearly trends in participation on Multix showed that the player-base was becoming older across the study years (Study 1). Men aged 18-29 had the highest number of participating players on Multix in any given study year, but the lowest gambling intensity in any given study year as measured by theoretical loss at 25th, 50th, or 90th percentiles. This shows that young men are more likely to try Multix but less likely to continue gambling at Multix compared to other age and gender groups. Young men seem to prefer online gambling and gambling types featuring skill-element (e.g., sports betting, poker) which could result in this demographic concentrating their gambling involvement on these game types and thus show less engagement with Multix (Pallesen et al., 2021; Welte et al., 2007). While Multix features some skill-element games it predominately contains chance games. However, men who do gamble on Multix also show a higher preference for skill-element games compared to women (comparing proportions within

gender categories that have >50% of their game sessions on skill-element games, see Table 1 in Paper 2). Women and older individuals share a higher preference for EGMs compared to men and younger individuals, and land-based gambling is preferred among older individuals (Ariyabuddhiphongs, 2012; Husky et al., 2015). For younger women such as the 18-29 age group at Multix, the gender-related preference for EGMs might also be more important in driving their gambling engagement compared to their youth-related preference for online gambling, leading to particularly large differences in theoretical loss estimates between women aged 18-29 and men aged 18-29 at 90th percentile theoretical loss.

Behavioral theory of disordered gambling emphasizes the role of reinforcement factors in disordered gambling development and such reinforcement factors are often highlighted when discussing the problem potential of EGMs (Griffiths & Calado, 2022; Yücel et al., 2018). Structural characteristics of EGMs include high event frequency, variable reinforcement schedules, and audio-visual reinforcement (Yücel et al., 2018). Women and older individuals might be more likely to experience a form of vicious cycle on EGMs such as Multix: By preferring this gambling type they are more likely to continue their engagement which in turn leads to greater positive reinforcement. Structural characteristics within EGMs are also postulated to promote cognitive biases (Myles et al., 2019). Previous research confirms that structural characteristics such as higher payback percentage, higher hit frequency, and losses disguised as wins increase gambling engagement at Multix (Leino et al., 2015, 2016). Such behavioral learning and the consequent development and strengthening of cognitive biases that maintain disordered gambling are common for all three pathways in the pathways model, although feature more isolated in the first pathway that also represent most people with disordered gambling (Nower et al., 2022). Overall then, more risky gambling among women and older adults at Multix might be explained by factors that are in themselves applicable to all gender and age groups (i.e., reinforcement and cognitive biases), but that

disproportionately affect women and older individuals at Multix due to these demographic groups' preference for EGMs and/or land-based gambling in general.

The results from Study 2 indicated that women develop risky gambling faster than men on Multix. This could reflect that women have overall higher gambling activity (as found in Study 1 measured by theoretical loss), although gender differences on various gambling activity measures such as gambling expenditure, time spent gambling, and number of gambling sessions were small or nonexistent among those who met a monthly loss limit (see Table 2, Paper 2). Further, there were no gender difference in setting personal loss limits below the mandatory amount, so the results cannot be explained by women setting lower limits. Beyond the influence of the positive reinforcement factors discussed earlier, it is possible that women develop risky gambling faster than men because women are more likely to gamble based on emotion regulation motivation. Gambling based on emotion regulation can be understood as reflecting negative reinforcement factors within behavioral theory, or alternatively the consequence of positive metacognition (belief that gambling can increase control of worry or reduce worry) within metacognitive theory. Emotion regulation motivation for gambling is itself associated with increased risk for disordered gambling, although this hypothesis could not be tested directly in Study 2 (Marchica et al., 2020; Sacco et al., 2011). In line with this thinking, women have been found to be overrepresented within pathway two, 'emotionally vulnerable gamblers', in the pathways model for disordered gambling development (Nower et al., 2022). This tendency for emotion regulation gambling also characterizes older adults which could explain why older adults also had higher likelihood of meeting the monthly loss limit early compared to younger adults (See Table 3, Paper 2; Nower et al., 2022; Tirachaimongkol et al., 2010).

The results from Study 3 contribute to the understanding of marital status as a risk factor for disordered gambling. The results indicated that getting divorced or married was

associated with increased or decreased risk for future GD diagnosis, respectively. Previous studies have not taken such directionality into account (Allami et al., 2021) and the results speak to the importance of social bonds and social network history in explaining disordered gambling risk. However, it should be noted that these results from Study 3 do not disprove that disordered gambling can influence marital status as well, such as by disordered gambling causing divorce. The negative impact of disordered gambling on romantic relationships is very likely given CSOs' own accounts and the existence of help-offerings that target such issues specifically (Jeffrey et al., 2019). The relationship between marital status and disordered gambling could likely be bidirectional then.

Individuals who are married will on average experience more opportunities to connect emotionally, socially, and physically compared to people who are single/divorced/widowed (Holt-Lundstad, 2018). Marriage has previously been found to decrease the risk for alcohol use disorder and results from Study 3 indicates a similar 'marriage effect' for disordered gambling (Kendler et al., 2016). It is unknown what causes such an effect, but two possible explanations are that couples provide emotional support to each other and that couples monitor and control each other's risk behaviors (Craddock et al., 2015). Another possible explanation emphasizes marriage as a contrast to being unmarried: Individuals who are unmarried may have fewer social and financial obligations that would otherwise discourage overinvolvement in gambling.

Divorce entails losing the opportunity for social connection and material support that can result from marriage ('resource model'), while it also constitutes a stressful life event ('crisis model'). Poor outcomes may follow divorce when individuals experience lack of clarity in their self-concept (i.e., not knowing who they are following the divorce), excessive rumination, and poor sleep (Sbarra et al., 2015). Individuals who go on to develop disordered gambling might do so because they are attempting to cope with this long-term stress. Emotion

regulation motivation for gambling increases the risk for disordered gambling development (Allami et al., 2017; Groupe et al., 2016).

Relational factors are emphasized within modern psychodynamic theories for disordered gambling (Mooney et al., 2019). Disordered gambling may develop when gambling becomes a substitute for healthy attachment to others. Individuals with addictive disorders, including disordered gambling, have higher prevalence of insecure attachment style which hampers the ability to establish and maintain long-lasting relationships (Flores, 2001; Keough et al., 2018; Thorberg & Lyvers, 2006). Within this understanding, individuals who go through a divorce might be more likely to develop disordered gambling due to an insecure attachment style that predisposes them for both relationship dissolution and disordered gambling. The results of Study 3 also showed that people who subsequently developed GD had higher levels of unmarried and separated/divorce status at baseline, as well as more marital transitions compared to the control groups (see Table 1 in Paper 3). This history with more frequent marital dissolution and relationship instability could potentially be the result of stable individual differences such as attachment styles.

4.2 Discussion on the use of registry data for acheiving study aims

The current thesis makes a novel contribution to the understanding of socio-demographic risk factors for disordered gambling by leveraging registry data. Following this, the strengths and limitations of the individual studies also rest on the characteristics of the registry data used.

Study 1 and Study 2 made use of behavioral tracking data to investigate age and gender in risky and disordered gambling. Behavioral tracking data on gambling can provide detailed information on gambling behavior for many people over time and is collected in a non-invasive manner (Griffiths, 2014). In the present studies, theoretical loss and monthly loss limit behavior were two key variables accessed in the behavioral tracking dataset.

Previous studies indicate that gamblers underestimate their losses when self-reporting and more so among individuals with disordered gambling (Auer & Griffiths, 2017; Braverman et al., 2014). This limitation was thus circumvented by using behavioral tracking data. Further, detailed information on specific games and their associated house advantage made it possible to incorporate information about varying risk for specific Multix*'* games for Study 1.

The degree to which the results from Study 1 and Study 2 can be taken to reflect age and gender differences in risky and disordered gambling is dependent on the degree to which theoretical loss and meeting monthly loss limits function as behavioral indicators (proxies) of disordered gambling. Gambling expenditure and/or losses are consistently and positively associated with disordered gambling, which can be taken to support theoretical loss as a proxy for risky and disordered gambling (Deng et al., 2021; Dragicevic et al., 2011; Fiedler et al., 2019; Grönroos et al., 2021). Variation in purchasing power/income likely influences the relationship between gambling expenditure and disordered gambling at the individual level, although this should be less impactful when focusing on larger group differences such as those between age- and gender groups. Meeting a loss limit is a categorical measure of higher gambling losses but can also indicate loss of control (when gambling is suspended by external means rather than own volitional control). Studies indicate that individuals with disordered gambling meet/exceed loss limits more than those without disordered gambling (Hing et al., 2015; Lalande & Ladouceur, 2011; Louderback et al., 2021). The cut-off in gambling losses for experiencing a reliable increase in risk for disordered gambling varies with income level (Langeland et al., 2022; Louderback et al., 2021). The mandatory loss limit at Multix was 2,700 NOK from 2016 onwards and a recent Norwegian study indicated that the cut-off in monthly losses for experiencing reliable increase in risk for disordered gambling ranged from 390 NOK for the lowest income group to 2,318 NOK for the highest income group (Langeland et al., 2022). This suggests that meeting the mandatory loss limit at Multix is

associated with higher risk for disordered gambling even among individuals in higher income groups.

Measurement and operationalization of age and gender in the current thesis reflects how these constructs are classified in national identity numbers. Gender operationalization reflected legal gender (see section 2.1.1 “Age and gender”). Individuals can legally change their gender but must choose among binary categories (man and woman) and no information was available on gender change frequency in the current studies. This ultimately meant that gender change and transgender- and non-binary gender identification could not be considered. There is some indication that transgender and gender diverse individuals experience higher rates of disordered gambling and a full understanding of the role of gender in disordered gambling requires studies that can take into account a more inclusive gender definition (Rider et al., 2019). While classification is more straightforward for age, the reliance on registry data poses another challenge: The inability to identify illegal underage gambling. Gambling at Norsk Tipping (excluding paper-based scratch cards) must be registered, and the individual must be over 18 years. This means that any underage gambling at Norsk Tipping requires that the adolescent/child in question has access to someone else’s player card. Norsk Tipping confirms that there are cases of individuals illegally using others player cards although it is uncertain to what degree this happens, including the degree to which underage gamblers partake in such activity (Norsk Tipping, 2020). As such, adolescent gambling at Multix could not be considered in Study 1 and Study 2, although results from the 18-29 years group might be generalizable to adolescents to some degree. Emerging adulthood (age period 18-29 years) represents a continuation of the brain maturation and social influences (e.g., identity development, self-focus, variability in jobs and relationships) that characterize adolescence (Arnett et al., 2014; Susssman & Arnett, 2014). Behavioral tracking data can also represent a strength for the study of age and gender. Previous studies indicate that men and younger

adults are less likely to respond to gambling surveys hence objective recording of gambling behavior circumvents such issues, possibly also resulting in less bias in age- and gender related findings (Fridberg & Birkelund, 2016; Pallesen et al., 2020; Scholes et al., 2008).

Individuals with disordered gambling in the general population and treatment-seeking individuals differ from each other, so findings from general population gamblers (as in Study 1 and Study 2) and treatment-seekers (as in Study 3) may not fully generalize to the opposite population group. Treatment-seekers tend to have more severe disordered gambling, more comorbid psychopathology, relationship difficulties, and financial problems, compared to individuals with disordered gambling in the general population (Loy et al., 2018). However, the extent to which this constitutes a limitation should be viewed in relation to the current knowledge base for each specific topic/research question. Study 2 examined the 'telescoping effect' among general population gamblers, while previous studies have predominantly studied treatment-seekers (Zakiniaeiz et al., 2017). Study 3 examined the association between marital status and disordered gambling among treatment-seekers, while previous studies have predominantly studied general population gamblers (Allami et al., 2021, Black et al., 2012). As such, the samples utilized in each of the studies alleviate previous limitations for their respective knowledge bases.

Study 3 utilized diagnostic data reported in the NPR. This reflects the diagnostic code for pathological gambling in ICD-10, although clinical assessment also appears informed by measures based on DSM-III/DSM-IV in practice (Torvund et al., 2018). There were several strengths to using health registry data in Study 3: First, it allowed for access to a large sample size of individuals with GD (n = 5,121) which provided sufficient statistical power to examine more select research questions and sub-groups such as individuals transitioning from one specific marital status to another. Secondly, date-specific registration of both diagnosis and marital changes allowed for investigating directionality, which has previously been lacking in

studies on marital status and disordered gambling (Allami et al., 2021; Black et al., 2012). Thirdly, nationwide data was collected which ensures greater representativeness of treatment-seekers compared to other studies that sample from one or a few clinical settings.

Despite the strengths of using registry data (health registry or behavioral tracking data) in gambling research, a key limitation is the lack of information on other variables known to be related to disordered gambling such as personality traits, cognitive variables, and risk behaviors such as drinking and smoking (Allami et al., 2021). Inclusion of such variables would likely have made it possible to better explain the pattern of results in the current studies. For instance, measuring motivations for gambling would have made it possible to examine whether women and older adults who develop risky gambling faster also report more emotion regulation motivation for gambling. The lack of variables that cannot be inferred from behavior can be alleviated by combining behavioral tracking data with self-report data, but this will also introduce common limitations to self-report data (e.g., lead to reduce samples, possible bias in response, social desirability bias, recall bias, and attrition bias). The main strength of using registry research in gambling research seems to be the opportunity to establish robust empirical phenomena within specific populations, which then needs to be complemented by other methods (e.g., self-report surveys, laboratory studies, qualitative interview studies) to reach a fuller understanding.

4.3 Implications for intervention

Study 1 and Study 2 included the full population of Multix players over a relatively long period of time which makes it relevant to discuss practical implications of the current findings for that specific population. Beyond this, the practical implications of Study 1 and Study 2 are limited on their own but can become more actionable if supported by additional research.

Specifically, if this pattern extends to other types of land-based EGMs and national settings then this should inform prevention efforts in a broader sense.

There are two broad approaches to prevention or minimization of gambling harm: The responsible gambling approach to gambling harm minimization and prevention emphasizes solutions that retain individual informed choice in gambling, while the public health approach emphasizes system level solutions (Blaszczynski et al., 2004; Latvala et al., 2019). Examples of practices that reflect the responsible gambling approach are voluntary loss limits, voluntary time breaks, and self-exclusion from gambling products. These practices retain individual control but have been criticized by proponents of the public health approach as shifting responsibility of minimizing gambling harm away from the gambling operators and over to the individual consumer (Livingstone & Rintoul, 2020). Examples of practices that reflect the public health approach are those acting on gambling policy, distribution of type and location of gambling products, structural characteristics in gambling products, and mandatory limits. Such practices facilitate safer gambler environments, rather than relying on the responses of an individual gambler (Livingstone & Rintoul, 2020).

The introduction of Multix is itself an example of a public health intervention because Multix was introduced to replace earlier and riskier mechanical slot machines (Rossow et al., 2013; Rossow & Hansen, 2016). See section 1.3 for background and details surrounding these changes. While Multix has already been involved in harm reduction intervention, it is likely that Multix players can still experience gambling harm. Results from Study 1 showed that individuals can have high gambling intensity at Multix with yearly theoretical loss ranging up to 109,618 NOK[4] among participants, and previous research suggests that even moderate to low expenditure/activity can be associated with gambling harm (Browne & Rockloff, 2018;

[4] Actual losses at Multix are lower given this amount exceeds the amount allowed by mandatory loss limits in a year (2700 NOK × 12 = 32,400 NOK).

Canale et al., 2016). While theoretical loss does not equate actual losses, comparisons between yearly theoretical loss and median income values for 2018 also show that the most intense gamblers (90^{th} percentile) of men aged 70+ and women aged 70+ had theoretical losses reflecting 8.5% and 7.4% of their income, respectively (see Paper 1 for more on this). Further, Study 2 showed that 55,535 individuals (30% of the analytic sample) across the study period had met at least one monthly loss limit (see Table 1, Paper 2) which places these individuals above the cut-off for experiencing increased risk for gambling harm, even when adjusting for higher income groups (Langeland et al., 2022).

Additional gambling harm reduction interventions for Multix players should consider the most vulnerable groups: Older adults and women. Older adults report being exposed to more gambling advertising in stores so reductions in store advertising, and thus subsequent reduction in gambling activity caused by advertising, could benefit older adults particularly well (Pallesen et al., 2020). This also considers that such advertising occurs near or at places where Multix terminals are present. Informed by Study 2 results, player protection solutions that incorporate behavioral tracking data could also be adjusted to weight the rate of accelerating expenditure stronger among older adults and women when classifying disordered gambling (i.e., incorporating the 'telescoping effect'). There also exists empirically supported interventions for reducing theoretical loss among individuals already experiencing (likely) gambling harm, constituting harm minimization rather than prevention. Interventions such as loss limit reminders (Auer et al., 2018), motivational telephone calls (Jonsson et al., 2019, 2020), and pop-up messages on responsible gambling (Auer & Griffiths, 2015, 2016) have been shown effective. If the current findings replicate in other types of EGMs and national settings, then similar interventions could be considered in these settings as well.

The practical implications from Study 3 results are most relevant for the clinical context, as the study sample comprised treatment seekers. The finding suggests that clinicians

and support groups should be aware of the risks associated with relationship break-ups and the benefits of close relationships. Relationship dissolution and overall social network health should thus be considered in case formulation work in therapy and these factors may even influence relapse risk (Bonnaire & Billieux, 2022). Within a psychodynamic understanding of disordered gambling, for instance, it is seen as crucial to resolve patients' maladaptive relationship patterns to ensure long-term recovery and gambling abstinence (Rosenthal, 2008). Viewing the findings in a broader perspective, the presence and quality of social relationships buffer against psychological and physical ill-health (Holt-Lunstad, 2018; Hsu & Barrett, 2020). Effective community-level interventions such as improving social interaction opportunities in neighborhoods, improving social climate at the workplace, and providing easier access to services offering family- and couples counseling such as the Family Welfare Service, could have beneficial effects that may ultimately also reduce the risk for disordered gambling in the population (Holt-Lunstad, 2018).

4.4 Conclusion

The current thesis presents three studies that investigate the role of sociodemographic risk factors for risky and disordered gambling. Study 1 showed that older adults and women had higher gambling intensity at a land-based EGM. Age-related differences in gambling intensity were also stronger among men compared to women. Study 2 indicated a 'telescoping effect' for women as women were older than men when first gambling on the EGM, and women reached their first monthly loss limit faster than men. Study 3 showed that going through divorce was associated with increased risk for future GD, and that getting married was associated with reduced odds for future GD. The studies indicate that registry data can be leveraged to extend knowledge about sociodemographic risk factors for risky and disordered

gambling while also alleviating common limitations in more traditional approaches such as self-report surveys.

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Appendix

Information available in Multix dataset

DATASET TIME PERIOD

Includes full population of Multix players between March 2013 - December 2018

REGISTRY INFORMATION

ID	Player ID (constructed for anonymization)
Date and year registered NT	Year and month player registered at Norsk Tipping for the first time
Date and year registered Multix	Year and month player registered at Multix for the first time (after 2010[5])

DEMOGRAPHICS

Age	Age in March 2013 (study start)
Gender	0 = Man; 1 = Woman. Extracted via personal identification number.

INDIVIDUAL BEHAVIOR AT SPECIFIC MULTIX GAME IN A MONTH

ID game/name	Specific ID number for the game and the game name
Number of days	Number of days played at a specific Multix game in a month
Number of sessions	Number of sessions played at a specific Multix game in a month. Session is defined as logging into the electronic gaming machines
Number of rounds	Number of rounds played on a specific Multix game in a month.
Sum bet amount	Sum amount of bets placed in NOK at specific Multix game in a month.
Number of wins	Number of wins at specific Multix game in a month.
Sum win amount	Sum amount of wins in NOK at specific Multix game in a month.
Sum net amount	Net amount of wins and losses in NOK at specific Multix game in a month.
Time played	Time played in seconds at a specific Multix game in a month.

GENERAL INDIVIDUAL BEHAVIOR AT MULTIX (I.E., ACROSS GAMES) IN A MONTH

Number of days	Number of days played at Multix in a specific month
Number of sessions	Number of sessions played at Multix in a specific month

GENERAL INDIVIDUAL BEHAVIOR AT NORSK TIPPING

[5] NB: Participants could have registered/played at Multix before 2010, but information is not available prior to 2010 on this.

Sum bet amount on Norsk Tipping Sum amount of bets placed in NOK across all Norsk Tipping products (including Multix) at month active on Multix.

LOSS LIMIT BEHAVIOR AT MULTIX

Personally set daily loss limit The sum amount in NOK a person has set for maximum allowed losses at Multix for each day.

Times met personal daily loss limit Times met personal daily loss limit for Multix in a specific month.

Times met obligatory daily loss limit Times met obligatory daily loss limit for Multix in a specific month. This was set at 600 NOK until November 2016 and 650 NOK afterwards.

Personally set monthly loss limit The sum amount in NOK a person has set for maximum allowed losses at Multix for each month.

Met personal monthly loss limit 0 = No; 1 = Yes. Whether or not a player met the monthly personal limit.

Met obligatory monthly loss limit 0 = No; 1 = Yes. Whether or not a player met the monthly personal limit. This was 2500 NOK until November 2016 and 2700 NOK afterwards.

SELF-EXCLUSION BEHAVIOR AT MULTIX AND NORSK TIPPING

Partial self-exclusion Multix 0 = No; 1 = Yes. Whether the player opted to voluntary exclude themself from Multix between 1 and 180 days.

Permanent self-exclusion Multix 0 = No; 1 = Yes. Whether the player opted to voluntary exclude themself from Multix permanently.

Permanent self-exclusion NT 0 = No; 1 = Yes. Whether the player opted to voluntary exclude themself from Norsk Tipping permanently.

INTERNATIONAL GAMBLING STUDIES
https://doi.org/10.1080/14459795.2023.2199051

Routledge
Taylor & Francis Group

Age and gender differences in gambling intensity in a Norwegian population of electronic gaming machine players

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ABSTRACT

Participation in various types of gambling is associated with age and gender. Younger men tend to be drawn toward online gambling whereas women and older individuals tend to engage more in land-based gambling such as electronic gaming machines (EGMs). The present study examined how annual trends in theoretical loss, a robust measure of risk propensity/gambling intensity, varied according to age groups and gender among an EGM-population in Norway ($N = 195{,}318$, 26.5% women, age range 18 to 103 years [$M = 40.13$, $SD = 16.29$]). Quantile regression on the 25th percentile, median, and 90th percentile theoretical loss showed that higher theoretical loss at these quantiles were associated with older age. At the 90th percentile: Individuals aged 60–69 years had highest theoretical loss at 15,343 NOK (1,784 USD). Compared to men, women had higher 90th percentile theoretical loss (1,658 NOK≈193 USD). Interaction analyses showed that the positive association between age and theoretical loss was stronger for men compared to women. Gambling expenditure is positively associated with disordered gambling and the findings suggests that older individuals and women represent more vulnerable groups among the EGM population.

ARTICLE HISTORY
Received 7 November 2022
Accepted 31 March 2023

KEYWORDS
Problem gambling; risky gambling; gambling disorder; behavioral tracking; player-account data

People of nearly all ages gamble, some even across the whole lifespan (Welte et al., 2017). Development of disordered or high-risk gambling may occur at any point during the life course and involves varying levels of accompanying harm (Shaffer & Korn, 2002). For the individual and affected others, severe forms of disordered gambling are associated with the most harm, even rivaling the harm related to alcohol use disorder (Browne et al., 2017; Currie et al., 2006; Langham et al., 2016; Li et al., 2017). However, when viewed

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/14459795.2023.2199051.

from a societal perspective, milder levels of risky gambling appear to confer the most harm due to their higher prevalence in the population (Browne & Rockloff, 2018; Canale et al., 2016). Milder levels of risky gambling can be understood as involving gambling harms occurring in absence or with milder amounts of behavioral symptoms of problem gambling (e.g. preoccupation, increased tolerance, loss chasing). Consequently, from a public health perspective it is important to monitor and examine the trends of varying levels of gambling to identify changes in gambling involvement and risky gambling behavior over time. Such patterns may be related to well-established demographic correlates of disordered gambling such as age and gender, leading to the implementation of appropriate prevention efforts.

The role of age and gender in disordered gambling and gambling preference

Age and gender are robust correlates of disordered gambling (Allami et al., 2021). Disordered gambling is more prevalent among younger compared to older individuals, and among men compared to women. Problem gambling has been estimated to affect between 0.12–5.8% worldwide and while demographic categorization differs between studies there is a trend indicating more problem gambling among men compared to women and for those aged below 30 years compared to those aged above (Calado & Griffiths, 2016; Calado et al., 2017). Within Norway (where the present study was carried out), 1.4% of the population has been categorized as problem gamblers (Pallesen et al., 2020). In relation to age and gender, this comprises 1.9% for men compared to 0.8% for women, and 1.6% for those aged below 30 years compared to 1.3% for those aged 30 and above. Young people might be more likely to develop disordered gambling because of a general tendency for risk-seeking behavior which itself could be affected by peer norms and influence, identity exploration, and ongoing brain maturation (Sussman & Arnett, 2014; Volberg et al., 2010). Men also display increased impulsivity and risk-seeking compared to women, which could partly explain men's increased susceptibility for disordered gambling (González-Ortega et al., 2013).

Still, disordered gambling is also prevalent among women and older adults, which makes it important to understand disordered gambling among these groups (Ariyabuddhiphongs, 2012; Merkouris et al., 2016). One systematic review found that disordered gambling among women was more strongly associated with psychological distress, unemployment, and childhood abuse compared to disordered gambling among men (Merkouris et al., 2016). For older adults (55+ years), unique gambling motivations could partly explain disordered gambling within this group (Ariyabuddhiphongs, 2012; Tse et al., 2012). Older adults are more likely to gamble to socialize and to escape loneliness, anxiety, or depression compared to younger adults (Botterill et al., 2016; Elton-Marshall et al., 2018; Parke et al., 2018). Gambling to escape loneliness might be an especially important motive among older men (Botterill et al., 2016). Gambling to escape shows a stronger association with disordered gambling compared to other gambling motivations (Marchica et al., 2020).

Disordered gambling within genders and different age groups might be better understood by considering that individuals of different ages and gender show preference for different gambling types. For instance, young men show stronger preference for online gambling compared to older individuals and women (Gainsbury et al., 2015; Pallesen

et al., 2021). Moreover, there is a stronger association between online gambling and disordered gambling compared to land-based gambling, which in turn might partly explain the higher prevalence of disordered gambling among young men (Allami et al., 2021). Women have been found to have a stronger preference for non-strategic gambling such as electronic gaming machines (EGMs) and bingo compared to men and disordered gambling among women is typically associated with their engagement with EGMs in some countries (Baggio et al., 2018; Husky et al., 2015; McCarthy et al., 2018).

Behavioral tracking data and markers of risky gambling

Specific forms of gambling behaviors are associated with disordered gambling, which reflect more risky patterns of gambling (Delfabbro et al., 2012). The identification of these patterns has been facilitated by a growing number of studies using data on actual gambling behavior, often termed 'behavioral tracking' or 'player-account data' (Chagas & Gomes, 2017; Deng et al., 2019). Behavioral tracking data are not subject to recall and social desirability bias like self-report data (Griffiths, 2014; Shaffer et al., 2010). Compared to these objective data, gamblers have subjectively been shown to overestimate their wins and underestimate their losses, a tendency which is stronger among those with higher losses and self-reported gambling problems (Braverman et al., 2014; M. Auer & Griffiths, 2017).

Studies using behavioral tracking data and survey data have found that gambling behavior can be used to predict disordered gambling or self-exclusion (which can act as an indicator of disordered gambling) (Chagas & Gomes, 2017; Delfabbro et al., 2012; Ukhov et al., 2021). For example, the amount of money spent/lost to gambling is one type of behavioral indicator that has been suggested to reflect gambling intensity and propensity for risk-taking while gambling (Braverman & Shaffer, 2012; Deng et al., 2021; Dragicevic et al., 2011; Fiedler et al., 2019; Grönroos et al., 2021). However, one limitation with relying on money spent/lost to gambling in isolation is that individual win/loss events (e.g. winning a large sum of money from a low stake, or losing a bet with an unusually high stake) and differences in house advantage across games may bias the measure. M. Auer and Griffiths (2014) argue that 'theoretical loss' represents one type of measure that can account for these limitations. Theoretical loss is calculated by multiplying the total bet size by the house advantage specific to each game type and is a robust and stable measure of gambling intensity. Consequently, expenditure on games with a lower house advantage will result in lower theoretical loss and therefore lower risk taking compared to expenditure on games with higher house advantage.

Another behavioral indicator of disordered gambling not directly contingent on money spent is gambling frequency (e.g. number of different days played) (Braverman & Shaffer, 2012; LaPlante et al., 2014), which cross-sectional data suggests being an especially important predictor of disordered gambling among EGM gamblers (Brosowski et al., 2021).

The distribution of gambling behavior and utility of quantile regression

Gambling activity appears to be heavily skewed in that a minority of gamblers account for most of the gambling activity (Deng et al., 2021; Fiedler et al., 2019; Orford et al., 2013; Whiteford et al., 2022). For instance, it was suggested in one study that the top 20% most

engaged gamblers account for 90% of the net losses (Deng et al., 2021). The concentration of losses among a minority of gamblers could also suggest that highly involved gamblers differ in other aspects such as their background variables. Quantile regression represents an approach to studying such potential differences between gambling involvement groups by analyzing specific parts of the distribution, dividing it into (for example) quantiles such as the 25th, 50th [median], and 90th percentile (Koenker & Hallock, 2001). There is currently a dearth of studies employing quantile regression to study gambling behavior (for exceptions, see Roukka & Salonen, 2020; Whiteford et al., 2022). Studies using regression analyses typically rely on ordinary least squares (OLS) regression which estimates the effect of independent variables on the mean of the dependent variable, therefore focusing on the middle of the distribution. Such estimations may fail to generalize to other parts of the distribution in case of non-linear effects. For instance, one study found a stronger positive association between age and gambling expenditure at the 10th percentile and 90th percentile compared to the 50th percentile (Roukka & Salonen, 2020). Quantile regression enables investigations of such non-linear effects. Additionally, when representing the average (and other parts of the distribution) it is robust in relation to outliers and can handle heteroscedasticity (Koenker & Hallock, 2001).

There are benefits to investigating gambling behavior at lower and higher ends of the distribution. Studies have found that, in total, lower levels of risky gambling and lower levels of expenditure are associated with the most gambling harm in the population overall (Browne & Rockloff, 2018; Canale et al., 2016). This suggests that prevention efforts achieve most harm reduction by prioritizing low intensity gamblers over high intensity/disordered gamblers, what is termed the 'prevention paradox'. However, individuals with problem gambling and high gambling expenditure are still important targets for intervention because these groups experience the highest number of gambling harms at the individual level, including the most severe harms. If the direction or strength of associations between background variables (such as age and gender) differ between low, average, and high intensity gamblers then this is important information for focused targeting in prevention efforts.

The Norwegian context and the present study

The present study was conducted based on data from gamblers in Norway. Since the beginning of the 2000s, Norway has employed strong restrictions on the availability and access to gambling products (Rossow & Hansen, 2016). The state-owned gambling operator *Norsk Tipping* has a monopoly on providing scratch-cards, sports betting, number games, electronic gaming machines, and internet-based casino games. The other monopoly gambling operator *Norsk Rikstoto* has exclusive rights on horserace betting. However, due to online gambling opportunities, Norwegians may also to some degree engage in gambling via unregulated foreign operators.

Norsk Tipping introduced a new interactive electronic gaming machine *Multix* in 2008. *Multix* is a multigame terminal and offer games such as slots, roulette, and poker. To play *Multix*, individuals must be 18 years and older. *Multix* terminals have several responsible gambling measures, such as mandatory and voluntary loss-limits, as well as opportunities for players to self-exclude temporarily or semi-permanently (i.e. one-year minimum and ongoing until canceled). In 2009, *Norsk Tipping* made registered play

mandatory for all their gambling products, except paper-based scratch-cards. Individuals are required to use a personalized player card which is linked to their social security number. Importantly, this enables complete records of gambling behavior such as gambling expenditure, frequency, and self-exclusion, as well as geographical data (i.e. where the gambling is taking place) (Leino et al., 2017). The terminals are widespread throughout Norway, typically located in convenience stores and gas stations.

The present study investigated the association between age and gender and gambling intensity (as measured using theoretical loss) for the full population of *Multix* customers between 2013 and 2018. As noted above, age and gender have been shown to be robust predictors of risky and disordered gambling. However, it is unclear how these demographic variables relate to gambling intensity at varying levels of engagement over time. The skewed distribution typically observed for gambling behavior suggests that explanatory variables such as age and gender can have different associations with gambling intensity for those with low, average, and high engagement, for example. There are currently few studies examining gambling behavior with quantile analysis and there is to date no consensus regarding what quantiles constitutes 'low', 'average', and 'high' in this context. The present study focused on a limited number of quantiles for parsimony and opted for the 25th percentile as representing 'low', the 50th percentile (median) representing 'average', and the 90th percentile representing 'high'. The 25th percentile was chosen because it represents the middle of the lower half distribution, while the 90th percentile was chosen because it represents higher values without being confined to participants with extreme scores. Therefore, the present study was guided by the following research question: How do annual trends in low-intensity gambling (defined as 25th percentile theoretical loss), average gambling participation (defined as median theoretical loss [50th percentile]) and high-intensity gambling (defined as 90th percentile theoretical loss) vary by age groups and gender among a population of EGM customers in Norway?

Methods

Participants

Norsk Tipping provided gambling behavior data from the full population of *Multix* EGM customers between March 2013 and December 2018, comprising 195,318 individuals (26.5% women). Participant age at first active month of *Multix* play during the study period ranged from 18 to 103 years ($M = 40.1$ years, $SD = 16.3$).

Procedure and materials

Behavioral tracking data were requested from *Norsk Tipping* including information on age, gender, and gambling behavior on individual and total *Multix* games, and total sum of bets on all *Norsk Tipping* games, as well as loss-limit and self-exclusion behavior. All customers were linked to a unique identifying number (see appendix part A for full list of variables). The data were aggregated at a monthly level resulting in a total of 70 time points between March 2013 and December 2018.

Measures

Demographic information included age and gender, which was extracted by *Norsk Tipping* through customers' personal identification numbers. Age was handled in categorical age bands in the present study (i.e. 18–29, 30–39, 40–49, 50–59, 60–69, and 70+). There was no access to information regarding participants' ethnicity.

The present study focused on annual theoretical loss, a measure of risk propensity, calculated by multiplying game-specific gambling expenditure by game-specific house advantage. *Norsk Tipping* provided estimates on house advantage percentages for each game on *Multix* between 2013 and 2018, including updated values when game changes affected associated house advantage percentage. Of the 44 different games offered on the *Multix* terminals in 2018, five had a skill element. For these games the house advantage was calculated based on optimal play or average house advantage when optimal play was unknown. The median house advantage across games was 8% (IQR = 7.4%, 8.8%) with minimum 0.5% (blackjack, based on optimal play) and maximum 50% ('*Monkey Business*', a skill-element matching game, based on average house advantage).

First, gambling expenditure was adjusted for annual inflation to provide the average value of NOK in 2021 as provided by the Central Bank of Norway (https://www.norges-bank.no/en/topics/Statistics/Price-calculator-/). Then, each customer's monthly theoretical loss was calculated for each game and summarized across games. Finally, this monthly aggregate measure was summed annually. Gambling behavior data were only available from March onwards in 2013, so annual theoretical loss for 2013 was multiplied by 1.2 to better compare these data to subsequent years in the study.

Statistical approach

All statistical analyses were conducted with R version 4.1.3 (R Core Team, 2022), see appendix part A for list of R packages used. Descriptive statistics included proportion of *Multix* EGM players (defined as having played at Multix at least once) by age group, gender, and year. Annual theoretical loss ranged from 0 to 109,618 NOK, $M = 6{,}782$ ($SD = 10{,}198$), $Md = 1{,}265$ ($IQR = 86,\ 10179$), and exhibited positive skewness (1.83) and kurtosis (3.25). Descriptive statistics also included observed 25^{th} percentile, median and 90^{th} percentile theoretical loss by year, gender, and age groups, presented visually. Quantile regression was used to examine the study's research question. Quantile regression is robust to outliers and allows for examination of covariates effects on separate parts of the conditional distribution (Koenker & Hallock, 2001). Estimates were calculated at the conditional 25^{th} percentile, median, and 90^{th} percentile of theoretical loss. Two types of models were examined with annual theoretical loss as the outcome variable: The first model examined main effects of age categories, gender, and year, whereas the second model examined all two-way interactions between age categories, gender, and year. Age was handled categorically to account for potential non-linear effects, either in general or within different parts of the distribution (i.e. different quantiles) and to be able to relate findings to different parts of adult life. The analysis followed recommendations to report simple effect sizes (original units) rather than standardized effect sizes when they are meaningful (Baguley, 2009). Theoretical loss was measured in Norwegian kroner (NOK) which can be interpreted directly, is easily converted to other currencies, and is of

practical interest. Confidence intervals were calculated and conversions to United States dollars (USD) are presented to facilitate international interpretability and comparisons. Average exchange rates for 2021 were obtained from the Central Bank in Norway in which 1 USD = 8.6 NOK (https://www.norges-bank.no/en/topics/Statistics/exchange_rates/?tab=currency&id=USD).

Two sensitivity analyses were conducted to account for potential study limitations. First, in order to assess the degree of which theoretical loss might give an indication of disordered gambling, the analysis examined the proportion of self-exclusion among categories of theoretical loss. Behavioral indicators have previously been assessed against self-exclusion as a form of proxy measure for disordered gambling (Finkenwirth et al., 2021; Haefeli et al., 2011; Haeusler, 2016). The 25th percentile theoretical loss (86 NOK), 50th percentile (median) theoretical loss (1,265 NOK), and 90th percentile annual theoretical loss (22,770 NOK) was calculated based on the whole study period. Individuals' annual theoretical loss was then categorized into below 25th percentile, 25th to below 50th percentile (median), 50th to below 90th percentile, and 90th percentile and above. Self-exclusion was defined as *Norsk Tipping* customer's having at least one of any type of self-exclusion that year (temporary or semi-permanent on *Multix*, or semi-permanent on all *Norsk Tipping's* gambling products). Second, to account for differences in affordability among analyzed groups (e.g. older individuals typically having more money to gamble compared to younger individuals which could explain potential differences in theoretical loss), main analyses were repeated on active days played (gambling frequency) which has also been associated with disordered gambling but is less contingent on money spent (Braverman & Shaffer, 2012; LaPlante et al., 2014). Quantile regression was not possible on 25th percentile days played due to low variation in the included predictors at that quantile. Only summary results are presented from sensitivity analyses for brevity whereas the full results are reported in Appendix part B.

Ethics

The present study used secondary data that was de-identified by *Norsk Tipping* before access. Therefore, the study was exempted from ethical approval in accordance with guidelines of the Norwegian Centre for Research Data. *Norsk Tipping* ensured participant anonymity by providing each participant a constructed and unique identification number and aggregated the customer tracking data to a monthly level.

Results

Table 1 shows number of individuals who played *Multix* at least once during each year broken down by gender. The number of individuals playing *Multix* has decreased from 101,695 in 2013 (data available from March to December only) to 80,607 in 2018. The group with the highest number playing *Multix* were men aged 18–29 years irrespective of year. Women had relatively larger proportion of participating gamblers among their older age groups compared to men across the years examined. However, within each gender, the relative number of players shifted from younger to older age categories across the years examined for both genders.

Table 1. Participants on multix between 2013 and 2018 by gender.

	2013[1] (*N* = 101,695)		2014 (*N* = 102,626)		2015 (*N* = 94,253)		2016 (*N* = 94,599)		2017 (*N* = 89,465)		2018 (*N* = 80,607)	
Age Categories	Men *N* = 75,564 (74%)	Women *N* = 26,131 (26%)	Men *N* = 75,459 (74%)	Women *N* = 27,167 (26%)	Men *N* = 69,327 (74%)	Women *N* = 24,926 (26%)	Men *N* = 69,645 (74%)	Women *N* = 24,954 (26%)	Men *N* = 65,890 (74%)	Women *N* = 23,585 (26%)	Men *N* = 59,318 (73%)	Women *N* = 21,289 (26%)
18–29 years	23,333 (31%)	5,273 (20%)	21,484 (28%)	5,229 (19%)	1,207 (26%)	4,409 (18%)	17,641 (25%)	4,173 (17%)	15,600 (24%)	3,658 (16%)	12,605 (21%)	2,939 (14%)
30–39 years	15,070 (20%)	4,200 (16%)	15,092 (20%)	4,309 (16%)	13,480 (19%)	3,716 (15%)	13,877 (20%)	3,679 (15%)	13,125 (20%)	3,422 (15%)	11,826 (20%)	3,036 (14%)
40–49 years	15,284 (20%)	5,194 (20%)	15,093 (20%)	5,346 (20%)	13,640 (20%)	4,802 (19%)	13,220 (19%)	4,691 (19%)	12,126 (18%)	4,344 (18%)	10,729 (18%)	3,834 (18%)
50–59 years	11,476 (15%)	4877 (19%)	12,365 (16%)	5,088 (19%)	12,199 (18%)	4,823 (19%)	12,464 (18%)	4,880 (20%)	12,330 (19%)	4,730 (20%)	11,553 (19%)	4,381 (21%)
60–69 years	7,046 (9.3%)	3,887 (15%)	7,648 (10%)	4,172 (15%)	7,782 (11%)	4,150 (17%)	8,049 (12%)	4,260 (17%)	8,019 (12%)	4,080 (17%)	7,806 (13%)	3,784 (18%)
70+ years	3,355 (4.4%)	2,700 (10%)	3,777 (5.0%)	3,023 (11%)	4,019 (5.8%)	3,026 (12%)	4,394 (6.3%)	3,271 (13%)	4,690 (7.1%)	3,351 (14%)	4,799 (8.1%)	3,315 (16%)

[1]From March to December. Column percentages.

Observed trends in terms of 25th percentile, median and 90th percentile theoretical loss are visualized by age category, gender, and year, in Figures 1, 2, and 3, respectively. The results show that theoretical loss was positively associated with age for both men and women at all quantiles (25th, 50th [median], and 90th). The results in Figure 1 show that among those in the 25th percentile theoretical loss group, theoretical loss was relatively

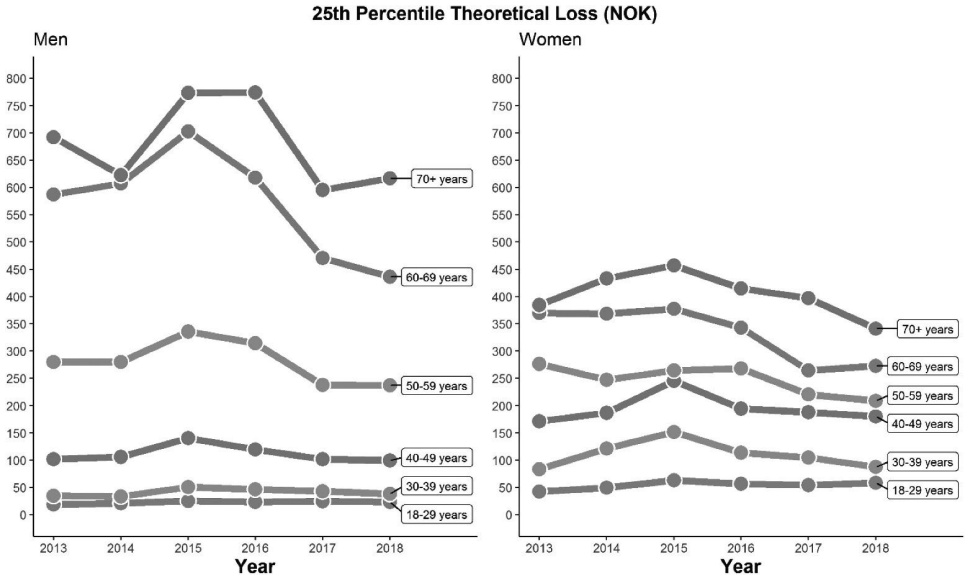

Figure 1.

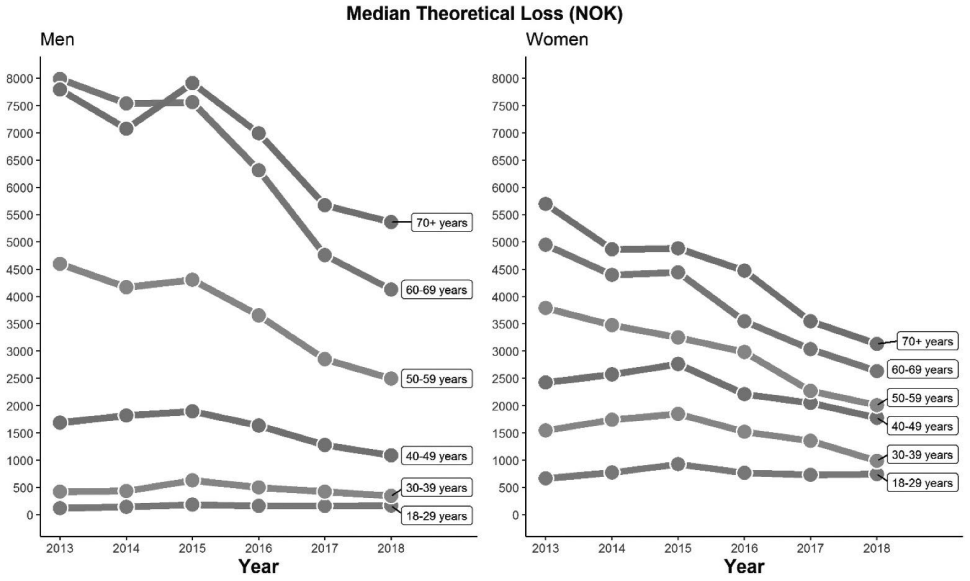

Figure 2.

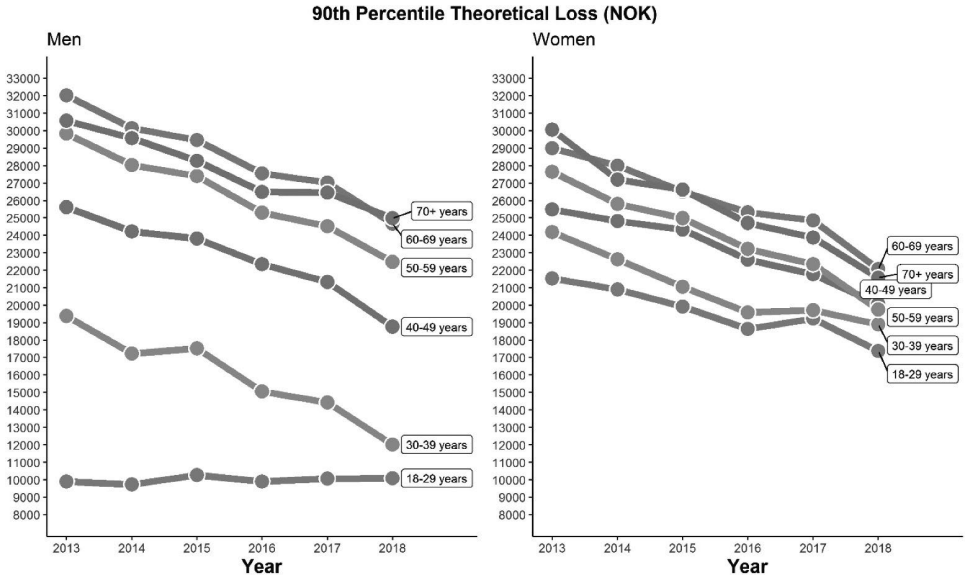

Figure 3.

stable between 2013 and 2018 for women at all age groups and men at age groups 18–29 years, 30–39 years, 40–49 years, and 50–59 years. Men aged 60–69 years and 70+ years showed more yearly variation, notably an increase in theoretical loss at 2015 (and 2016 for those aged 70+) followed by a reduction in 2017. The results in Figure 2 show that among those in the median theoretical loss group, theoretical loss was relatively stable between 2013 and 2018 among men aged 18–29 years and 30–39 years, and women aged 18–29 years. Median theoretical loss decreased between 2013 and 2018 for the other age groups and the reduction was stronger among older age groups. At all quantiles, the range in theoretical loss between the youngest and oldest age group was greater for men compared to women (i.e. men were more heterogeneous across age categories compared to women). The results in Figure 3 indicate that this pattern was more pronounced when considering the 90th percentile. Figure 3 also suggests that there is more overlap in levels of theoretical loss among the oldest age categories when considering the 90th percentile values of theoretical loss compared to median values and the 25th percentile values.

Results from quantile regressions are presented in Tables 2 and 3 and provide more precise estimates of the strength of associations between unique predictors and annual theoretical loss. Model 1 (Table 2 with main effects) indicated no annual changes in theoretical loss at the 25th percentile, and only small annual reductions at the median (35 NOK≈4 USD) and 90th percentile (1,061 NOK≈123 USD). Theoretical loss increased with age. The oldest age group (70+ years) had the highest estimated 25th percentile theoretical loss at 500 NOK (≈58 USD) and median theoretical loss at 5,280 NOK (≈614 USD), while the second oldest age group (60–69 years) had the highest estimated 90th percentile theoretical loss at 15,343 NOK (≈1,784 USD). Women had a higher theoretical loss than men when considering main effects at the 25th percentile, median, and 90th percentile. Model 2 (Table 3 with interaction effects) indicated stronger age-related

Table 2. Quantile regressions on 25th percentile, median, and 90th percentile yearly theoretical loss in NOK.

	Theoretical Loss (Model 1: Main Effects)					
Predictors	τ = *0.25*	*95% CI*	τ = *0.50*	*95% CI*	τ = *0.90*	*95% CI*
(Intercept)	22*	[21–23]	254*	[242–267]	14,503*	[14,264–14,742]
Year[1]	0.15	[−0.24–0.53]	−35*	[−38 – −32]	−1,061*	[−1,109 – −1,012]
Age 30–39 years[2]	22*	[21–24]	367*	[349–385]	5,048*	[4,749–5,347]
Age 40–49 years	99*	[95–103]	1,473*	[1,427–1,518]	10,581*	[10,295–10,867]
Age 50–59 years	237*	[228–245]	3,079*	[2,999–3,159]	13,383*	[13,114–13,652]
Age 60–69 years	427*	[408–445]	4,905*	[4,762–5,048]	15,343*	[15,067–15,620]
Age 70+ years	500*	[473–527]	5,280*	[5,111–5,449]	14,395*	[14,068–14,721]
Women[3]	26*	[23–29]	334*	[302–367]	1,658*	[1,478–1,838]
Observations:	563,255					

[1]Reference: 2013, [2]Reference: Age group 18–29 years. [3]Reference: Men. *Statistically significant at $p < .001$. *CI* = confidence interval. Coefficients rounded to nearest integer when≥1. Adjust decimal point in NOK values one digit to the left for rough approximation of conversion to USD

Table 3. Quantile regressions with interaction effects on 25th percentile, median, and 90th percentile yearly theoretical loss in NOK.

	Theoretical Loss (Model 2: Includes Interaction Effects)					
Predictors	τ = *0.25*	*95% CI*	τ = *0.50*	*95% CI*	τ = *0.90*	*95% CI*
(Intercept)	20*	[19–20]	135*	[129–141]	10,196*	[9,864–10,528]
Year[1]	1*	[0.86–1]	9*	[6–11]	−94	[−206–19]
Age 30–39 years[2]	18*	[15–20]	377*	[347–407]	8,915*	[8,396–9,434]
Age 40–49 years	94*	[87–101]	1,794*	[1,700–1,888]	15,436*	[14,955–15,906]
Age 50–59 years	291*	[272–310]	4,604*	[4,423–4,784]	19,588*	[19,117–20,058]
Age 60–69 years	626*	[584–667]	7,986*	[7,662–8,311]	21,540*	[21,067–22,013]
Age 70+ years	698*	[628–767]	7,933*	[7,543–8,322]	20,557*	[20,012–21,102]
Women[3]	27*	[22–33]	585*	[509–662]	10,021*	[9,486–10,556]
Age 30–39 Women	39*	[30–47]	457*	[358–557]	−4,749*	[−5,410 – −4,087]
Age 40–49 Women	50*	[37–64]	114	[−19–247]	−9,292*	[−9,938 – −8,647]
Age 50–59 Women	−65*	[−83 – −47]	−1,338*	[−1,507 – −1,168]	−12,070*	[−12,690 – −11,451]
Age 60–69 Women	−263*	[−297 – −228]	−2,987*	[−3,239 – −2,736]	−12,277*	[−12,899 – −11,654]
Age 70+ Women	−306*	[−362 – −250]	−2,966*	[−3,271 – −2,661]	−11,817*	[−12,482 – −11,152]
Year × Women	1	[−1–4]	12	[−15–39]	−95	[−201–12]
Year × Age 30–39	0.02	[−0.81–0.85]	−33*	[−42 – −23]	−1,155*	[−1,323 – −987]
Year × Age 40–49	−2	[−4–0.07]	−157*	[−184 – −130]	−1,075*	[−1,239 – −911]
Year × Age 50–59	−14*	[−19 – −9]	−433*	[−482 – −385]	−1,318*	[−1,470 – −1,167]
Year × Age 60–69	−33*	[−44 – −22]	−729*	[−809 – −649]	−1,212*	[−1,371 – −1,054]
Year × 70+	−17[a]	[−32 – −0.48]	−525*	[−621 – −430]	−1,128*	[−1,303 – −952]
Observations: 563,255						

[1]Reference: 2013, [2]Reference: Age group 18–29 years. [3]Reference: Men. * $p \leq .001$. [a] $p = .044$. τ = quantile. *CI* = confidence interval. Coefficients rounded to nearest integer when≥1. Adjust decimal point in NOK values one digit to the left for rough approximation of conversion to USD. Interpretation example for median value women aged 40–49 in 2015: 135 (Intercept) + 9 × 2 (Year) + 1 794 (Age 40–49 years) + 585 (Women) + 114 (Age 40–49 Women) + 12 × 2 (Year × Women) − 157 × 2 (Year × Age 40–49) = 2,356 NOK. Note that some discrepancy with observed values (Figure 2) are to be expected as the quantile regression provides values contingent on model variables specifically.

differences in theoretical loss among men compared to among women. For instance, considering the 90th percentile at 2013, men aged 18–29 years had a theoretical loss of 10,196 NOK (≈1,186 USD) while women aged 18–29 years had a theoretical loss of 20,217 NOK (≈2,351 USD). However, in the 70+ years bracket, men had the highest theoretical loss of 30,753 NOK (≈3,576 USD) compared to women 28,957 NOK (≈3,367 USD). Interactions between years and gender were small and statistically non-significant, where women as compared to men, showed a small increase of 1 NOK (≈0.12 USD) in

25th percentile theoretical loss and 12 NOK (≈1 USD) in median theoretical loss over the years, and a small decrease of 95 NOK (≈11 USD) in 90th percentile theoretical loss over the years. Interaction between years and age groups indicated that those aged 60–69 reduced their 25th percentile theoretical loss and median theoretical loss the most over the years with 33 NOK (≈4 USD) and 729 NOK (≈85 USD) decrease, respectively. Those aged 50–59 reduced their 90th percentile theoretical loss most over the years with 1 318 NOK (≈153 USD) decrease.

Results from sensitivity analyses (full results are presented in Appendix part B) showed that those with 50th to below 90th percentile theoretical loss had the highest proportion of self-exclusion (5.6%) compared to the 90th percentile and above (3.4%), the 25th percentile to below median (2.3%), and those below the 25th percentile (0.6%). Quantile regressions on median and 90th percentile days played (Table B2) showed that days played increased with age, Model 1: Age 70+ years had the highest median of 44 days and 90th percentile of 101 days. Model 2 indicated stronger age-related differences in days played for men compared to among women. For instance, considering the 90th percentile at 2013, men aged 18–29 years had 54 days played while women aged 18–29 years had 79 days played. However, in the 70+ years bracket, men had the highest days played at 180 days compared to women at 139 days.

Discussion

The present study investigated how gambling intensity in a population of EGM gamblers was related to age and gender differences. The results indicated that gambling on *Multix* EGMs decreased between 2013 and 2018 and that the player base had become older across the period. Reductions in EGM participation have also been observed in Finland between 2007 to 2015 (Castrén et al., 2018). One explanation for this decrease could be the increasing popularity of online gambling over the same period. Online gambling is more frequent among younger individuals and men in Norway (Pallesen et al., 2021). In terms of age, this is in line with the finding that the *Multix* player-base is becoming older. In terms of gender, the relative proportion of men and women participating each year remained nearly the same from 2013 to 2018 in the present study (74%/73% men versus 26%/27% women). Men aged 18–29 years had the highest rate of participation on *Multix* (i.e. having played at least once during a year) but the lowest gambling intensity. It is conceivable that young men might concentrate their gambling online or on other types of gambling such as sports betting, resulting in low gambling intensity on EGMs such as *Multix* (Pallesen et al., 2021; Venne et al., 2020). Women aged 18–29 years also reduced their *Multix* participation over the examined years compared to other age categories of women. Younger women have increased online presence compared to older women which could increase their exposure to online gambling marketing leading them to engage in other types of gambling besides EGM gambling (McCarthy et al., 2018).

The results supported the notion about age and gender differences in gambling intensity among EGM players. Gambling intensity as measured by theoretical loss was positively associated with age for low (25th percentile), average (median) and highly involved (90th percentile) gamblers. However, it was somewhat surprising that older age was associated with the highest theoretical loss because disordered gambling is typically more prevalent among younger individuals (Allami et al., 2021). The results of the

present study suggest that older individuals might be at higher risk compared to younger individuals playing EGMs. It has been suggested that a key motivation for gambling among older individuals is to socialize and/or alleviate feelings of isolation which is possible at many venues with *Multix* (Parke et al., 2018). This is important to keep in mind because gambling to escape negative emotions appears to be more strongly associated with disordered gambling compared to other types of gambling motivations (Marchica et al., 2020).

Men showed more age-related differences in gambling intensity compared to women, and this pattern was more pronounced when considering the most involved gamblers (90^{th} percentile theoretical loss). Previous studies suggest that women show a relative preference for EGM gambling which could explain why they have higher gambling intensity on *Multix* compared to men who typically prefer other game types such as sports betting and poker (Holdsworth et al., 2012; McCarthy et al., 2018; Venne et al., 2020). Disordered gambling among women is typically associated with EGMs in particular (Baggio et al., 2018). The difference in gambling intensity was especially strong between men and women aged 18–29 years at the 90^{th} percentile, where women were found to have twice as high gambling intensity. Being of young adult age is associated with higher preference for online gambling (Gainsbury et al., 2015; Pallesen et al., 2021), but the influence of women`s preference for EGMs might exceed this for young adult women which results in especially strong gender differences in EGM gambling intensity at this age group. Among the most involved gamblers (90^{th} percentile), gambling intensity fell markedly across observed years for men in age groups 30–39 years and 40–49 years. Men in older age groups might become increasingly comfortable with online gambling solutions which would be coinciding with the expansion of online gambling opportunities over the years examined (Pallesen et al., 2021).

Both older individuals and women have more often than their younger counterparts reported being motivated to gamble to reduce negative emotions, anxiety, depression, and loneliness, which has been termed escapism motivation (Holdsworth et al., 2012; Parke et al., 2018). Escapism motivation has also been found to drive gambling participation and frequency with EGMs, with stronger associations for those with risky gambling (Abarbanel, 2014; Balodis et al., 2014; Wood & Griffiths, 2007). Taken together, these findings may explain why older individuals and women emerged as the groups with the highest gambling intensity in the present study.

Results from the present study can also be interpreted in relation to income among Norwegians. Statistics Norway (2023) provides information concerning the median income in Norway after tax for select demographic groups in 2021: single individuals aged 18–30 years earned 302,000 NOK (≈30,541 USD), those aged 30–44 years earned 372,000 NOK (≈37,606 USD), those aged 45–66 years earned 366,000 NOK (≈36,992 USD), and those aged 67+ years earned 293,000 NOK (≈29,615 USD). Individuals cohabiting show the same pattern of relative age group differences in median income after tax (Statistics Norway, 2023). Based on these median income values and theoretical loss in 2018, the most intense gamblers (90th percentile) among men aged 18–29 years had a theoretical loss reflecting 3.3% of their income, while men aged 70+ years had a theoretical loss reflecting 8.5% of their income. The most intense gamblers among women aged 18–29 years had theoretical loss reflecting 5.8% of their income, while women aged 70+ years had theoretical loss reflecting 7.4% of their income. However, it should be emphasized that theoretical loss does

not equate to actual losses and disposable income for gambling and is dependent on multiple factors such as debt, wealth accumulation, and caretaker responsibilities. Notably, gender can influence income, although this appears to be less influential in Norway compared to many other countries such as the US (Reisel et al., 2019).

The present study focused on theoretical loss as an outcome measure, a measure that reflects risk-taking (M. Auer & Griffiths, 2014). Theoretical loss is sensitive to house advantage and therefore the same money stake can reflect more or less risk of loss depending on the specific game where it is staked. Theoretical loss is also robust against single extreme wins or losses and gives a stable measure of the risk an individual is willing to take while gambling. Still, there appears to be lack of research demonstrating a direct link between theoretical loss and disordered gambling. Despite this, gambling expenditure, which theoretical loss is a modified version of, have consistently been associated with disordered gambling (Braverman & Shaffer, 2012; Deng et al., 2021; Dragicevic et al., 2011; Fiedler et al., 2019; Grönroos et al., 2021).

Previous behavioral tracking studies have also used self-exclusion from gambling as a proxy indicator of disordered gambling in the absence of a direct measure of disordered gambling (Finkenwirth et al., 2021; Haefeli et al., 2011; Haeusler, 2016). As such, a sensitivity analysis was conducted examining the relationship between categories of theoretical loss and self-exclusion. The results indicated that theoretical loss between both the 50–90th percentile and at the 90th percentile and above were associated with more self-exclusions from gambling (*Norsk Tipping* globally or *Multix* specifically) compared to theoretical loss below the 50th percentile. However, the highest proportion of self-exclusions was in the 50–90th percentile, and not the 90th percentile and above. It should, however, be noted that self-exclusion is itself a limited proxy measure for disordered gambling because individuals may choose to self-exclude for reasons other than having a gambling problem (e.g. being annoyed with the gambling operator) (Catania & Griffiths, 2021).

Individuals differ in the amount of money they have available for gambling – what is termed gambling affordability. Differences in theoretical loss, and other measures of gambling expenditure, should be discussed in relation to this. In the present study, older individuals had higher theoretical loss compared to younger individuals and older individuals tend to have higher incomes. However, it is notable that the oldest age groups (60–69 years and 70+ years) had the highest theoretical loss as national statistics show these age groups also have lower median income compared to younger adults in Norway (Statistics Norway, 2022). Sensitivity analyses on gambling frequency were also carried out which is another indicator that has been found to be positively associated with disordered gambling (Braverman & Shaffer, 2012; Brosowski et al., 2021; Jonsson et al., 2022; LaPlante et al., 2014), including among *Norsk Tipping* customers specifically (Jonsson et al., 2022). The results from the sensitivity analyses largely mirrored the analyses on theoretical loss, i.e. older individuals had higher gambling frequency compared to younger individuals, and age differences were more pronounced among men.

Strengths and limitations

The present study was strengthened by examining a complete population of gamblers totaling 195,318 over nearly six years. The study took an age-specific and gender-specific

approach to understand gambling intensity, notably including participants across the full adult lifespan (age ranged from 18 to 103 years). The high number of participants ensured strong representation even among the oldest age groups broken down by gender. Use of behavioral tracking data made it possible to avoid limitations of social desirability and recall bias which can limit self-report data (Griffiths, 2014; Shaffer et al., 2010). This may be especially beneficial when analyzing theoretical loss and other measures of gambling expenditure as previous research suggests that gamblers underestimate their losses when self-reporting (Braverman et al., 2014; M. Auer & Griffiths, 2017). Motivated by a public health approach, the present study focused on annual trends for different age groups of men and women rather than on individual trajectories. The use of quantile regression enabled the observation that age-related differences were more pronounced among men compared to women. Quantile regression is robust to outliers and allows for examination of different parts of the distribution, which accommodates the typical skewed distribution of gambling behavior (Deng et al., 2021; Fiedler et al., 2019).

The study also had some limitations that should be mentioned. Notably, the study did not assess disordered gambling directly, although previous studies linking gambling expenditure with disordered gambling, theoretical loss' association with higher self-exclusion rates, and the sensitivity analysis on gambling frequency can be taken to suggest that older individuals' and women playing *Multix* might experience more gambling harm/disordered gambling (as discussed above). Use of behavioral tracking data also poses risks as recorded gambling behavior is tied to individual player-account cards which can be shared with others (despite being prohibited). *Norsk Tipping* also acknowledges this issue, although it is unclear to what extent it influences data accuracy (Norsk Tipping, 2020). Age was treated as a categorical variable in the present study to allow for potential non-linear effects and so the findings could be related to different life periods of adult life. However, this approach can also pose some limitations as the chosen categories constitute rough approximations of different life periods of adult life and since age categorization can be performed in various ways, implying that choosing different cutoffs for age groups could lead to different results. The present study is also limited to a population of Norwegian *Multix* gamblers which put restrictions on the generalizability to other types of EGMs and in other national settings. Finally, studies on behavioral tracking data often lack information about contextual variables (e.g. income, personality, cognitive factors) which can be redeemed by combining this type of data with other data types (e.g. survey data).

Implications and conclusion

The results of the present study emphasize the importance of accounting for gambling type when discussing risky gambling and preventive efforts. Disordered gambling is typically associated with men and young age, but the present results suggest that this might not be the case among land-based EGM gamblers in Norway. Future studies should investigate if older individuals and women show similar patterns of gambling intensity in other EGM populations and examine if the demographic pattern also translates to direct measures of gambling harm and/or disordered gambling within such EGM populations. Such findings could then be used to inform preventive efforts targeting EGM gamblers. The findings of the present study also showed that women have less age-related differences

in gambling at the 90th percentile compared to the median and 25th percentile. If women with high gambling intensity show less age-related differences compared to average and low gambling intensity in other studies, this would suggest that it is more important to take age into account when targeting women in low and average gambling intensity groups compared to women at high intensity.

Pallesen

There are several interventions that have been shown to be effective in reducing theoretical loss among gamblers in a natural setting. M. Auer et al. (2018) found that *Norsk Tipping* customers receiving a reminder of exceeding 80% of the personally set loss limit reduced subsequent theoretical loss. Jonsson et al. (2019, 2020) employed a randomized-controlled trial design and found that a brief motivational contact based on personalized feedback reduced theoretical loss among those with the 0.5 highest percentile of theoretical loss. A one-year follow-up showed a 30% reduction in theoretical loss for those contacted over telephone and 13% reduction for those contacted over mail. Finally, M. M. Auer and Griffiths (2015, 2016) found that receiving personalized feedback on actual gambling behavior can reduce theoretical loss.

Overall, the present study finds support for age and gender differences in annual trends of gambling intensity. If these findings were replicated among other land-based EGM populations and with more direct measures of gambling harm/disordered gambling they would have implications for prevention of risky and disordered gambling. Older individuals and women would then appear to represent a more vulnerable segment of the EGM population which would make it important to prioritize these groups with responsible gambling interventions.

Disclosure statement

The study was funded by the Research Council of Norway, grant number 273718. Study data were provided by the Norwegian gambling operator, Norsk Tipping. The funding agency and data provider had no influence on the study design, data analyses, or data interpretation.

MDG's university has received research funding from Norsk Tipping (the gambling operator owned by the Norwegian Government). MDG has also received funding for a number of research projects in the area of gambling education for young people, social responsibility in gambling and gambling treatment from Gamble Aware (formerly the Responsible Gambling Trust), a charitable body which funds its research program based on donations from the gambling industry. MDG regularly undertakes consultancy for various gaming companies in the area of social responsibility in gambling.

Conflict of Interest

The authors report that there are no constraints on publishing and no additional competing interests to declare.

Funding

The work was supported by the Norges Forskningsråd [273718].

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Abstract

Objective: Telescoping refers to the accelerated progression from starting a potentially addictive behavior to reaching a disordered level. For disordered gambling, telescoping has been reported for women compared to men. Most previous studies on telescoping have used clinical samples and retrospective reports, but this study examined a non-clinical population of gamblers using electronically tracked gambling behavior. Method: The sample consisted of Norsk Tipping's *Multix* electronic gaming machine (EGM) customers during the period of March 2013 to December 2018 (n = 184,113, 27.0% women, age range from 18 to 103 years (M = 41, SD = 16)). We hypothesized that women would be older than men when first playing *Multix* and that the time between first playing *Multix* to reaching first loss limit (money one is allowed to lose) would be shorter for women compared to men. Results: Welch two-sample t-tests revealed that women were older than men at *Multix* gambling onset (Women: M = 46, SD = 17; Men: M = 40, SD = 15; $p < .001$). Kaplan–Meier revealed a median survival time of 46 months (*95% CI* [45, 47]) for women and 55 months (*95% CI* [54, 56]) for men before the first loss limit. Cox regression showed higher risk for meeting the loss limit for women compared to men (HR = 1.22, *95% CI* [1.20, 1.25], $p < .001$) when controlling for age. Conclusion: Prevention efforts should consider that adult women playing EGMs appear to be at risk for developing high-risk gambling faster than men.

Keywords: gambling progression, risky gambling, player-account data, behavioral tracking, sex differences

Public Health Significance

This study found that adult women gambling on electronic gaming machines progress faster than men towards risky gambling, supporting a telescoping phenomenon.

Telescoping and Gender Differences in High-Risk Gambling: Loss Limit Behavior in a Population of Electronic Gaming Machine Players

Disordered gambling refers to gambling involving lack of control and harms experienced by the gambler and others who are affected, and it can be understood as existing on a continuum with more severe forms qualifying for the diagnosis of gambling disorder (Shaffer & Korn, 2002; Shaffer & Martin, 2011). One phenomenon that has been identified regarding development of disordered gambling is "telescoping", which refers to accelerated progression from starting a potentially addictive behavior to reaching a disordered level of that behavior. In terms of gambling, it has been reported that women tend to start gambling later in life but progress faster from gambling onset to disordered gambling compared to men (González-Ortega et al., 2013; Grant et al., 2012; Ibáñez et al., 2003; Ladd & Petry, 2002; Nelson et al., 2006; Potenza et al., 2001; Ronzitti et al., 2016; Tavares et al., 2001). Such a telescoping effect has also been observed related to other problems, such as alcohol and substance abuse (Hernandez-Avila et al., 2004; Piazza et al., 1989; Randall et al., 1999; Zilberman et al., 2004). A detailed understanding of potential telescoping for women in gambling and under which circumstances it occurs is important for the prevention and treatment of disordered gambling (Zakiniaeiz et al., 2017).

Several potential explanations have been suggested for the telescoping effect (Zakiniaeiz et al., 2017). For example, women report higher motivation to regulate mood states with gambling compared to men (Sacco et al., 2011), and this motivation could influence women's tendency for faster progression to disordered gambling because mood-regulating motives for gambling have been associated with disordered gambling (Marchica et al., 2020. Compared to men, women with disordered gambling also display higher rates of comorbid mood and anxiety disorders that also may reinforce gambling for mood regulation and thus overinvolvement in gambling (Blanco et al., 2006; Desai & Potenza, 2008; Tavares

et al., 2003). Still, the telescoping effect has been observed even when controlling for psychiatric comorbidity (Grant et al., 2012). Hence, psychiatric comorbidity cannot fully account for telescoping, although the influence of emotion regulation motivation cannot be ruled out.

Another explanation for telescoping is related to gambling preferences (Zakiniaeiz et al., 2017). Women gamblers report, for instance, higher preference for high event frequency games (i.e., games with short time interval between stake and outcome) such as electronic gaming machines (EGMs) compared to men (Blanco et al., 2006; LaPlante et al., 2006). EGMs and other high event frequency games have consistently been linked to increased risk of developing disordered gambling compared to low event frequency games (Dowling et al., 2005; Leino et al., 2015). However, telescoping has also been observed while controlling for game type preference (Grant et al., 2012).

It has further been suggested that changes in social norms and gambling opportunities for women might be an explanation for telescoping (Zakiniaeiz et al., 2017). Historically, gambling has not been considered a suitable activity for women, and such negative perceptions of women gamblers may have reduced women`s access to gambling (McCarthy et al., 2019, Potenza et al., 2001). Women who do engage in gambling may thus start later in life due to the reduced social access to gambling opportunities. Further, gambling among women may be more easily considered problematic due to norm violations, and women who have problems related to gambling may experience more stigmatization compared to men, which may further reinforce their gambling problems. Differences in division of labor, notably lower income among women, might also explain the telescoping effect because women have less money to lose and thus more quickly experience the negative consequences of gambling (Brown & Coventry, 1997).

Social norms concerning gender are, however, constantly changing and societies are in general becoming more egalitarian (Khamis & Ayuso, 2021). For example, Richmond-Rakerd, Slutske, and Piasecki (2013) studied gambling onset among different birth cohorts. They found that gambling onset took place earlier in more recent birth cohorts and that the gender gap in gambling onset was diminishing. These findings run counter to one part of telescoping, i.e., that women start gambling later than men. Relatedly, a study by Nelson, LaPlante, LaBrie, and Shaffer (2006) found that men and women's progression to disordered gambling did not differ when controlling for age of gambling onset. Participation in gambling may be increasing among younger women. One study found that younger women are more likely to engage in sports betting and to gamble in casinos compared to older women (McCarthy et al., 2018). Multiple factors appear to be influencing young women's gambling participation, including family traditions of gambling, peer influences, gambling marketing targeting women, and women experiencing that social attitudes towards women gambling is changing (McCarthy et al., 2020).

Most studies on telescoping in gambling have relied on clinical samples (Zakiniaeiz et al., 2017). In contrast, Slutske, Piasecki, Deutsch, Statham, and Martin (2015) studied telescoping using a general population sample in Australia and did not find support for this phenomenon. If telescoping is only observable within clinical samples, this may reflect gender differences in help-seeking behavior rather than reflecting the nature of development of disordered gambling itself. Notably, women with disordered gambling show lower rates of treatment seeking compared to men (Braun et al., 2014). This underscores the importance of studying telescoping effects across different types of populations of gamblers.

Another limitation to previous studies on telescoping in gambling is that they typically have relied on self-report data, which are subject to both recall and social desirability bias. Studies on gambling are now increasingly making use of behavioral tracking data that

circumvents these limitations (Chagas & Gomes, 2017; Deng et al., 2019). Such data often involve large sample sizes with detailed information on gambling behavior and are collected without being invasive to the player, thus increasing the ecological validity of the data (Griffiths, 2014). However, a potential limitation of behavioral tracking data is a lack of clinical information about disordered gambling in addition to contextual factors. Still, limited clinical information may be mitigated by using proxy measures based on behavioral tracking data that have been found to be associated with disordered gambling (Deng et al., 2019).

Reaching pre-set loss limits, assumed to reflect lack of control, is one proxy for disordered gambling because people with disordered gambling are far more likely to reach their loss limit threshold for gambling compared to those without disordered gambling (Hing et al., 2015; Lalande & Ladouceur, 2011).

Loss limits are intended as tools to minimize negative consequences from gambling (i.e., as a responsible gambling tool) and refer to the maximum amount of money a player is allowed to lose before play is temporarily stopped, typically for a day, week, or month depending on the timeframe of the loss limit (Delfabbro & King, 2021). Use of loss limits can be voluntary or mandatory. One study on voluntary loss limits found that voluntary loss limits were viewed more favorably by people with risky/problem gambling, young people, and women (Engebø et al., 2019). Mandatory loss limits are less frequently offered/demanded by gambling operators, and information about their use is mostly based on data from Norway (Delfabbro & King, 2021). Most gamblers who reach mandatory loss limits report that they stop gambling altogether while the restriction is in effect, although those with high-risk gambling appear more likely to report continuing play at another gambling provider where there is no restriction (Auer et al., 2020).

Gambling in Norway and the current study

The current study was conducted in Norway and is based on data from customers of Norsk Tipping's *Multix* EGMs. In Norway gambling is regulated, with Norsk Tipping as the monopoly provider of online and land-based lotteries, sports betting games, and EGMs (Rossow & Hansen, 2016). The most recent nationally representative survey of gambling in Norway was conducted in 2019 and found that 67.1% of Norwegian men and 60.2% of Norwegian women aged 16–74 years had gambled at least once during the last year (Pallesen et al., 2020). Men tend to participate in more game types compared to women. Further, younger people are more likely to participate in online games (e.g., online casino games, online poker) while older people are more likely to participate in lottery games and horse race betting. It was found that 1.4% of the Norwegian adult population (men: 1.9% vs. women: 0.8%) could be classified as problem gamblers, which represents a statistically significant increase from the 0.9% estimate found in 2015. This places Norway around the middle compared to problem gambling rates in other European countries, which ranges between 0.12% and 3.4%, although methodological variations across studies preclude direct comparisons (Calado & Griffiths, 2016).

Norsk Tipping introduced *Multix* in 2008. *Multix* is a multigame terminal that offers a collection of different games within its interface, including casino games, card games, and other games of chance and skill. *Multix* is situated at different public locations such as kiosks, hotels, pubs, bingo halls, and racing tracks. There were 31 different games available in 2013 and 44 different games available in 2018. One example of a chance game is *Wolf Run*, which is a 5-wheel slot game where one hopes to match symbols. Casino games include electronic versions of traditional table games such as *Roulette*, *Street Holdem* (poker), and *Blackjack*. The latter two are also examples of *Multix* games with skill elements, of which there were 5 in total between 2013 and 2018. The age limit is 18 years, and *Multix* has built-in responsible gambling tools such as mandatory monthly loss limits, which were set to 2,500 Norwegian

kroner (≈ 250 €) in 2013 and were adjusted to 2,700 NOK (≈ 270 €) in November 2016. Players may alternatively set voluntary limits below mandatory thresholds (see Leino et al. (2015) for more details about *Multix*).

The current study aims to account for previous limitations in study designs on telescoping by examining a non-clinical population of gamblers and by using behavioral tracking data. To the authors' knowledge, the present study is the first to use actual gambling data to study telescoping in gambling and the first to include a whole population of gamblers.

We posit the following hypotheses in line with a telescoping phenomenon for women gamblers:

1. Women will be older than men when they first gamble on *Multix* during the study period.
2. The time between the first gambling on *Multix* to when the first loss limit threshold is reached will be shorter for women compared to men.
3. Women will be more likely to reach their first loss limit compared to men at any point during the study period when controlling for age when first gambling on *Multix.*

Hypothesis 3 reflects the expectation that this telescoping effect of high-risk gambling will not be fully explained by age of gambling onset, as suggested by Nelson et al. (2006).

Methods

Transparency and openness

In the following we report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. Data were analyzed with R version 4.1.1. The study was not preregistered. The analysis code, information about specific R package versions, and supplemental material referenced in the text are available at

https://osf.io/wa6gq/. Data are only available upon application due to a data provider agreement.

Participants and procedure

The sample consisted of the whole population of Norsk Tipping's *Multix* EGM customers. Data were collected between March 2013 and December 2018 (N = 195,318 [26.5% women]) and were organized into 70 monthly time points. The data were provided and anonymized by Norsk Tipping. The data included detailed information about gambling behavior on *Multix*, such as number of active days gambling, time played, losses, mandatory and voluntary loss limits in NOK, and sessions played (see supplemental material for the full list). We excluded participants who would have been younger than 18 years at study start (March 2013) so that measures of gambling behavior would be complete and thus more comparable between age groups. The final analytic sample (n = 184,113) comprised 27.0% women, and the age at the first month of gambling on *Multix* (in the period between March 2013 and December 2018) ranged from 18 to 103 years (M = 41, SD = 16).

Measures

Demographic information

Demographic information included age and gender based on Norsk Tipping's access to customers' personal identification numbers. Age refers to a participants' age at first active gambling month on *Multix* in the study period and was handled both continuously and categorically (18–29, 30–39, 40–49, 50–59, 60–69, and 70+ years). Information on ethnicity was not available.

Gambling behavior

Gambling behaviors on *Multix* included gambling participation (active gambling months and sessions played in a month, number of different *Multix* games played across the study period, and preference for chance versus skill-based games based on the proportion of

sessions played), gambling involvement (amount staked in NOK and time spent), and responsible gambling measures (setting a monthly loss limit below the mandatory threshold, reaching a monthly loss limit). In addition, the data included the amount staked in NOK across all of Norsk Tipping's gambling products during months with active *Multix* gambling.

Some participants had reached their loss limits without this being registered by Norsk Tipping (for mandatory limit: n = 873, for voluntary limit: n = 7674), which was corrected for in the analysis. Registration errors may happen due to communication failure between the gambling machine and the responsible gambling software used by Norsk Tipping (Norsk Tipping, personal communication, March 14th, 2022). In most cases only the status of registration was affected, and play was stopped even if this was not registered, although a small minority of cases showed losses exceeding the limit amount (for mandatory limit: n = 239, for voluntary limit: n = 444). The exceeding loss amount among those affected ranged from 1 NOK to 1,558 NOK for mandatory limits (median = 120; IQR = 19, 324) and from 1 NOK to 2,500 NOK for voluntary limits (median = 197; IQR = 33, 498).

Statistical analysis

Descriptive statistics were calculated to obtain an overview of gender differences related to the key study variables, namely the age at *Multix* gambling onset and age at reaching loss limits. This included mean/median/distribution of age at *Multix* onset, frequencies of reaching one's loss limit, and the number of active gambling months until the first loss limit was reached or study end stratified by gender for the whole population. Additional descriptives were calculated for those who had reached the loss-limit threshold. This included minutes spent gambling on *Multix*, number of sessions on *Multix*, and total bets on *Multix* and on all of Norsk Tipping's products stratified by gender. Reaching a monthly loss limit was defined as reaching either the monthly mandatory set loss limit or the voluntary set loss limit because some customers set the voluntary loss limit lower than the mandatory

loss limit. For time spent gambling on *Multix*, number of bets total, and number of sessions, we divided all of a participant's monthly totals by active months gambled to calculate an average for each participant. Only age at *Multix* onset satisfied the normality assumption (see supplemental material). Welch two-sample *t*-tests were used to test the first hypothesis that women would be older than men when first gambling on *Multix.* Wilcoxon rank sum tests were used for analyses of all other continuous variables. Pearson's chi-squared tests were calculated where differences in frequencies were tested for age categories and for having reached the loss limit. Effect sizes were calculated using Cohen's *d* for *t*-tests, correlation-coefficient *r* for Wilcoxon rank sum tests, and Cramer's *V* for Pearson's chi-squared tests. A Cohen's *d* of 0.2 is regared as a small effect, 0.5 is regarded as a medium effect, and 0.8 is regarded as a large effect. An *r* and Cramer's *V* of 0.1 constitute a small effect, 0.3 constitutes a medium effect, and 0.5 constitutes a large effect (Cohen, 1992; Tomczak & Tomczak, 2014).

Survival analysis with the Kaplan–Meier estimate of survival function was performed to test the second hypothesis that the time between first playing *Multix* to reaching the first loss limit would be shorter for women compared to men. Time-to-event was operationalized as the number of months between the first active *Multix* gambling month to the month when the loss limit threshold on *Multix* was reached or the last active gambling month for those who did not reach the monthly loss limit threshold (right-censored gamblers). The Kaplan–Meier estimates of survival function was used to analyze the probability of not having met the monthly loss limit at a specific time point given that it had not occurred during previous time points. It was expected that women would have lower survival probabilites compared to men, and this was investigated by a log-rank test.

Cox proportional hazards regression was used to test the third hypothesis by investigating gender differences regarding the probability of meeting a monthly loss limit at

any time period while controlling for age categories. Finally, we also examined whether the gender effect differed across age categories by including its interaction in the model. Gender effects across age categories were reported contingent on the statistical significance of the interaction effect. Cox regresssion involves analyzing *hazard ratios* (*HRs*). In the current context, hazard refers to the probability of meeting a monthly loss limit for the first time within a specific time point (1 to 70, reflecting the number of months in the current dataset) provided that it has not occurred during preceding time points. *HR* refers to differences in hazards between men and women. An *HR* greater than 1 would indicate that women have a greater risk of reaching the loss limit threshold compared to men, whereas an *HR* less than 1 would indicate that men have a greater risk of reaching the loss limit threshold compared to women. It was hypothesized that the *HR* would be higher for women compared to men. Statistical assumptions were checked (see supplemental material). Visual inspection of the Schoenfeld residuals against time indicated that the proportional hazards assumption was met for both gender and age. Visual inspection of deviance residuals revealed the presence of influential outliers, which were handled by using a robust method of Cox regression that modifies the partial likelihood estimator to account for this (Bednarski, 1993; Minder & Bednarski, 1996).

Some participants could have gambled on *Multix* before study start, thus having earlier *Multix* gambling onset. If there were any systematic differences between men and women in this unobserved period then this could conceivably also affect hypothesized gender differences about gambling onset and meeting first loss limit, for example, if men met their first loss limit earlier than women but this pattern emerged during the unobserved period. Therefore, we conducted sensitivity analyses on a sub-sample that had their first gambling after month 12 or later in the study period (n = 76,182 (28.9% women)) because this was assumed to increase the proportion that truly had their *Multix* gambling onset during the

analysis period. The sensitivity analysis included the distribution of age at *Multix* gambling onset, the Kaplan–Meier estimate, and Cox regression, as accounted for above.

Ethics

Because no personally identifiable information was collected by the authors, the study was exempt from ethical approval in accordance with the guidelines of the Norwegian Centre for Research Data. To ensure participant anonymity, Norsk Tipping aggregated the data at the monthly level, and each participant received a constructed identification number.

Results

Within the entire sample, 30% of participants had met at least one monthly loss limit during the study period. The median number of active months on *Multix* during the study period was 6, with an interquartile range from 2 to 27 months. Participant characteristics are presented broken down by gender in Table 1. In relation to the first hypothesis, the results showed that women playing *Multix* were older than men by a mean age difference of 6 years when they gambled at *Multix* for the first time (during the study period). Examination by age category showed that the largest differences in percentages between men and women were in the 18–29 years category. Table 2 presents gambling behavior among those who had met at least one monthly loss limit broken down by gender. The results showed small effect size differences in gambling behavior between men and women who had reached a monthly loss limit in gambling behavior. This also included time to when the loss limit was met. However, this measure was not taken as a test of the second hypothesis because median or mean measures do not consider rates of people who stop gambling before study end and/or reaching loss limit.

In relation to the second hypothesis, the time to first monthly loss limit reached was examined with the Kaplan–Meier survival estimate (Figure 1). The results showed that the probability of having exceeded at least one loss limit increased with participants' time in the

study. The median survival time was 55 months (*95% CI* [54, 56]) for men compared to 46 months (*95% CI* [45, 47] for women. The Cox regression results with main effects for gender and age category are presented in Table 3 and inform the third hypothesis. They showed that women had 22% higher probability to reach the monthly loss-limit threshold at any time point compared to men after controlling for age categories. Inclusion of the interaction effect between gender and age category indicated that the effect of gender differed across age categories (Wald test = 3156, 11 df, $p < .001$). Cox regressions stratified by gender (also reported in Table 3) showed increasing *HRs* for older age groups up to the oldest bracket of 70+ years for men and up to 60–69 years for women. Men showed higher within-gender differences for age compared to women. The highest age-related *HR* was 2.52 for men (age group 60–69 years) and 1.15 for women (age group 40–49 years).

Sensitivity analyses mirrored the results of the main analyses. The difference in age at start between men and women was almost identical (Women: $M = 44$, $SD = 17$; Men: $M = 39$, $SD = 15$; $p < .001$, Cohen's $d = –0.355$). Kaplan–Meier estimates showed a median survival time of 36 months (95% *CI* [35, 38]) for women and 47 months (95% *CI* [46, 48]) for men before the first loss limit was reached. Thus, the median survival time difference was in the same direction and stronger (11 months vs. 9 months in the main analysis). Cox regression showed higher risk for meeting the loss limit for women compared to men (*HR* = 1.28, 95% *CI* [1.23, 1.33], $p < .001$) when controlling for age categories. See the supplemental material for full results on Cox regressions for the main analyses and sensitivity analyses.

Discussion

In the current study we examined the telescoping effect in gambling using a non-clinical sample and actual gambling data. The results support the first hypothesis as women were older than men when they played *Multix* for the first time during the study period, as shown by a mean age difference of 6 years. The results also support the second hypothesis as

women met their first monthly loss limit earlier than men, with a median difference of 9 months. Finally, the Cox regression supported the third hypothesis as it showed that women had 22% higher probability than men of meeting their first loss limit at any time in the study period when controlling for age at *Multix* onset.

Previous studies have found support for the telescoping effect while using various operationalizations of time to event, i.e., time from non-problematic to problematic gambling (Grant et al., 2012; Ibáñez et al., 2003; Ladd & Petry, 2002; Potenza et al., 2001; Tavares et al., 2001). Start time has typically included age when first gambling, age when starting gambling regularly, and age at first symptom of disordered gambling. Event has typically been operationalized as symptoms of disordered gambling, diagnosis of disordered gambling, entering treatment, or attempts to stop gambling. The current study provides further support for the telescoping effect by showing that it is observable within a whole population of EGM customers with reaching loss limits as a marker of high-risk gambling. Differences in time to loss limit could not be explained by women setting lower loss limits because the median of self-set loss limit was the same for both genders. Further, frequencies of setting a less-than-mandatory amount for the loss limit occurred at a 2% higher frequency among men, hence potential lower self-set loss limits in women could not explain the findings.

The 6-year mean age difference between men and women for age at *Multix* gambling onset constituted a small effect, although it appears comparable to gambling onset age differences reported by several previous studies ranging from 1 year to 16 years (Grant et al., 2012; Ibáñez et al., 2003; Ladd & Petry, 2002; Nelson et al., 2006; Potenza et al., 2001; Slutske et al., 2015; Tavares et al., 2001). The current study results are comparable to the lower end of these studies (Nelson et al., 2006; Potenza et al., 2001; Slutske et al., 2015). However, direct comparison is limited by the fact that the current study examined age when starting gambling on *Multix* during the study period rather than starting any gambling. The

mean age of *Multix* gambling onset is likely higher than the mean age of lifetime gambling onset.

Reasons for the telescoping effect remain largely unknown, as indicated by the different proposed explanations in the introduction. The current study results both support and contradict previously suggested explanations. Because the telescoping effect was observed in the population of *Multix* gamblers, the results run counter to the notion that telescoping is exclusive to treatment-seeking gamblers (Slutske et al., 2015). Further, the results run counter to the idea that telescoping is due to increased preference for non-strategic games among women because telescoping was observed within a population of EGM customers exclusively (Grant et al., 2012). Men were more likely to prefer *Multix* games with a skill element compared to women, although the difference was very small among those who met a monthly loss limit. Some proposed explanations are hard to evaluate based on the current study design. The notion that women develop disordered gambling faster due to less income (Brown & Coventry, 1997) was not possible to evaluate in the current study because data on income or diagnosis of disordered gambling were not available. Still, it was notable that women and men did not differ considerably in frequency of setting loss limits lower than the mandatory amount. In addition, in Norway the gender wage gap difference is lower compared to other countries (e.g., the US), which suggests that differences in disordered gambling progression would be less influenced by gender differences in financial ability in Norway compared to other countries (Reisel et al., 2018).

The Cox regression analyses showed that the *HR* for meeting a monthly loss limit increased for older age groups up to the oldest bracket of 70+ years for men and 60–69 years for women. Relatedly, a previous study found that middle-aged women EGM players were at heightened risk for disordered gambling (Hing et al., 2016). However, the effect of age was stronger within men compared to within women. Taken together, the age-related effects for

men and women are in line with the findings by Nelson et al. (2006) who showed that older age at gambling onset predicted shorter duration to disordered gambling, which was greater than the effect of gender. The results from the current study still support a unique contribution of gender, hence supporting the notion of the telescoping effect for women gamblers.

Strengths and limitations

Some strengths of the current study deserve mention. The data reflected actual gambling behavior for the whole population of EGM customers for nearly 6 years, with the participant age range covering the whole lifespan. There might be some limitations in terms of the generalizability of the current findings to other gambling operators, game types not available on *Multix* (e.g., sports betting and bingo), and gambling in other formats (e.g., physical table games and online games). However, it should still be noted that men and women who reached their monthly loss limit on *Multix* showed similar gambling expenditure across Norsk Tipping's products. Because Norsk Tipping is by far the largest gambling provider monopolist in Norway, data on gambling expenditure at Norsk Tipping likely cover the vast majority of most participants' overall gambling expenditures. Hence, the inherent limitation of behavioral tracking data normally stemming from using only one specific gambling operator/site is to some extent mitigated by the nature of the Norwegian gambling market (Griffiths, 2014). Behavioral tracking data can also be limited by tracking errors and technology abuse. In the present study there were participants with losses indicating that their voluntary or mandatory loss limits were met despite not being registered as such. Fortunately, most cases only affected registration with a small minority being able to continue play. *Multix* requires player-specific game cards, and it has been reported by Norsk Tipping that some players use other people's cards to circumvent responsible gambling measures, although it is unknown to what extent this happens (Norsk Tipping, 2020). This could affect hypothesized gender differences if men are more likely to borrow women's player cards, for example.

Interpretation of the results should take into account the operationalization of landmark events of the telescoping effect, including what constituted the start time and what event represented disordered/high-risk gambling. Time-to-event was calculated with start time equalling *Multix* gambling onset during the study period. The data were left censored in that participants may have played and met a monthly loss limit at *Multix* before the study period. However, results from the sensitivity analyses that were performed to account for this mirrored the main analysis results. More caution should be used when interpreting the main effect of age when first playing *Multix* on the *HR* for reaching loss limit (Table 3). The effect of age when starting gambling is influenced by many participants likely having their first gambling experience before playing *Multix*, more so for older participants. In addition, we did not measure disordered gambling directly, but used reaching the monthly loss limit as a proxy. Reaching loss limits may be understood as indicative of high-risk gambling because those with disordered gambling are more likely to reach loss limits (Hing et al., 2015; Lalande & Ladouceur, 2011). Telescoping has previously been examined in relation to multiple landmark events in the progression of disordered gambling and substance abuse, such as time to first symptom of a condition or initiating treatment (Hernandez-Avila et al., 2004; Ladd & Petry, 2002; Slutske et al., 2015). Because the present study used a novel operationalization of gambling problems, was based on behavioral tracking data, and included the whole population of EMG gamblers, it significantly extends our understanding of the telescoping effect and provides further support for this effect. Another asset of the current study is its prospective design, which stands in stark contrast to previous studies reliying on retrospective reports and cross-sectional designs.

Participants' ethnicity was not measured, although general population surveys of Norwegian gamblers in 2019 provide some indication about the distribution of participants' country of birth where approximately 89% reported Norway as country of birth, 7.5%

reported a country in Europe outside Norway/North America/Oceania, and 3.4% reported Africa/Asia/South and Central America (Pallesen et al., 2021). Country of birth was unrelated to participation in online versus land-based gambling in that study, which suggests that the distribution of country of birth may be similar among *Multix* customers.

Implications and conclusions

It is suggested that future studies should combine behavioral tracking data with other forms of data to examine questions that remain unanswered. In addition to using actual gambling data, individual reports on gambling motivation, problem involvement, personality traits, and other risky behaviors (e.g., smoking and alcohol use) can be included. For example, one could investigate the proposed explanation that women progress faster to disordered gambling due to higher emotion regulation motivation by controlling for self-reported gambling motivation. One could also combine information from different registries, such as behavioral tracking data, with information on disordered gambling diagnosis from patient health registries.

Women EGM players were found to progress faster towards high-risk gambling compared to men, and gambling operators should consider incorporating this knowledge into responsible gambling strategies. For example, responsible gambling pop-up messages have been shown to be effective in reducing excessive gambling, and gambling operators may thus consider increasing the use of such messages among gamblers who show early signs of escalating gambling behavior (Bjørseth et al., 2021). Broader information campaigns that seek to spread knowledge about help offers and responsible gambling should also incorporate what is known about the telescoping effect.

Overall, the current study provides additional support for a telescoping phenomenon among women gamblers and suggests that the effect is not restricted to treatment-seeking individuals with more severe forms of disordered gambling. This finding underlines the

importance of incorporating what is known about telescoping not only into treatment strategies, but also to include its implications in wider prevention efforts in the general population.

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Table 1

Participant Characteristics by Gender

Gender	Men, *n* = 134 359	Women, *n* = 49 754	*p*-value	Effect size[4]
Met a monthly loss limit[1]	38 690 (29%)	16 845 (34%)	<0.001	0.049
Preference for games with a skill element[1, 5]	6 377 (4.7%)	673 (1.4%)	<0.001	0.079
Age at start[1]			<0.001	0.161
18 – 29 years	43 372 (32%)	11 011 (22%)		
30 – 39 years	29 777 (22%)	8 788 (18%)		
40 – 49 years	25 723 (19%)	9 899 (20%)		
50 – 59 years	18 925 (14%)	8 806 (18%)		
60 – 69 years	11 122 (8.3%)	6 553 (13%)		
70 + years	5 440 (4.0%)	4 697 (9.4%)		
Age at start[2]				
Median (IQR)	37 (27, 50)	45 (31, 58)		
Mean (SD)	40 (15)	46 (17)	<0.001	-0.358
Active gambling months[3]				
Median (IQR)	6 (2, 27)	7 (2, 28)	<0.001	0.021
Mean (SD)	17 (22)	18 (21)		
Multix games played[3,]				
Median (IQR)	7 (2, 19)	9 (3, 21)	<0.001	0.038
Mean (SD)	13 (15)	14 (15)		

Note. [1]Pearson's chi-squared test; [2]Welch two-sample *t*-test; [3]Wilcoxon rank sum test; [4]Cramer's *V* for chi-square, Cohen's *d* for t-test, *r* for Wilcoxon rank sum test; [5]Defined as having >50% of game sessions on skill element game type.

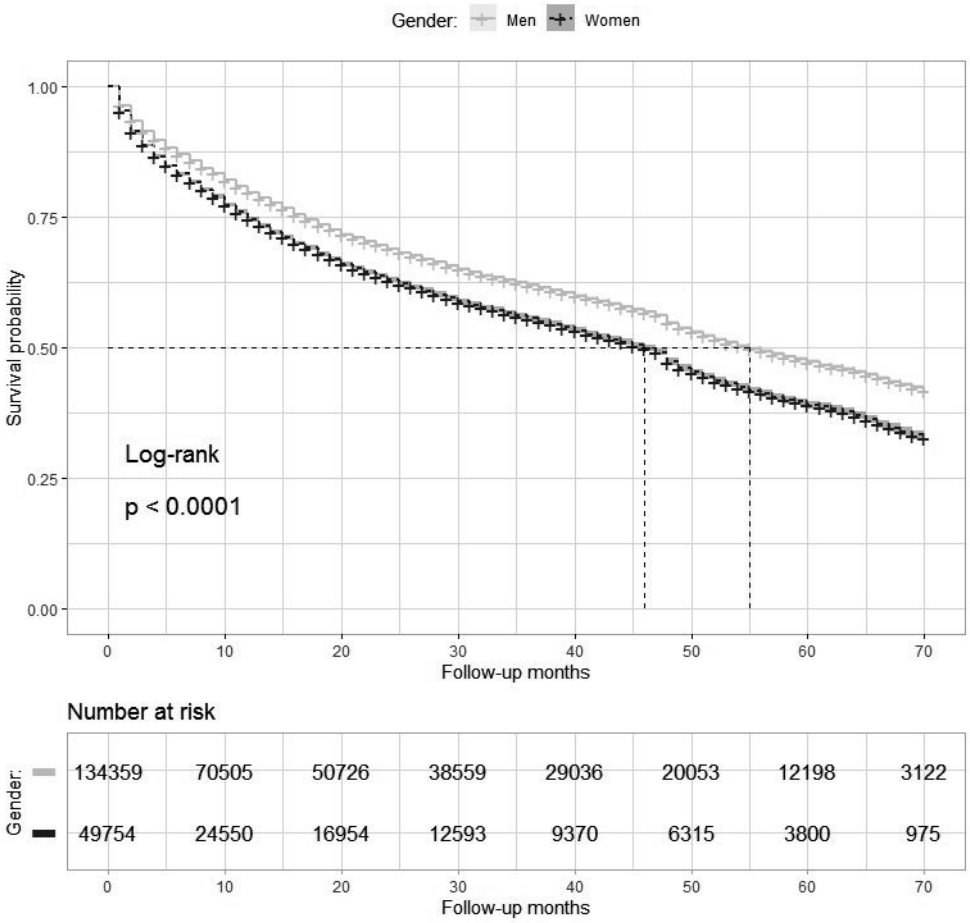
Table 2

Gender Differences Within the Loss Limit Group

Gender	Men, *n* = 38 690	Women, *n* = 16 845	*p*-value	Effect size[4]
Personal limit set below mandatory[1]	7 806 (20%)	3 044 (18%)	<0.001	0.068
Preference for games with a skill element[1, 5]	174 (0.4%)	31 (0.2%)	<0.001	0.020
Age at start in categories[1]			<0.001	0.089
18 – 29 years	7 262 (19%)	2 780 (17%)		
30 – 39 years	7 156 (18%)	2 748 (16%)		
40 – 49 years	8 812 (23%)	3 544 (21%)		
50 – 59 years	7 972 (21%)	3 369 (20%)		
60 – 69 years	5 194 (13%)	2 679 (16%)		
70 + years	2 294 (5.9%)	1 725 (10%)		
Age at start[2]				
Median (IQR)	45 (33, 56)	48 (35, 60)		
Mean (SD)	45 (15)	48 (17)	<0.001	-0.163
Average bet total Norsk Tipping[3]				
Median (IQR)	18 335 (9 889, 29 398)	18 854 (10 632, 29 511)	<0.001	0.016
Mean (SD)	22 790 (20 686)	22 941 (19 594)		
Average bet total *Multix*[3]				
Median (IQR)	13 181 (6 849, 21 068)	14 051 (7 700, 21 667)	<0.001	0.033
Mean (SD)	15 155 (11 588)	15 825 (11 629)		
Active gambling months*Multix*[3]				
Median (IQR)	7 (3, 16)	7 (3, 15)	<0.001	0.027
Mean (SD)	11 (12)	11 (12)		
Time to loss limit[3]				
Median (IQR)	13 (4, 29)	11 (4, 27)	<0.001	0.038
Mean (SD)	19 (18)	18 (18)		
Average minutes spent *Multix*[3]				
Median (IQR)	159 (78, 277)	168 (86, 279)	<0.001	0.024
Mean (SD)	206 (188)	209 (179)		
Average sessions *Multix*[3]				
Median (IQR)	15 (8, 25)	15 (9, 25)	<0.001	0.020
Mean (SD)	20 (24)	21 (24)		
Personal amount for loss limit[3]				
Median (IQR)	2 500 (2 500, 2 500)	2 500 (2 500 2 500)	<0.001	0.031
Mean (SD)	2 134 (842)	2 172 (813)		

Note. [1]Pearson's chi-squared test, [2]Welch two-sample *t*-test; [3]Wilcoxon rank sum test; [4]Cramer's V for chi-square, Cohen's *d* for t-test, *r* for Wilcoxon rank sum test; bet totals are in Norwegian Kroner (NOK); [5]Defined as having >50% of game sessions on skill element game type.

Figure 1.



Caption: Survival curves for first monthly loss limit on *Multix* by gender. Dotted lines equal median survival times.

Table 3

Cox Regressions for First Monthly Loss Limit

Characteristic	*HR*	95% *CI*	*p*-value
Men (reference)	1	-	-
Women	1.22	[1.20, 1.25]	<0.001
18 – 29 (reference)	1	-	-
30 – 39	1.40	[1.35, 1.44]	<0.001
40 – 49	1.67	[1.62, 1.72]	<0.001
50 – 49	1.89	[1.83, 1.95]	<0.001
60 – 69	1.93	[1.86, 2.00]	<0.001
70+	1.80	[1.72, 1.88]	<0.001
Men 18 – 29 (reference)	1	-	-
Men 30 – 39	1.49	[1.44, 1.55]	<0.001
Men 40 – 49	1.88	[1.81, 1.95]	<0.001
Men 50 – 59	2.27	[2.18, 2.36]	<0.001
Men 60 – 69	2.52	[2.41, 2.63]	<0.001
Men 70+	2.31	[2.18, 2.45]	<0.001
Women 18 – 29 (reference)	1	-	-
Women 30 – 39	1.11	[1.05, 1.18]	<0.001
Women 40 – 49	1.15	[1.09, 1.22]	<0.001
Women 50 – 59	1.12	[1.06, 1.19]	<0.001
Women 60 – 69	1.03	[0.97, 1.09]	0.34
Women 70+	1.06	[0.99, 1.13]	0.11

Note. *HR* = Hazard ratio. *CI* = Confidence Interval

BMC Psychiatry

RESEARCH

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Marital status and gambling disorder: a longitudinal study based on national registry data

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Abstract

Background Marital status is a robust correlate of disordered gambling, but few studies have examined the direction of this association.

Methods The present study used a case–control design by including all adults receiving their first gambling disorder (GD) diagnosis between January 2008 to December 2018 (Norwegian Patient Registry, $n = 5{,}121$) and compared them against age and gender matched individuals with other somatic/psychiatric illnesses (Norwegian Patient Registry, $n = 27{,}826$) and a random sample from the general population (FD-Trygd database, $n = 26{,}695$). The study examined marital status before GD, getting divorced as a risk factor for future GD, and becoming married as a protective factor of future GD.

Results The findings indicated an 8–9 percentage points higher prevalence of unmarried people and about a 5 percentage points higher prevalence of separation/divorce among those that subsequently experienced GD compared to controls. Logistic regressions showed that transition through divorce was associated with higher odds of future GD compared to illness controls (odds ratio [OR] = 2.45, *95% CI* [2.06, 2.92]) and the general population (OR = 2.41 [2.02, 2.87]). Logistic regressions also showed that transition through marriage was associated with lower odds of future GD compared to illness controls (OR = 0.62, *CI* [0.55, 0.70]) and the general population (OR = 0.57, *CI* [0.50, 0.64]).

Conclusions Social bonds have previously been shown to impact physical and mental health, and the findings of the study emphasize the importance of considering social network history and previous relationship dissolution among individuals with GD.

Keywords Risk factors, Gambling disorder, Registry data, Relationship status, Marriage, Divorce

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Background

Marital status is a robust correlate of disordered gambling, a form of gambling characterized by lack of control and harm caused to the gambler and others [1, 44]. Individuals with disordered gambling are more likely to be single and to be divorced [1, 5]. Still, few studies have investigated the directionality between marital status and disordered gambling. Divorce could happen because of gambling problems but it is also possible that divorce could predispose disordered gambling. Relatedly, marriage may protect against subsequent disordered gambling. Answering questions regarding directionality requires longitudinal studies. This may ultimately help decide how associations between marital status and disordered gambling should inform therapy and prevention efforts.

Previous reviews on marital status and disordered gambling have indicated marital status a risk factor for disordered gambling while being agnostic regarding its directionality (e.g., [1, 20]. Risk factors can be defined as measurable characterizations of individuals within a specified population that can be used to divide the population into low-risk and high-risk groups [25]. Risk factors can be viewed as either fixed (e.g., ethnicity, genotype) or variable (e.g., age, marital status). Variable risk factors must precede the outcome of interest (here disordered gambling) rather than only appearing concomitantly or as a consequence, often termed as correlates [25]. Protective factors may be understood likewise but inversely (i.e., the protective factor results in reduced risk for the future outcome) [22].

Associations between disordered gambling and relationship difficulties are often understood causally, implying that gambling problems lead to relationship difficulties and break-ups [21]. This appears a plausible route given that studies have consistently found individuals to report distress due another individual's gambling [10]. Disordered gambling in one individual is estimated to affect six others on average, among whom spouses/partners report the most distress [12, 13, 41]. This includes a wide range of psychological and emotional difficulties, alongside higher prevalence of divorce [19]. Untruthfulness, and possible illegal behaviors such as stealing money from one's spouse may particularly damage relationships [30]. Family dysfunction such as impaired communication, emotional responsiveness and familial problem-solving, increases along with severity of gambling problems [5]. Relatedly, relationship satisfaction is inversely associated with severity of gambling problems [16].

The association between marital status and disordered gambling may also be understood in different ways. Being unmarried or divorced may potentially predispose an individual for excessive gambling. In the case of being unmarried, less social and financial obligations may increase the risk of excessive gambling as the individual experiences fewer relationship incitements for reducing gambling involvement. Having unmarried status would also preclude potential positive effects associated with marriage, such as social control and support (see below). Lack of social support has been associated with more severe gambling problems [34]. Excessive gambling may also develop or be exacerbated as a way of coping with relationship break-ups (i.e., seeing marital status change as a transitional event). Relationship dissolution has been associated with increased risk for psychopathology and poorer physical health (including early death) [42, 51]. Divorce typically represents a psychologically stressful life event and gambling motivated by emotional coping has shown to predict disordered gambling in this regard [7, 32].

Less attention has been given to marriage as a potential protective factor for disordered gambling. Research generally suggests that being married is associated with better physical and mental health [18, 24, 27]. Marriage has also been associated with reduced risk of alcohol use disorder which has been termed the 'marriage effect' [23, 28]. Marriage may be protective in that spouses often monitor and control each other's alcohol drinking and/or marriage may instill a general expectation for the individual to control their alcohol drinking behavior (i.e., to *"shape up"*) [23, 49]. Such social control involves intentionally trying to influence another's behavior and can be positive (e.g., using positive reinforcement, modeling) or negative (e.g., pressuring, restricting), with positive control being shown to promote health behaviors, and increase well-being and relationship satisfaction [11]. It is conceivable a similar 'marriage effect' might be observed for gambling such as spouses intentionally encouraging alternative activities to gambling for example (positive social control). Marriage might also instill an expectation to restrict gambling involvement to prioritize financial and social obligations that follow marriage.

It is not known whether gender moderates the relationship between marital status and GD. More broadly, there are also conflicting findings as to whether gender can moderate the relationship between marital status and psychological health. Leopold [29] investigated gender differences in outcomes following divorce over a 32-year period and found that men reported reduced well-being short-term compared to women, while women experienced stronger reduction in income long-term compared to men. However, other studies have not found gender differences in post-divorce and post-marriage trajectories (e.g., [47, 48, 52].

Previous studies on marital status and disordered gambling have mostly utilized general population samples

and screening measures for disordered gambling, often collapsing groups that display moderate gambling risk and problem gambling in order to achieve sufficient statistical power [1]. Gambling disorder (GD) represents a more severe category and a diagnosis marked by persistent and recurring pattern of disordered gambling that is associated with substantial distress or impairment [35]. Studies on marital status that include participants with GD are typically small, with participants recruited through convenience sampling [5].

In view of these methodological limitations, the present study aimed to examine exposure to divorce as risk factor for subsequent GD diagnosis as well as exposure to marriage as a protective factor against subsequent GD diagnosis. Variable risk/protective factors require that the factor precedes the outcome. Therefore, the present study focused on marital status before GD diagnosis and transitional events in marital status happening before GD diagnosis. The latter involves either transitioning from marriage to separation/divorce or from being unmarried to marriage. Moreover, the present study explored gender differences relating to these longitudinal associations. The study overcomes limitations in previous research by use of registry-based data covering a period of 11 years allowing for high powered analyses of nationwide data concerning GD. The association between marital status and general ill-health [42, 51] was also be accounted for. More specifically, this case–control study compared those receiving their first GD diagnosis to individuals that have previously received a somatic or psychiatric diagnosis, as well as individuals from the general population. The study was guided by the following three research questions (RQs):

RQ1: Are individuals who subsequently receive their first gambling disorder diagnosis more likely to be unmarried or separated/divorced compared to those that do not receive a gambling disorder diagnosis?

RQ2: Is going through a divorce associated with increased odds of experiencing a gambling disorder diagnosis compared to remaining married? If so, is this association moderated by gender?

RQ3: Is getting married associated with reduced odds of experiencing gambling disorder diagnosis compared to remaining unmarried? If so, is this association moderated by gender?

Methods

Participants and procedure

The study comprised a population-based case–control study of all individuals in Norway 18 years or older receiving their first GD diagnosis within specialist health services between January 2008 to December 2018 ($n = 5{,}121$). Information on participants and controls was collected from the Norwegian Patient Registry (NPR), providing information about diagnosis and time for diagnosis, and the FD-Trygd database providing information about dates for change in marital status. Data from the two registries were linked using unique 11-digit National identity numbers. NPR contains health information on patients in Norwegian specialist health services and has included unique national birth numbers necessary for linking registry information since 2008 [4]. FD-Trygd contains demographic information, including marital status, as well as information on work status and social benefits for the Norwegian population from 1992 and onwards [46]. Participants with GD were frequency matched on age and gender characteristics using two control/contrast populations of 30,000 randomly drawn individuals with illness diagnoses other than GD (from NPR) and from the general population (from FD-Trygd), aiming for approximately five matched controls per GD case. After removing duplicate cases and cases missing marital status information, the following sample sizes were obtained: NPR illness controls ($n = 27{,}826$) and FD-Trygd general controls ($n = 26{,}695$).

The study received ethical approval from the Regional Committee for Medical and Health Related Research Ethics in Western Norway (no. 30393) and the Norwegian Centre for Research Data. The approval included a waiver of informed consent because the data was anonymized before the authors got access to it. The ethical approval covers the stated aims of the current study. The study was conducted in accordance with the Helsinki Declaration. A Data Protection Impact Assessment (DPIA) was also made in collaboration with the University of Bergen and approved by the Institute of Psychosocial Science, University of Bergen.

Measures

Demographic information included age, gender, and marital status. Age and gender information was extracted based on information in the National identity number which is assigned at birth or at permanent migration into Norway. Information about marital status was collected from FD-Trygd and was categorized into unmarried, married (including registered partnership), separated/divorced, and widowed. Changes in marital status within study period January 2008 to December 2018 were recorded and summarized into four categories: No change in marital status (0), one change in marital status (1), two changes in marital status (2), and three or more changes in marital status (3). Information was not available on cohabitation status and ethnicity. Gambling disorder was defined according to medical diagnosis in NPR

which is based on the ICD-10 code F63.0 for pathological gambling [53].

Statistical analysis

All statistical analyses were conducted with R version 4.1.1. Descriptive statistics and statistics to inform RQ1 included distribution of age at baseline, gender, marital status at baseline, and number of changes in marital status within the study period (i.e., an indication of marital status variability across the study period), stratified by case and control groups. RQ2 and RQ3 were examined by two pairs of logistic regressions, one pair for examining divorce as a risk factor for GD and another pair for examining marriage as a protective factor for GD. Each pair included a logistic regression against illness control participants from NPR and a logistic regression against general population control participants from FD-Trygd. Unconditional logistic regression analyses were used to examine if exposure was associated with the odds of receiving a GD diagnosis, with the matching variables age and gender included as control variables, and with an interaction term between gender and marital status to investigate if the associations were dependent upon gender. A two-step approach was used by separately estimating a main effect only model and a model including an interaction term for gender. Unconditional logistic regressions have been shown to be suitable for analysis in case–control designs that frequency match participants on demographic variables such as age and gender (i.e., studies that employ *"loose matching"*) [26, 33]. Both adjusted and unadjusted odds ratios are presented (i.e., the effect of each predictor when controlling for other predictors versus not controlling for other predictors).

When examining the association between exposure to divorce and the odds of receiving a GD diagnosis, the study included participants who were married at baseline and defined those that got divorced during the study period as exposed. Participants who subsequently got re-married or became widowed during the study period were excluded from this analysis to examine divorce only. For the GD sample, only changes in marital status before diagnosis were included. The study also censored any marital changes within the control groups that happened after the median time to GD diagnosis (72 months for this analytic sample) to allow for comparable follow-up periods.

When examining the association between exposure to marriage and odds of receiving GD diagnosis, the study included participants who were unmarried at baseline and defined those that married during study period as exposed. Participants who subsequently got separated/divorced after marriage were excluded from this analysis to examine marriage only. For the GD sample, only changes in marital status before diagnosis were included. The study also censored any marital changes within the control groups that happened after the median time to GD diagnosis (85 months for this analytic sample) to allow for comparable follow-up periods.

Results

Descriptive data are provided in Table 1 broken down by case and control group. Chi-square test on marital status categories was significant, informed RQ1 and shows that individuals who eventually received a GD diagnosis were more likely to be unmarried or separated/divorced at baseline compared to controls, and less likely to be married at baseline compared to controls (χ^2 [df = 6, n = 59,642] = 487.50, $p < 0.001$). Moreover, individuals who subsequently received a GD diagnosis were more likely to experience multiple changes in marital status throughout the study period (χ^2 [df = 6, n = 59,642] = 129.61, $p < 0.001$).

Logistic regression results on analysis of exposure to divorce on GD are provided in Table 2 and informed RQ2. The interaction terms between gender and exposure were not statistically significant (NPR control: OR = 1.11, 95% CI [0.74, 1.66]; FD-Trygd control: OR = 1.15, 95% CI [0.76, 1.72]), so only main effect analyses are reported in the table. ORs were similar between the adjusted and unadjusted analysis. The analytic samples were comparable in terms of age distributions: M = 50 (9) among GD cases, M = 50 (10) among NPR controls, and M = 51 (10) among FD-Trygd controls. Distribution gender differed somewhat, with the proportion of women being lower among cases with GD (23%) compared to NPR controls (26%) and FD-Trygd controls (28%). The results showed that getting divorced was associated with a higher odds ratio of receiving a GD diagnosis. The strength of association was comparable using both types of control groups. Using individuals with other illnesses as controls, those getting divorced had 2.45 (95% CI [2.06, 2.92]) times the odds of getting a GD diagnosis compared to individuals who remained married during the exposure period, based on the adjusted analysis. Using individuals from the general population as controls, those getting divorced had 2.41 (95% CI [2.02, 2.87]) times the odds of getting a GD diagnosis compared to individuals who remained married during the exposure period, based on the adjusted analysis.

Logistic regression results on analysis of exposure to marriage on GD are provided in Table 3 and informed RQ3. The interaction terms between gender and exposure were not statistically significant (NPR control: OR = 0.91, 95% CI [0.64, 1.27]; FD-trygd control: OR = 0.80, 95% CI [0.56, 1.11]), therefore, only main effect analyses are reported in the table. ORs were similar between the

Table 1 Participant characteristics at baseline

Sample	GD (*n* = 5,121)	Illness control (*n* = 27,826)	General control (*n* = 26,695)	*p*-value[1]
Women	935 (18.3%)	5,038 (18.1%)	5,193 (19.5%)	< 0.001
Age in 2008				< 0.001
Median (IQR)	29 (22, 39)	29 (22, 39)	30 (22, 39)	
Mean (SD)	30.9 (12)	30.8 (12)	31.3 (12)	
Marital status in 2008				< 0.001
Unmarried	3,674 (71.7%)	17,828 (64.1%)	16,819 (63.0%)	
Married	914 (18.9%)	8,404 (30.2%)	8,345 (31.3%)	
Separated/divorced	510 (10.0%)	1,510 (5.4%)	1,444 (5.4%)	
Widowed	23 (0.4%)	84 (0.3%)	87 (0.3%)	
Marital status changes[a]				< 0.001
0	4,024 (78.6%)	22,324 (80.2%)	21,123 (79.1%)	
1	812 (15.9%)	4,730 (17.0%)	4,757 (17.8%)	
2	224 (4.4%)	633 (2.3%)	685 (2.6%)	
3+	61 (1.2%)	139 (0.5%)	130 (0.5%)	

[a] During study period January 2008 to December 2018. Total percentage slightly exceeds 100 in some cases due to rounding

[1] Pearson's Chi-squared test for categorical; One-way ANOVA for continuous

Table 2 Logistic regressions for divorce on odds for first gambling disorder diagnosis

Predictor	Against NPR illness control (*n* = 8,114)			Against FD-Trygd general control (*n* = 8,116)		
	OR[1]	95% CI[a]	*p*-value	OR[a]	95% CI[a]	*p*-value
Unadjusted analysis						
Age in 2008	1.00	[1.00, 1.01]	0.519	0.99	[0.99, 1.00]	0.144
Gender						
Men (reference)	1.00	—		1.00	—	
Women	0.78	[0.67, 0.91]	0.001	0.75	[0.64, 0.87]	< 0.001
Exposure						
Married (reference)	1.00	—		1.00	—	
Divorce	2.42	[2.03, 2.88]	< 0.001	2.42	[2.03, 2.88]	< 0.001
Adjusted analysis						
Age in 2008	1.01	[1.00, 1.01]	0.134	1.00	[0.99, 1.00]	0.573
Gender						
Men (reference)	1.00	—		1.00	—	
Women	0.77	[0.66, 0.90]	0.001	0.75	[0.64, 0.87]	< 0.001
Exposure						
Married (reference)	1.00	—		1.00	—	
Divorce	2.45	[2.06, 2.92]	< 0.001	2.41	[2.02, 2.87]	< 0.001

[a] *OR* Odds ratio, *CI* Confidence interval. GD cases = 1,076

adjusted and unadjusted analysis (although the effect of gender was statistically significant in the unadjusted analysis but not in the adjusted analysis). The analytic samples were comparable in terms of age and gender distributions. For age: $M = 37$ years ($SD = 9$) among GD cases, $M = 36$ years ($SD = 9$) among NPR controls, and $M = 36$ years ($SD = 9$) among FD-Trygd controls. For the proportion of women: GD (14%), NPR controls (13%) and FD-Trygd controls (14%). The results showed that getting married was associated with a lower odds ratio of getting GD diagnosis, and the strength of association was comparable using both the respective types of control groups. Using individuals with other illnesses as controls, those getting married had 0.62 (95% CI [0.55, 0.70]) times the odds of getting a GD diagnosis compared to individuals who remained unmarried during the exposure period,

Table 3 Logistic regressions for marriage on odds for first gambling disorder diagnosis

Predictor	Against NPR illness control ($n = 16,925$)			Against FD-Trygd general control ($n = 15,940$)		
	OR[a]	95% CI[a]	*p*-value	OR[a]	95% CI[a]	*p*-value
Unadjusted analysis						
Age in 2008	1.01	[1.00, 1.01]	< 0.001	1.01	[1.00, 1.01]	0.006
Gender						
Men (reference)	1.00	—		1.00	—	
Women	1.12	[1.01, 1.24]	0.034	1.00	[0.90, 1.11]	0.985
Exposure						
Unmarried (reference)	1.00	—		1.00	—	
Marriage	0.64	[0.56, 0.72]	< 0.001	0.58	[0.51, 0.66]	< 0.001
Adjusted analysis						
Age in 2008	1.01	[1.00, 1.01]	< 0.001	1.01	[1.00, 1.01]	< 0.001
Gender						
Men (reference)	1.00	—		1.00	—	
Women	1.10	[0.99, 1.22]	0.076	1.00	[0.90, 1.11]	0.976
Exposure						
Unmarried (reference)	1.00	—		1.00	—	
Marriage	0.62	[0.55, 0.70]	< 0.001	0.57	[0.50, 0.64]	< 0.001

[a] *OR* Odds ratio, *CI* Confidence interval. GD cases = 3,610

based on the adjusted analysis. Using individuals from the general population as controls, those getting married had 0.57 (95% CI [0.50, 0.64]) times the odds of getting a GD diagnosis compared to individuals who remained unmarried during the exposure period, based on the adjusted analysis.

Discussion

The present study examined marital status as a risk/protective factor for subsequent first GD diagnosis. One of the study aims was to examine if individuals that went on to receive their first GD diagnosis were more likely to be unmarried or separated/divorced compared to control populations at baseline (RQ1). The results showed that within the GD population there was an 8–9 percentage points higher prevalence of unmarried individuals compared to controls (case: 72% vs. controls: 64% illness and 63% general population). Further, prevalence of separation/divorce were nearly twice as high at baseline among those that would go on to receive GD compared to controls (case: 10% vs. controls 5.4% for the respective control groups). These results suggest that those who receive a diagnosis of GD represent a group of individuals with reduced social networks and who experience more relationship dissolution compared to individuals with other forms of ill-health or from the general population. Marital status represents a structural indication of an individual's social connectedness and experiencing social connection through a spouse is beneficial for both physical and mental well-being [17, 40]. Relatedly, lack of social support has been associated with more severe gambling problems and poorer prognosis in treatment [34]. It has also been found that loneliness can mediate a positive association between being unmarried/divorced/widowed and having disordered gambling for men [8]. The results also showed that individuals with GD had more variability in marital status across the study period compared to the control groups. Although differences between study groups were of small magnitude, they were still statistically significant, due to the present study's large sample size.

The study examined how changes in marital status affected the odds for GD diagnosis (RQ2 and RQ3). The results showed that going through a divorce was associated with 2.45 and 2.41 higher odds of receiving a subsequent GD diagnosis in the case group compared to the NPR illness group and FD-Trygd general population group, respectively. It is notable that the increased odds for GD diagnosis was similar when using a general population control group and a control group based on individuals with different types of psychiatric and somatic diagnoses. The similar ORs for receiving GD diagnosis when using both types of control groups suggest similar number of divorces across the analyzed period for married individuals in both types of control groups. This appears somewhat surprising because there is a frequently observed association between divorce and mental/somatic ill-health, although this might stem from divorce influencing health rather than ill-health influencing divorce [42, 51]. The illness control group in the present study only included individuals with existing

diagnoses so differences in number of divorces due to ill-health influencing divorce would be captured primarily. If divorce influences health rather than the reverse, then this could explain why rates of divorce were similar between the illness control group and general control group.

Most individuals who go through a divorce experience little or no negative long-term effects (i.e., > 12 months) which raises the question as to what predicts poor outcomes such as physical illness and psychopathology (including disordered gambling) following divorce [3]. Sbarra et al. [43] propose that excessive rumination, lack of a clear self-concept (i.e., individuals not knowing who they are as a person following divorce), and poor sleep may predispose poor outcomes following divorce. These factors could then promote long-term stress which might predispose some individuals' excessive gambling because they use gambling as a coping strategy. Gambling as a means of regulating affective states is a well-established pathway in the development of disordered gambling [2, 6, 14].

Getting married was in the present study found to be associated with 0.62 and 0.57 lower odds of receiving a subsequent GD diagnosis in the case group compared to the NPR illness group and FD-Trygd general population group, respectively. This suggests a protective effect of marriage and the effect was similar when using a general population control group and when using a control group based on individuals with different types of psychiatric and somatic diagnoses. Marriage has been associated with reduced risk of developing alcohol use disorder [23, 28]. Kendler et al. [23] proposed that a 'marriage effect' related to alcohol use disorder was primarily due to social control between spouses (i.e., couples monitoring and controlling each other's alcohol drinking). This is likely also the case with gambling (i.e., couples monitoring and controlling each other's gambling behavior). Marriage can also confer social support which is related to better health behaviors and less stress [50], also potentially protecting against disordered gambling behavior.

Finally, the study examined if gender moderated the relationship between transition in marital status and odds for being diagnosed with GD (the conditional aspect of RQ2 and RQ3). The results showed non-significant findings for both types of marital transitions. For divorce, this contrasts with previous research suggesting that divorce has stronger impact on men's short-term wellbeing and women's long-term income level, compared to the other gender [29]. However, a recent Danish study [47] did not find any gender-related differences in post-divorce trajectories between men and women. The authors argued that such gender differences were less likely to appear in egalitarian societies, such as the Danish. Norway in this regard is like Denmark and this could explain a similar pattern in results. For marriage, the lack of gender differences in the present study matched that of previous studies [48, 52].

Strengths and limitations

The present study employed data from national registries data, which have several benefits. Data collection is done automatically and without being intrusive, which eliminates the risk for recall bias, social desirability bias, and research demand characteristics. Previously, very few studies have investigated marital status in relation to the more severe GD category and sample sizes have been relatively low in these studies (e.g., [5]. Using registry data allows researchers to get access to much higher numbers of participants which leads to high statistical power. In the present study, this allowed for investigating the more specific research questions that required sub-groups related to marital status (e.g., those starting as married and then getting divorced). Notably, having time-specific data on both marital status and GD diagnosis made it possible to investigate directionality which previous studies have not been able to do.

Some study limitations should be noted. The present study only included treatment-seeking individuals with GD diagnosis and did not include individuals with less severe problem gambling. It is estimated that only between 5–20% of those with problem gambling seek treatment [31]. Individuals with gambling problems who seek treatment tend to report more severe relationship difficulties compared to those who do not seek treatment [37]. The present study also only included age and gender as control variables. Disordered gambling has also been shown to associated with other correlates such as ethnicity, socio-economic status, and poor physical and mental health [1]. Individuals with various somatic and psychiatric diagnosis where such correlates are relative frequent were included as a control group and results were comparable between two control groups which strengthens the generalizability of the study's findings. Still, it cannot be ruled out that these other variables (e.g., ethnicity, socio-economic status) could have impacted the results as explanatory or confounding variables.

Another limitation concerns the age and gender matching process used. More specifically, individuals with GD were matched on age and gender in the total sample, but not within specific subgroups analyzed such as those transitioning from marriage to divorce. Age distribution was comparable between cases and controls in this subgroup but there were some differences in gender distribution between case and control groups. Results were comparable when assessing GD cases against both control groups despite these groups showing some variation

in gender distribution. There might also be unidentified confounding factors that can explain the associations observed in the present study. In the case of divorce for example, individuals may alternatively first develop excessive gambling, facilitating break-up/divorce, which then motivates the individual to seek treatment (and receive a GD diagnosis).

Finally, information on cohabitation status was not available in the present study. This means that it was not possible to account for potential increased or reduced risk for GD diagnosis among individuals starting cohabiting during the study period (analogue to marriage) or break-up from cohabiting during the study period (analogue to divorce). Not accounting for cohabitation could have led to reduced effect sizes for transitions through marriage or divorce regarding odds/risks for GD diagnosis. For instance, in the analysis concerning individuals starting out unmarried (Table 3), some individuals might have already been cohabiting or started cohabiting later which would mean that any potential reduced risk for future GD diagnosis associated with cohabitation would be attributed to the "unmarried" reference group. In Norway, cohabitation has been shown to be associated with increases in well-being that are almost identical to the increases associated with marriage [45]. Individuals who are cohabiting with children have previously been found to have comparable reduction in risk for alcohol use disorder as married individuals [23]. Therefore, future research should examine if the same relationship between marriage/divorce and risk for GD diagnosis also holds for cohabitation/break-up from cohabitation.

Implications and conclusions

In the present study, individuals that subsequently received their first GD diagnosis were more likely to show indications of reduced social connectedness (i.e., more likely to be unmarried and separated/divorced). Moreover, it was found that transitioning through divorce or marriage was associated with increased or reduced odds of GD diagnosis, respectively. Notably, examining marital status/changes before GD diagnosis demonstrated that these factors are risk or protective factors for developing GD. Future studies may expand on the findings reported here by examining the relationship between marital quality and disordered gambling. Marital quality has been found to be positively associated with physical and mental health [36, 38]. Additionally, studies have also suggested that divorce can lead to improved health in cases where there was low marital quality [9, 15].

It is not possible to conclude that transitions in marital status causally affect the development of GD based on the present study's design. However, this might be the case as a large body of previous research substantiates the association between relationship dissolution and poorer physical and mental health [42, 51], as well as between social connectedness and better physical and mental health [17, 40].

Treatment for GD include efforts to minimize harms caused by disordered gambling on current relationships [12, 39]. The present study's findings emphasize the importance of considering both individuals' previous and current social factors, including social network history and experiences with relationship dissolution. Interventions that increase an individual's level and quality of social connectedness might in turn improve their GD therapy prognosis as well as overall wellbeing [34, 40].

Abbreviations

GD	Gambling disorder
NPR	Norwegian Patient Registry
FD-Trygd	Forløpsdatabasen-Trygd

Acknowledgements

Not applicable.

Authors' contributions

AS, SP, TL, and RAM conceptualized the study. AS did statistical analysis of the data and wrote the original draft of the manuscript. ORFS validated the statistical analysis. SP, TL, ORFS, BS, MDG, and RAM contributed significantly to interpretation and revision of the manuscript. SP played lead role in funding acquisition and project administration. All authors read and approved the final manuscript.

Funding

Open access funding provided by University of Bergen. The study was funded by the Research Council of Norway (no. 273718).

Availability of data and materials

This study used data from national registries and is available upon application only. The data is not publicly available due to restrictions from the Norwegian Patient Registry and the FD-Trygd registry.

Declarations

Ethics approval and consent to participate

The study received ethical approval from the Regional Committee for Medical and Health Related Research Ethics in Western Norway (no. 30393) and the Norwegian Centre for Research Data. The approval included a waiver of informed consent because the data was anonymized before the authors got access to it. The ethical approval covers the stated aims of the current study. The study was conducted in accordance with the Helsinki Declaration. A Data Protection Impact Assessment (DPIA) was also made in collaboration with the University of Bergen and approved by the Institute of Psychosocial Science, University of Bergen.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests except MDG. MDG has received research funding from ***Norsk Tipping*** (the gambling operator owned by the Norwegian government). MDG has received funding for a number of research projects in the area of gambling education for young people, social responsibility in gambling and gambling treatment from Gamble Aware (formerly the Responsibility in Gambling Trust), a charitable body which funds its research program based on donations from the gambling industry. MDG

undertakes consultancy for various gambling companies in the area of player protection and harm-minimization in gambling.

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Received: 20 June 2022 Accepted: 20 March 2023
Published online: 28 March 2023

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	Seltzer, Wencke J., Dr. philos.	Studies of Psychocultural Approach to Families in Therapy.
	Brun, Wibecke, Dr. philos.	Subjective conceptions of uncertainty and risk.
	Aas, Henrik N., Dr. psychol.	Alcohol expectancies and socialization: Adolescents learning to drink.
	Bjørkly, Stål, Dr. psychol.	Diagnosis and prediction of intra-institutional aggressive behaviour in psychotic patients
1996	Anderssen, Norman, Dr. psychol.	Physical activity of young people in a health perspective: Stability, change and social influences.
	Sandal, Gro Mjeldheim, Dr. psychol.	Coping in extreme environments: The role of personality.
	Strumse, Einar, Dr. philos.	The psychology of aesthetics: explaining visual preferences for agrarian landscapes in Western Norway.
	Hestad, Knut, Dr. philos.	Neuropsychological deficits in HIV-1 infection.
	Lugoe, L.Wycliffe, Dr. philos.	Prediction of Tanzanian students' HIV risk and preventive behaviours
	Sandvik, B. Gunnhild, Dr. philos.	Fra distriktsjordmor til institusjonsjordmor. Fremveksten av en profesjon og en profesjonsutdanning
	Lie, Gro Therese, Dr. psychol.	The disease that dares not speak its name: Studies on factors of importance for coping with HIV/AIDS in Northern Tanzania
	Øygard, Lisbet, Dr. philos.	Health behaviors among young adults. A psychological and sociological approach
	Stormark, Kjell Morten, Dr. psychol.	Emotional modulation of selective attention: Experimental and clinical evidence.
	Einarsen, Ståle, Dr. psychol.	Bullying and harassment at work: epidemiological and psychosocial aspects.

1997	Knivsberg, Ann-Mari, Dr. philos.	Behavioural abnormalities and childhood psychopathology: Urinary peptide patterns as a potential tool in diagnosis and remediation.
	Eide, Arne H., Dr. philos.	Adolescent drug use in Zimbabwe. Cultural orientation in a global-local perspective and use of psychoactive substances among secondary school students.
	Sørensen, Marit, Dr. philos.	The psychology of initiating and maintaining exercise and diet behaviour.
	Skjæveland, Oddvar, Dr. psychol.	Relationships between spatial-physical neighborhood attributes and social relations among neighbors.
	Zewdie, Teka, Dr. philos.	Mother-child relational patterns in Ethiopia. Issues of developmental theories and intervention programs.
	Wilhelmsen, Britt Unni, Dr. philos.	Development and evaluation of two educational programmes designed to prevent alcohol use among adolescents.
	Manger, Terje, Dr. philos.	Gender differences in mathematical achievement among Norwegian elementary school students.
1998 V	Lindstrøm, Torill Christine, Dr. philos.	«Good Grief»: Adapting to Bereavement.
	Skogstad, Anders, Dr. philos.	Effects of leadership behaviour on job satisfaction, health and efficiency.
	Haldorsen, Ellen M. Håland, Dr. psychol.	Return to work in low back pain patients.
	Besemer, Susan P., Dr. philos.	Creative Product Analysis: The Search for a Valid Model for Understanding Creativity in Products.
H	Winje, Dagfinn, Dr. psychol.	Psychological adjustment after severe trauma. A longitudinal study of adults' and children's posttraumatic reactions and coping after the bus accident in Måbødalen, Norway 1988.
	Vosburg, Suzanne K., Dr. philos.	The effects of mood on creative problem solving.
	Eriksen, Hege R., Dr. philos.	Stress and coping: Does it really matter for subjective health complaints?
	Jakobsen, Reidar, Dr. psychol.	Empiriske studier av kunnskap og holdninger om hiv/aids og den normative seksuelle utvikling i ungdomsårene.
1999 V	Mikkelsen, Aslaug, Dr. philos.	Effects of learning opportunities and learning climate on occupational health.
	Samdal, Oddrun, Dr. philos.	The school environment as a risk or resource for students' health-related behaviours and subjective well-being.
	Friestad, Christine, Dr. philos.	Social psychological approaches to smoking.
	Ekeland, Tor-Johan, Dr. philos.	Meining som medisin. Ein analyse av placebofenomenet og implikasjoner for terapi og terapeutiske teoriar.
H	Saban, Sara, Dr. psychol.	Brain Asymmetry and Attention: Classical Conditioning Experiments.

	Carlsten, Carl Thomas, Dr. philos.	God lesing – God læring. En aksjonsrettet studie av undervisning i fagtekstlesing.
	Dundas, Ingrid, Dr. psychol.	Functional and dysfunctional closeness. Family interaction and children's adjustment.
	Engen, Liv, Dr. philos.	Kartlegging av leseferdighet på småskoletrinnet og vurdering av faktorer som kan være av betydning for optimal leseutvikling.
2000 V	Hovland, Ole Johan, Dr. philos.	Transforming a self-preserving "alarm" reaction into a self-defeating emotional response: Toward an integrative approach to anxiety as a human phenomenon.
	Lillejord, Sølvi, Dr. philos.	Handlingsrasjonalitet og spesialundervisning. En analyse av aktørperspektiver.
	Sandell, Ove, Dr. philos.	Den varme kunnskapen.
	Oftedal, Marit Petersen, Dr. philos.	Diagnostisering av ordavkodingsvansker: En prosessanalytisk tilnærmingsmåte.
H	Sandbak, Tone, Dr. psychol.	Alcohol consumption and preference in the rat: The significance of individual differences and relationships to stress pathology
	Eid, Jarle, Dr. psychol.	Early predictors of PTSD symptom reporting; The significance of contextual and individual factors.
2001 V	Skinstad, Anne Helene, Dr. philos.	Substance dependence and borderline personality disorders.
	Binder, Per-Einar, Dr. psychol.	Individet og den meningsbærende andre. En teoretisk undersøkelse av de mellommenneskelige forutsetningene for psykisk liv og utvikling med utgangspunkt i Donald Winnicotts teori.
	Roald, Ingvild K., Dr. philos.	Building of concepts. A study of Physics concepts of Norwegian deaf students.
H	Fekadu, Zelalem W., Dr. philos.	Predicting contraceptive use and intention among a sample of adolescent girls. An application of the theory of planned behaviour in Ethiopian context.
	Melesse, Fantu, Dr. philos.	The more intelligent and sensitive child (MISC) mediational intervention in an Ethiopian context: An evaluation study.
	Råheim, Målfrid, Dr. philos.	Kvinners kroppserfaring og livssammenheng. En fenomenologisk – hermeneutisk studie av friske kvinner og kvinner med kroniske muskelsmerter.
	Engelsen, Birthe Kari, Dr. psychol.	Measurement of the eating problem construct.
	Lau, Bjørn, Dr. philos.	Weight and eating concerns in adolescence.
2002 V	Ihlebæk, Camilla, Dr. philos.	Epidemiological studies of subjective health complaints.
	Rosén, Gunnar O. R., Dr. philos.	The phantom limb experience. Models for understanding and treatment of pain with hypnosis.

	Høines, Marit Johnsen, Dr. philos.	Fleksible språkrom. Matematikklæring som tekstutvikling.
	Anthun, Roald Andor, Dr. philos.	School psychology service quality. Consumer appraisal, quality dimensions, and collaborative improvement potential
	Pallesen, Ståle, Dr. psychol.	Insomnia in the elderly. Epidemiology, psychological characteristics and treatment.
	Midthassel, Unni Vere, Dr. philos.	Teacher involvement in school development activity. A study of teachers in Norwegian compulsory schools
	Kallestad, Jan Helge, Dr. philos.	Teachers, schools and implementation of the Olweus Bullying Prevention Program.
H	Ofte, Sonja Helgesen, Dr. psychol.	Right-left discrimination in adults and children.
	Netland, Marit, Dr. psychol.	Exposure to political violence. The need to estimate our estimations.
	Diseth, Åge, Dr. psychol.	Approaches to learning: Validity and prediction of academic performance.
	Bjuland, Raymond, Dr. philos.	Problem solving in geometry. Reasoning processes of student teachers working in small groups: A dialogical approach.
2003 V	Arefjord, Kjersti, Dr. psychol.	After the myocardial infarction – the wives' view. Short- and long-term adjustment in wives of myocardial infarction patients.
	Ingjaldsson, Jón Þorvaldur, Dr. psychol.	Unconscious Processes and Vagal Activity in Alcohol Dependency.
	Holden, Børge, Dr. philos.	Følger av atferdsanalytiske forklaringer for atferdsanalysens tilnærming til utforming av behandling.
	Holsen, Ingrid, Dr. philos.	Depressed mood from adolescence to 'emerging adulthood'. Course and longitudinal influences of body image and parent-adolescent relationship.
	Hammar, Åsa Karin, Dr. psychol.	Major depression and cognitive dysfunction- An experimental study of the cognitive effort hypothesis.
	Sprugevica, Ieva, Dr. philos.	The impact of enabling skills on early reading acquisition.
	Gabrielsen, Egil, Dr. philos.	LESE FOR LIVET. Lesekompetansen i den norske voksenbefolkningen sett i lys av visjonen om en enhetsskole.
H	Hansen, Anita Lill, Dr. psychol.	The influence of heart rate variability in the regulation of attentional and memory processes.
	Dyregrov, Kari, Dr. philos.	The loss of child by suicide, SIDS, and accidents: Consequences, needs and provisions of help.
2004 V	Torsheim, Torbjørn, Dr. psychol.	Student role strain and subjective health complaints: Individual, contextual, and longitudinal perspectives.
	Haugland, Bente Storm Mowatt Dr. psychol.	Parental alcohol abuse. Family functioning and child adjustment.

	Milde, Anne Marita, Dr. psychol.	Ulcerative colitis and the role of stress. Animal studies of psychobiological factors in relationship to experimentally induced colitis.
	Stornes, Tor, Dr. philos.	Socio-moral behaviour in sport. An investigation of perceptions of sportspersonship in handball related to important factors of socio-moral influence.
	Mæhle, Magne, Dr. philos.	Re-inventing the child in family therapy: An investigation of the relevance and applicability of theory and research in child development for family therapy involving children.
	Kobbeltvedt, Therese, Dr. psychol.	Risk and feelings: A field approach.
2004 H	Thomsen, Tormod, Dr. psychol.	Localization of attention in the brain.
	Løberg, Else-Marie, Dr. psychol.	Functional laterality and attention modulation in schizophrenia: Effects of clinical variables.
	Kyrkjebø, Jane Mikkelsen, Dr. philos.	Learning to improve: Integrating continuous quality improvement learning into nursing education.
	Laumann, Karin, Dr. psychol.	Restorative and stress-reducing effects of natural environments: Experiencal, behavioural and cardiovascular indices.
	Holgersen, Helge, PhD	Mellom oss - Essay i relasjonell psykoanalyse.
2005 V	Hetland, Hilde, Dr. psychol.	Leading to the extraordinary? Antecedents and outcomes of transformational leadership.
	Iversen, Anette Christine, Dr. philos.	Social differences in health behaviour: the motivational role of perceived control and coping.
2005 H	Mathisen, Gro Ellen, PhD	Climates for creativity and innovation: Definitions, measurement, predictors and consequences.
	Sævi, Tone, Dr. philos.	Seeing disability pedagogically – The lived experience of disability in the pedagogical encounter.
	Wiium, Nora, PhD	Intrapersonal factors, family and school norms: combined and interactive influence on adolescent smoking behaviour.
	Kanagaratnam, Pushpa, PhD	Subjective and objective correlates of Posttraumatic Stress in immigrants/refugees exposed to political violence.
	Larsen, Torill M. B. , PhD	Evaluating principals` and teachers` implementation of Second Step. A case study of four Norwegian primary schools.
	Bancila, Delia, PhD	Psychosocial stress and distress among Romanian adolescents and adults.
2006 V	Hillestad, Torgeir Martin, Dr. philos.	Normalitet og avvik. Forutsetninger for et objektivt psykopatologisk avviksbegrep. En psykologisk, sosial, erkjennelsesteoretisk og teorihistorisk framstilling.
	Nordanger, Dag Øystein, Dr. psychol.	Psychosocial discourses and responses to political violence in post-war Tigray, Ethiopia.

	Rimol, Lars Morten, PhD	Behavioral and fMRI studies of auditory laterality and speech sound processing.
	Krumsvik, Rune Johan, Dr. philos.	ICT in the school. ICT-initiated school development in lower secondary school.
	Norman, Elisabeth, Dr. psychol.	Gut feelings and unconscious thought: An exploration of fringe consiousness in implicit cognition.
	Israel, K Pravin, Dr. psychol.	Parent involvement in the mental health care of children and adolescents. Emperical studies from clinical care setting.
	Glasø, Lars, PhD	Affects and emotional regulation in leader-subordinate relationships.
	Knutsen, Ketil, Dr. philos.	HISTORIER UNGDOM LEVER – En studie av hvordan ungdommer bruker historie for å gjøre livet meningsfullt.
	Matthiesen, Stig Berge, PhD	Bullying at work. Antecedents and outcomes.
2006 H	Gramstad, Arne, PhD	Neuropsychological assessment of cognitive and emotional functioning in patients with epilepsy.
	Bendixen, Mons, PhD	Antisocial behaviour in early adolescence: Methodological and substantive issues.
	Mrumbi, Khalifa Maulid, PhD	Parental illness and loss to HIV/AIDS as experienced by AIDS orphans aged between 12-17 years from Temeke District, Dar es Salaam, Tanzania: A study of the children's psychosocial health and coping responses.
	Hetland, Jørn, Dr. psychol.	The nature of subjective health complaints in adolescence: Dimensionality, stability, and psychosocial predictors
	Kakoko, Deodatus Conatus Vitalis, PhD	Voluntary HIV counselling and testing service uptake among primary school teachers in Mwanza, Tanzania: assessment of socio-demographic, psychosocial and socio-cognitive aspects
	Mykletun, Arnstein, Dr. psychol.	Mortality and work-related disability as long-term consequences of anxiety and depression: Historical cohort designs based on the HUNT-2 study
	Sivertsen, Børge, PhD	Insomnia in older adults. Consequences, assessment and treatment.
2007 V	Singhammer, John, Dr. philos.	Social conditions from before birth to early adulthood – the influence on health and health behaviour
	Janvin, Carmen Ani Cristea, PhD	Cognitive impairment in patients with Parkinson's disease: profiles and implications for prognosis
	Braarud, Hanne Cecilie, Dr.psychol.	Infant regulation of distress: A longitudinal study of transactions between mothers and infants
	Tveito, Torill Helene, PhD	Sick Leave and Subjective Health Complaints
	Magnussen, Liv Heide, PhD	Returning disability pensioners with back pain to work

	Thuen, Elin Marie, Dr.philos.	Learning environment, students' coping styles and emotional and behavioural problems. A study of Norwegian secondary school students.
	Solberg, Ole Asbjørn, PhD	Peacekeeping warriors – A longitudinal study of Norwegian peacekeepers in Kosovo
2007 H	Søreide, Gunn Elisabeth, Dr.philos.	Narrative construction of teacher identity
	Svensen, Erling, PhD	WORK & HEALTH. Cognitive Activation Theory of Stress applied in an organisational setting.
	Øverland, Simon Nygaard, PhD	Mental health and impairment in disability benefits. Studies applying linkages between health surveys and administrative registries.
	Eichele, Tom, PhD	Electrophysiological and Hemodynamic Correlates of Expectancy in Target Processing
	Børhaug, Kjetil, Dr.philos.	Oppseding til demokrati. Ein studie av politisk oppseding i norsk skule.
	Eikeland, Thorleif, Dr.philos.	Om å vokse opp på barnehjem og på sykehus. En undersøkelse av barnehjemsbarns opplevelser på barnehjem sammenholdt med sanatoriebarns beskrivelse av langvarige sykehusopphold – og et forsøk på forklaring.
	Wadel, Carl Cato, Dr.philos.	Medarbeidersamhandling og medarbeiderledelse i en lagbasert organisasjon
	Vinje, Hege Forbech, PhD	Thriving despite adversity: Job engagement and self-care among community nurses
	Noort, Maurits van den, PhD	Working memory capacity and foreign language acquisition
2008 V	Breivik, Kyrre, Dr.psychol.	The Adjustment of Children and Adolescents in Different Post-Divorce Family Structures. A Norwegian Study of Risks and Mechanisms.
	Johnsen, Grethe E., PhD	Memory impairment in patients with posttraumatic stress disorder
	Sætrevik, Bjørn, PhD	Cognitive Control in Auditory Processing
	Carvalhosa, Susana Fonseca, PhD	Prevention of bullying in schools: an ecological model
2008 H	Brønnick, Kolbjørn Selvåg	Attentional dysfunction in dementia associated with Parkinson's disease.
	Posserud, Maj-Britt Rocio	Epidemiology of autism spectrum disorders
	Haug, Ellen	Multilevel correlates of physical activity in the school setting
	Skjerve, Arvid	Assessing mild dementia – a study of brief cognitive tests.

	Kjønniksen, Lise	The association between adolescent experiences in physical activity and leisure time physical activity in adulthood: a ten year longitudinal study
	Gundersen, Hilde	The effects of alcohol and expectancy on brain function
	Omvik, Siri	Insomnia – a night and day problem
2009 V	Molde, Helge	Pathological gambling: prevalence, mechanisms and treatment outcome.
	Foss, Else	Den omsorgsfulle væremåte. En studie av voksnes væremåte i forhold til barn i barnehagen.
	Westrheim, Kariane	Education in a Political Context: A study of Konwledge Processes and Learning Sites in the PKK.
	Wehling, Eike	Cognitive and olfactory changes in aging
	Wangberg, Silje C.	Internet based interventions to support health behaviours: The role of self-efficacy.
	Nielsen, Morten B.	Methodological issues in research on workplace bullying. Operationalisations, measurements and samples.
	Sandu, Anca Larisa	MRI measures of brain volume and cortical complexity in clinical groups and during development.
	Guribye, Eugene	Refugees and mental health interventions
	Sørensen, Lin	Emotional problems in inattentive children – effects on cognitive control functions.
	Tjomsland, Hege E.	Health promotion with teachers. Evaluation of the Norwegian Network of Health Promoting Schools: Quantitative and qualitative analyses of predisposing, reinforcing and enabling conditions related to teacher participation and program sustainability.
	Helleve, Ingrid	Productive interactions in ICT supported communities of learners
2009 H	Skorpen, Aina Øye, Christine	Dagliglivet i en psykiatrisk institusjon: En analyse av miljøterapeutiske praksiser
	Andreassen, Cecilie Schou	WORKAHOLISM – Antecedents and Outcomes
	Stang, Ingun	Being in the same boat: An empowerment intervention in breast cancer self-help groups
	Sequeira, Sarah Dorothee Dos Santos	The effects of background noise on asymmetrical speech perception
	Kleiven, Jo, dr.philos.	The Lillehammer scales: Measuring common motives for vacation and leisure behavior
	Jónsdóttir, Guðrún	Dubito ergo sum? Ni jenter møter naturfaglig kunnskap.
	Hove, Oddbjørn	Mental health disorders in adults with intellectual disabilities - Methods of assessment and prevalence of mental health disorders and problem behaviour
	Wageningen, Heidi Karin van	The role of glutamate on brain function

	Bjørkvik, Jofrid	God nok? Selvaktelse og interpersonlig fungering hos pasienter innen psykisk helsevern: Forholdet til diagnoser, symptomer og behandlingsutbytte
	Andersson, Martin	A study of attention control in children and elderly using a forced-attention dichotic listening paradigm
	Almås, Aslaug Grov	Teachers in the Digital Network Society: Visions and Realities. A study of teachers' experiences with the use of ICT in teaching and learning.
	Ulvik, Marit	Lærerutdanning som danning? Tre stemmer i diskusjonen
2010 V	Skår, Randi	Læringsprosesser i sykepleieres profesjonsutøvelse. En studie av sykepleieres læringserfaringer.
	Roald, Knut	Kvalitetsvurdering som organisasjonslæring mellom skole og skoleeigar
	Lunde, Linn-Heidi	Chronic pain in older adults. Consequences, assessment and treatment.
	Danielsen, Anne Grete	Perceived psychosocial support, students' self-reported academic initiative and perceived life satisfaction
	Hysing, Mari	Mental health in children with chronic illness
	Olsen, Olav Kjellevold	Are good leaders moral leaders? The relationship between effective military operational leadership and morals
	Riese, Hanne	Friendship and learning. Entrepreneurship education through mini-enterprises.
	Holthe, Asle	Evaluating the implementation of the Norwegian guidelines for healthy school meals: A case study involving three secondary schools
H	Hauge, Lars Johan	Environmental antecedents of workplace bullying: A multi-design approach
	Bjørkelo, Brita	Whistleblowing at work: Antecedents and consequences
	Reme, Silje Endresen	Common Complaints – Common Cure? Psychiatric comorbidity and predictors of treatment outcome in low back pain and irritable bowel syndrome
	Helland, Wenche Andersen	Communication difficulties in children identified with psychiatric problems
	Beneventi, Harald	Neuronal correlates of working memory in dyslexia
	Thygesen, Elin	Subjective health and coping in care-dependent old persons living at home
	Aanes, Mette Marthinussen	Poor social relationships as a threat to belongingness needs. Interpersonal stress and subjective health complaints: Mediating and moderating factors.
	Anker, Morten Gustav	Client directed outcome informed couple therapy

	Bull, Torill	Combining employment and child care: The subjective well-being of single women in Scandinavia and in Southern Europe
	Viig, Nina Grieg	Tilrettelegging for læreres deltakelse i helsefremmende arbeid. En kvalitativ og kvantitativ analyse av sammenhengen mellom organisatoriske forhold og læreres deltakelse i utvikling og implementering av Europeisk Nettverk av Helsefremmende Skoler i Norge
	Wolff, Katharina	To know or not to know? Attitudes towards receiving genetic information among patients and the general public.
	Ogden, Terje, dr.philos.	Familiebasert behandling av alvorlige atferdsproblemer blant barn og ungdom. Evaluering og implementering av evidensbaserte behandlingsprogrammer i Norge.
	Solberg, Mona Elin	Self-reported bullying and victimisation at school: Prevalence, overlap and psychosocial adjustment.
2011 V	Bye, Hege Høivik	Self-presentation in job interviews. Individual and cultural differences in applicant self-presentation during job interviews and hiring managers' evaluation
	Notelaers, Guy	Workplace bullying. A risk control perspective.
	Moltu, Christian	Being a therapist in difficult therapeutic impasses. A hermeneutic phenomenological analysis of skilled psychotherapists' experiences, needs, and strategies in difficult therapies ending well.
	Myrseth, Helga	Pathological Gambling - Treatment and Personality Factors
	Schanche, Elisabeth	From self-criticism to self-compassion. An empirical investigation of hypothesized change prosesses in the Affect Phobia Treatment Model of short-term dynamic psychotherapy for patients with Cluster C personality disorders.
	Våpenstad, Eystein Victor, dr.philos.	Det tempererte nærvær. En teoretisk undersøkelse av psykoterapautens subjektivitet i psykoanalyse og psykoanalytisk psykoterapi.
	Haukebø, Kristin	Cognitive, behavioral and neural correlates of dental and intra-oral injection phobia. Results from one treatment and one fMRI study of randomized, controlled design.
	Harris, Anette	Adaptation and health in extreme and isolated environments. From 78°N to 75°S.
	Bjørknes, Ragnhild	Parent Management Training-Oregon Model: intervention effects on maternal practice and child behavior in ethnic minority families
	Mamen, Asgeir	Aspects of using physical training in patients with substance dependence and additional mental distress
	Espevik, Roar	Expert teams: Do shared mental models of team members make a difference
	Haara, Frode Olav	Unveiling teachers' reasons for choosing practical activities in mathematics teaching

2011 H	Hauge, Hans Abraham	How can employee empowerment be made conducive to both employee health and organisation performance? An empirical investigation of a tailor-made approach to organisation learning in a municipal public service organisation.
	Melkevik, Ole Rogstad	Screen-based sedentary behaviours: pastimes for the poor, inactive and overweight? A cross-national survey of children and adolescents in 39 countries.
	Vøllestad, Jon	Mindfulness-based treatment for anxiety disorders. A quantitative review of the evidence, results from a randomized controlled trial, and a qualitative exploration of patient experiences.
	Tolo, Astrid	Hvordan blir lærerkompetanse konstruert? En kvalitativ studie av PPU-studenters kunnskapsutvikling.
	Saus, Evelyn-Rose	Training effectiveness: Situation awareness training in simulators
	Nordgreen, Tine	Internet-based self-help for social anxiety disorder and panic disorder. Factors associated with effect and use of self-help.
	Munkvold, Linda Helen	Oppositional Defiant Disorder: Informant discrepancies, gender differences, co-occuring mental health problems and neurocognitive function.
	Christiansen, Øivin	Når barn plasseres utenfor hjemmet: beslutninger, forløp og relasjoner. Under barnevernets (ved)tak.
	Brunborg, Geir Scott	Conditionability and Reinforcement Sensitivity in Gambling Behaviour
	Hystad, Sigurd William	Measuring Psychological Resiliency: Validation of an Adapted Norwegian Hardiness Scale
2012 V	Roness, Dag	Hvorfor bli lærer? Motivasjon for utdanning og utøving.
	Fjermestad, Krister Westlye	The therapeutic alliance in cognitive behavioural therapy for youth anxiety disorders
	Jenssen, Eirik Sørnes	Tilpasset opplæring i norsk skole: politikeres, skoleledereres og læreres handlingsvalg
	Saksvik-Lehouillier, Ingvild	Shift work tolerance and adaptation to shift work among offshore workers and nurses
	Johansen, Venke Frederike	Når det intime blir offentlig. Om kvinners åpenhet om brystkreft og om markedsføring av brystkreftsaken.
	Herheim, Rune	Pupils collaborating in pairs at a computer in mathematics learning: investigating verbal communication patterns and qualities
	Vie, Tina Løkke	Cognitive appraisal, emotions and subjective health complaints among victims of workplace bullying: A stress-theoretical approach
	Jones, Lise Øen	Effects of reading skills, spelling skills and accompanying efficacy beliefs on participation in education. A study in Norwegian prisons.

2012 H	Danielsen, Yngvild Sørebø	Childhood obesity – characteristics and treatment. Psychological perspectives.
	Horverak, Jøri Gytre	Sense or sensibility in hiring processes. Interviewee and interviewer characteristics as antecedents of immigrant applicants' employment probabilities. An experimental approach.
	Jøsendal, Ola	Development and evaluation of BE smokeFREE, a school-based smoking prevention program
	Osnes, Berge	Temporal and Posterior Frontal Involvement in Auditory Speech Perception
	Drageset, Sigrunn	Psychological distress, coping and social support in the diagnostic and preoperative phase of breast cancer
	Aasland, Merethe Schanke	Destructive leadership: Conceptualization, measurement, prevalence and outcomes
	Bakibinga, Pauline	The experience of job engagement and self-care among Ugandan nurses and midwives
	Skogen, Jens Christoffer	Foetal and early origins of old age health. Linkage between birth records and the old age cohort of the Hordaland Health Study (HUSK)
	Leversen, Ingrid	Adolescents' leisure activity participation and their life satisfaction: The role of demographic characteristics and psychological processes
	Hanss, Daniel	Explaining sustainable consumption: Findings from cross-sectional and intervention approaches
	Rød, Per Arne	Barn i klem mellom foreldrekonflikter og samfunnsmessig beskyttelse
2013 V	Mentzoni, Rune Aune	Structural Characteristics in Gambling
	Knudsen, Ann Kristin	Long-term sickness absence and disability pension award as consequences of common mental disorders. Epidemiological studies using a population-based health survey and official ill health benefit registries.
	Strand, Mari	Emotional information processing in recurrent MDD
	Veseth, Marius	Recovery in bipolar disorder. A reflexive-collaborative exploration of the lived experiences of healing and growth when battling a severe mental illness
	Mæland, Silje	Sick leave for patients with severe subjective health complaints. Challenges in general practice.
	Mjaaland, Thera	At the frontiers of change? Women and girls' pursuit of education in north-western Tigray, Ethiopia
	Odéen, Magnus	Coping at work. The role of knowledge and coping expectancies in health and sick leave.
	Hynninen, Kia Minna Johanna	Anxiety, depression and sleep disturbance in chronic obstructive pulmonary disease (COPD). Associations, prevalence and effect of psychological treatment.
	Flo, Elisabeth	Sleep and health in shift working nurses

	Aasen, Elin Margrethe	From paternalism to patient participation? The older patients undergoing hemodialysis, their next of kin and the nurses: a discursive perspective on perception of patient participation in dialysis units
	Ekornås, Belinda	Emotional and Behavioural Problems in Children: Self-perception, peer relationships, and motor abilities
	Corbin, J. Hope	North-South Partnerships for Health: Key Factors for Partnership Success from the Perspective of the KIWAKKUKI
	Birkeland, Marianne Skogbrott	Development of global self-esteem: The transition from adolescence to adulthood
2013 H	Gianella-Malca, Camila	Challenges in Implementing the Colombian Constitutional Court's Health-Care System Ruling of 2008
	Hovland, Anders	Panic disorder – Treatment outcomes and psychophysiological concomitants
	Mortensen, Øystein	The transition to parenthood – Couple relationships put to the test
	Årdal, Guro	Major Depressive Disorder – a Ten Year Follow-up Study. Inhibition, Information Processing and Health Related Quality of Life
	Johansen, Rino Bandlitz	The impact of military identity on performance in the Norwegian armed forces
	Bøe, Tormod	Socioeconomic Status and Mental Health in Children and Adolescents
2014 V	Nordmo, Ivar	Gjennom nåløyet – studenters læringserfaringer i psykologutdanningen
	Dovran, Anders	Childhood Trauma and Mental Health Problems in Adult Life
	Hegelstad, Wenche ten Velden	Early Detection and Intervention in Psychosis: A Long-Term Perspective
	Urheim, Ragnar	Forståelse av pasientaggresjon og forklaringer på nedgang i voldsrate ved Regional sikkerhetsavdeling, Sandviken sykehus
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Graphic design: Communication Division, UiB / Print: Skipnes Kommunikasjon AS

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ISBN: 9788230856673 (print)
9788230840078 (PDF)