Tampere University

KIMMO SUOKAS

Social Determinants of Mental Disorders in Finland

A Register-Based Study

Tampere University Dissertations 941

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A Register-Based Study

ACADEMIC DISSERTATION
To be presented, with the permission of
the Faculty of Social Sciences
of Tampere University,
for public discussion in the auditorium F114
of the Arvo Building, Arvo Ylpön katu 34, 33520 Tampere,
on 12 April 2024, at 12 o'clock.

ACADEMIC DISSERTATION
Tampere University, Faculty of Social Sciences
Finland

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Cover design: Roihu Inc.

ISBN 978-952-03-3252-5 (print)
ISBN 978-952-03-3253-2 (pdf)
ISSN 2489-9860 (print)
ISSN 2490-0028 (pdf)
http://urn.fi/URN:ISBN:978-952-03-3253-2

HIILINEUTRAALI PAINOTUOTE
ClimateCalc CC-000025/FI
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PunaMusta Oy – Yliopistopaino
Joensuu 2023

To my family

ACKNOWLEDGEMENTS

First and foremost, I extend my heartfelt gratitude to my supervisors, Professor Sami Pirkola and Professor Olli Kampman. Professor Pirkola has been a constant source of encouragement throughout the entire study, recognizing the potential in this project while being highly constructive and pragmatic instructor. Meanwhile, Professor Kampman has imparted fundamental concepts of psychiatric practice and knowledge, igniting the inspiration to this type of research.

Secondly, I would like to express my sincere thanks to both pre-examiners, Assistant Professor David Gyllenberg and Professor Jouko Miettunen, for their invaluable feedback and constructive comments that played an important role in refining the draft of this thesis into its final form. I am deeply grateful to Professor John McGrath for agreeing to act as my dissertation opponent.

Thirdly, I would like to express my gratitude to all those who have assisted, encouraged, and contributed throughout this journey. In particular, I want to thank university lecturer Anna-Maija Koivisto, who guided me through the initial stages of statistical analysis for the first article and encouraged me to acquire the problem-solving programming skills necessary. I extend my appreciation to Professor Christian Hakulinen for the effective collaboration, encouragement, and expert advice on the entirety of registry study. I would like to thank Dr. Sonja Lumme and other personnel at THL for their assistance in navigating the national registries and introducing the problem of overlapping register entries. Professor R. Sund, I appreciate your insightful statistical advice and discussions on the nature of the healthcare registries. My gratitude goes to Olli Kurkela and Professor Jaakko Nevalainen for sharing their time and expertise through regular meetings, which greatly contributed to structuring the research for the second article. I would like to thank Professor Jaana Suvisaari, who provided valuable comments on the results and significantly aided in clarifying my thoughts regarding the second part of the study. Finally, I extend my appreciation to Dr. Teemu Kärnä, who assisted me in selecting the correct English sex/gender terminology for this dissertation.

Fourthly, I want to acknowledge significant support that, while not directly tied to the content of this thesis, has played a crucial role in my academic journey and deserves recognition. I express my gratitude to Professor Aarno Palotie for providing

a motivating example of how to lead a large-scale research project and for his support in facilitating my participation in the EEPE summer school. Additionally, I extend my thanks to Dr. Aki Hietaharju for inspiring collaboration, engaging discussions, and imparting valuable lessons on scientific thinking and writing. Furthermore, I would like to extend my appreciation to the Jalmari and Rauha Ahokas Foundation, as well as the Finnish Psychiatric Association, for their support of this work. Additionally, I would like to express my gratitude to all the colleagues who have shared their wisdom and guidance in the clinic.

Finally, I want to extend my deepest appreciation to my family for all the encouragement and support I have received. My parents have encouraged and supported me my entire life. With love, I thank Veera for offering boundless support, understanding, and encouragement. Aaro and Eliel, the moments of joy and inspiration with you have added immeasurable richness to my journey.

Helsinki, December 2023

Kimmo Suokas

ABSTRACT

Persistent global health inequalities exist, but despite generous welfare policies they are not consistently smaller in the Nordic countries. Mental disorders are closely linked to lower socioeconomic position and reduced life expectancy, with complex causal connections. In Finland, prevalence of psychotic disorders is higher in the eastern and northern regions and co-occurs with the distribution of schizophrenia polygenic risk scores. Contrary to consistent findings from elsewhere in Northern Europe, urban birth has previously been linked to a reduced risk of these disorders in Finland.

As the landscape of mental health and disorders, their social determinants, and healthcare systems are constantly evolving, updating epidemiological knowledge is crucial. Healthcare and population registers provide comprehensive insights into treated mental disorders in Finland and were the source of data in this study. Key findings are as follows:

First, the incidence of first psychiatric hospital admissions was evaluated over a 19-year population-based follow-up between 1996 and 2014 and was approximately 1.6 admissions per 1 000 person-years in 2016. A clear negative income gradient in the incidence rates of first hospital admissions in the adult population was observed throughout income deciles. In addition, income-specific trends in incidence showed temporal changes in disparities within the population. These findings provide evidence for the role of relative income in the incidence of severe mental disorders and suggest that the shift to outpatient-oriented services may not have been equally successful among all social groups.

Second, observed prevalences of all mental disorders and psychotic disorders treated in both primary and secondary care were higher in the eastern and northern regions of the country compared to coastal regions, as expected. However, after adjusting for sociodemographic and economic factors, this geographical difference was no longer evident. By contrast, urban prominence in the prevalence of psychotic and all mental disorders was observed, and this difference persisted even after the adjustments. The current results indicated a shift in this pattern, suggesting that Finland is no longer an exception in terms of urban-rural differences in the occurrence of psychotic disorders in Northern Europe.

Third, there is excess mortality in individuals with a recent history of treated mental disorders in Finland, which has not previously been evaluated with both primary and secondary care data. A novel finding was that even when considering both primary and secondary care and adjusting for socioeconomic factors, as well as for physical comorbidity, excess mortality persists, although to a significantly reduced extent.

Finally, the Finnish national healthcare registers are a comprehensive and complex source of information. In order to reduce overlapping work, improve the accuracy of register-based data, and to enhance open science, a method for preprocessing of the partly overlapping register entries was made publicly available as a part of this project.

Altogether, the current series of studies added robust nation-wide observations on some key epidemiological variables regarding treated mental disorders. These findings suggest that many of the inequalities in mental health are subject to variation over time and may be amenable to interventions. The field has accumulated a wealth of knowledge, with some strengths and controversies relatively stabilized. Experimental studies could offer a way to make progress in both understanding the social determinants and improving population mental health.

TIIVISTELMÄ

Sosioekonomisten ryhmien välisiä terveyseroja havaitaan maailmanlaajuisesti eivätkä ne ole Pohjoismaissa muita länsimaita pienemmät hyvinvointivaltioon tähtäävästä poliittisesta traditiosta huolimatta. Mielenterveyden häiriöt ovat vahvasti yhteydessä heikompaan sosioekonomiseen asemaan sekä lyhentyneeseen elinajanodotteeseen. Suomessa psykoottiset häiriöt ovat yleisempiä maan itä- ja pohjoisosissa kuin rannikolla ja tämä jakauma noudattelee skitsofrenian geneettisen riskin jakaumaa. Toisin kuin muualla Pohjois-Euroopassa, aiemmissa suomalaisissa tutkimuksissa syntyminen urbaanilla alueella ei ole yhdenmukaisesti assosioitunut matalampaan psykoosien riskiin.

Väestön mielenterveys ja siihen vaikuttavat sosiaaliset taustatekijät sekä mielenterveyspalvelut ovat muuttuvat ajassa ja siksi epidemiologista perustieto vaatii toistuvaa päivittämistä. Terveydenhuollon ja Tilastokeskuksen rekisterit mahdollistavat hoidon piirissä olleiden mielenterveyden häiriöiden kattavan arvioinnin ja niitä käytettiin tämän tutkimuksen aineistona. Tärkeimmät havainnot ovat seuraavat:

Ensimmäistä kertaa psykiatriseen sairaalahoitoon päätymisen ilmaantuvuutta ja sen muutoksia tarkasteltiin tulokymmenyksittäin vuosina 1996–2014. Mitä matalammat asuntokunnan tulot olivat, sitä todennäköisempää oli päätyä ensimmäistä kertaa psykiatriseen sairaalahoitoon. Tämä havainto tukee näkemystä, että suhteellinen tulotaso on merkittävä tekijä aikuisten vakavien mielenterveyden häiriöiden ilmaantumisen kannalta. Ensimmäisen sairaalahoidon ilmaantuvuus laski tasaisesti vain ylimmissä tuloryhmissä viitaten siihen, että tavoite siirtää psykiatrisen hoidon painopistettä pois sairaalahoidosta ei ole onnistunut tasapuolisesti eri tuloryhmissä.

Toiseksi tutkimuksessa havaittiin, että kaikkien mielenterveyden häiriöiden sekä psykoottisten häiriöiden esiintyvyys oli suurempaa Itä- ja Pohjois-Suomessa, kun sekä perusterveydenhuollon että psykiatrisen erikoissairaanhoidon kontaktit huomioitiin. Kun alueellisia eroja sosiaalisten taustatekijöiden jakaumassa huomioitiin, perinteiset itä-länsi-erot katosivat, eikä psykoosien maantieteellinen jakauma enää seurannut geneettisen riskin jakaumaa. Psykoosien esiintymien oli nyt kaupunkien keskustoissa ja maaseutukeskuksissa muita alueita suurempaa ja toisin

kuin itä-länsi-erot, nämä erot eivät hävinneet sosioekonomisten taustatekijöiden huomioimisen jälkeenkään. Suomi ei siis enää ole poikkeus psykoosien ja urbaniteetin yhteyden suhteen Pohjois-Euroopassa.

Kolmanneksi mielenterveyden häiriöihin liittyy ylikuolleisuutta, mutta sitä ei ole aiemmin tutkittu niin, että kaikki hoidon piirissä olleet mielenterveyden häiriöt sekä perusterveydenhuollossa että erikoissairaanhoidossa huomioidaan. Tässä tutkimuksessa osoitettiin, että kun perusterveydenhuollossa asioineet henkilöt huomioitiin, kohonnut kuoleman riski havaittiin edelleen, mutta se oli huomattavasti aiemmin kuvattua matalampi.

Neljänneksi tutkimuksessa kiinnitettiin huomiota siihen, että kansalliset terveydenhuollon rekisterit ovat kattava tietolähde sekä tieteelliselle tutkimukselle että terveydenhuollon toiminnan arvioinnille, mutta niiden hyödyntämiseen liittyy teknisiä haasteita. Päällekkäisen työn vähentämiseksi ja avoimen tieteen periaatteiden mukaisesti, tässä projektissa rekisterien esivalmisteluun käytetyt ohjelmointikoodit saatettiin avoimesti saataville.

Tässä väitöskirjassa päivitettiin suomalaista tietopohjaa hoidon piirissä olleiden mielenterveyden häiriöiden osalta. Nämä tulokset viittaavat siihen, että sosiaaliryhmien väliset terveyserot vaikkakin ovat sitkeästi läsnä, muuttuvat ajassa ja siten niihin todennäköisesti pystyttäisiin toimenpitein vaikuttamaan. Sosiaalisia terveyseroja on tutkittu runsaasti ja tietämys aiheesta samoin kuin siihen liittyvät erimielisyydet ovat varsin vakiintuneita. Kokeelliset tutkimukset voisivat tulevaisuudessa auttaa sekä ymmärtämään sosiaalisten tekijöiden ja terveyden monimuotoisia suhteita aiempaa paremmin, että parantaa väestön terveyttä.

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ABBREVIATIONS

APC	Annual Percentage Change
ASMR	Age-Standardized Mortality Rate
CCI	Charlson Comorbidity Index
CEPHOS-LINK	Comparative Effectiveness Research on Psychiatric HOSpitalisation by record LINKage of large administrative data sets in six European countries
FCRHC	The Finnish Care Register for Health Care
FHDR	Finnish Hospital Discharge Register
ICD-10	International Statistical Classification of Diseases and Related Health Problems, Tenth Revision
ICD-8	International Classification of Diseases, Eighth Revision
ICD-9	International Statistical Classification of Diseases, Injuries, and Causes of Death, Ninth Revision
ICPC-2	International Classification of Primary Care, Revised Second Edition
IRR	Incidence Rate Ratio
MRR	Mortality Rate Ratio
PR	Prevalence Ratio
RCT	Randomized Controlled Trial
REDD	Regional disparities, social segregation and socioeconomic patterning: Where do inequities in access to health care arise? [research project]
THL	The Finnish Institute for Health and Welfare
TRIAD	Unfortunate Trio - Mental Disorders, Somatic Morbidity and Social Exclusion Across the Lifespan [research project]
SDH	Social Determinants of Health

ORIGINAL PUBLICATIONS

Suokas, K., Koivisto, A., Hakulinen, C., Kaltiala, R., Sund, R., Lumme, S., Kampman, O., Pirkola, S. (2020). Association of Income With the Incidence Rates of First Psychiatric Hospital Admissions in Finland, 1996-2014. JAMA Psychiatry, 77(3):274–284. doi:10.1001/jamapsychiatry.2019.3647

Suokas, K., Kurkela, O., Nevalainen, J., Suvisaari, J., Hakulinen, C., Kampman, O., Pirkola, S. (2023). Geographical variation in treated psychotic and other mental disorders in Finland by region and urbanicity. Soc Psychiatry Psychiatr Epidemiol. https://doi.org/10.1007/s00127-023-02516-

Suokas, K., Hakulinen, C., Sund, R., Kampman, O. and Pirkola, S. (2022), Mortality in persons with recent primary or secondary care contacts for mental disorders in Finland. World Psychiatry, 21: 470-471. https://doi.org/10.1002/wps.21027

1 INTRODUCTION

Social factors are significant determinants of health and have attracted scientific interest since the nineteenth century (Deaton, 2016; Marmot, 2005). Within social policies and political agendas in Europe, health inequalities have gained considerable attention since the 1980s (Macintyre, 1997). Mental disorders typically manifest their first onset before or during early adulthood, affecting approximately half of the population by the age of 75. These disorders constitute a substantial source of disability, often influencing the socioeconomic circumstances of the individuals afflicted and those in their vicinity. Furthermore, they impose a notable financial burden (Christensen et al., 2020; GBD 2019 Mental Disorders Collaborators, 2022; McGrath et al., 2023). As a result, comprehending the social determinants of mental health is fundamental to both clinical psychiatry and any endeavor aimed at enhancing public mental health (Alegría et al., 2023).

In the field of psychiatry, a longstanding tradition revolves around the collection of asylum statistics and the aspiration to estimate the number of individuals requiring treatment (Demazeux, 2014; *Mielisairaat ja vajaamieliset*, 1940; Stoep & Link, 2011). Bruce and Barbara Dohrenwend categorized the discipline of psychiatric epidemiology into three waves (Demazeux, 2014; Dohrenwend & Dohrenwend, 1982). The first wave persisted until the outbreak of World War II and was characterized by the utilization of records and insights from key informants to delineate cases. The second wave marked a shift towards addressing mental illness beyond institutional settings, prompting the development of population surveys. The third wave emerged subsequently to advancements in nosology, notably with the introduction of DSM-III. In addition, noteworthy sociological contributions, such as Durkheim's work on suicide and the Chicago School's research on social ecology, have profoundly influenced the field's evolution (Demazeux, 2014; Susser et al., 2006b). More recently, the identification of risk factors has attracted increasing attention, mirroring trends observed in other branches of epidemiology (Susser et al., 2006a).

Epidemiological investigation plays a crucial role in the realm of social psychiatry. Coined in Germany in the first years of the twentieth century, the term 'social psychiatry' found its way into American literature during the 1930s (Bebbington &

Kuipers, 2022; Gogineni et al., 2023). Its development has traced two major branches: the inception of therapeutic communities and the ascent of community psychiatry, and a parallel curiosity about the influences of the social environment on the causes and consequences of disturbances in mental health. According to Leff (2010, p. 5), social psychiatry is a field "concerned with the effects of the social environment on the mental health of the individual, and with the effects of the mentally ill person on his/her social environment". The 1990s marked a turning point, with the National Comorbidity Surveys in the USA and the Global Burden of Disease study, spotlighting the substantial burden of mental disorders in the population (Insel & Fenton, 2005). This revelation catalyzed the recognition of mental health as a critical public health concern (Chadda et al., 2018).

In the field of socially oriented psychiatric epidemiology, principles of social epidemiology and public health research serve as valuable guides. In addition to confining analysis to the investigation of potential causal links between well-defined outcomes and risk factors in counterfactual or interventionist approaches, there is value in adopting a broader perspective on investigation. Socioeconomic factors and mental health are linked in mutually reinforcing ways throughout the course of an individual's life. Hence, a rigorous elimination of potential confounding factors may lead to over-adjustments, as stated by Mackenbach (2019, p. 51): "the paradox is that the closer we get to identifying a true causal effect, the farther we may get from a good understanding of how socioeconomic position affects health".

Instead, expanding examination to the spectrum of social systems and conditions operating at multiple levels and their connections to diverse health-related outcomes proves to be advantageous. This approach aims not only to contribute insights to the broader social and political discourse surrounding health and well-being, but also may sometimes identify potential intervention avenues (Diez Roux, 2022; Glass et al., 2013).

Despite the advancements made in analytical epidemiology concerning mental disorders, the role of descriptive analysis remains important for comprehending the landscape of psychiatry and mental health. Trends such as deinstitutionalization, changes in attitudes towards mental disorders, the integration of mental health into primary care, and economical and political transformations all underscore the need for continuously updated descriptive statistics and monitoring. These efforts serve not only to enlighten both the public and clinicians but also to facilitate informed dialogues on optimal practices.

This thesis addresses three classical questions in psychiatric epidemiology: the correlation between income and mental health; excess mortality; and regional and

urban-rural disparities in mental disorders. These inquiries are investigated through the utilization of comprehensive national register data. Additionally, this work contributes updated descriptive estimates of the incidence and prevalence of mental disorders.

2 REVIEW OF THE LITERATURE

2.1 Social determinants of mental health: Income and mental disorders

2.1.1 A brief introduction to social determinants of health

Socioeconomic differences in mortality have been recognized since the nineteenth century (Deaton, 2016; Lynch & Kaplan, 2000; Mackenbach, 2019, p. 1). While the extent of social inequalities before this era remains uncertain, historical records shed some light on England's transition around 1750, when disparities in life expectancies at birth emerged between the general population and ducal families (Harris, 2004). This observation has prompted suggestions that significant health inequalities might not have existed before the mid-18th century (Deaton, 2011). Further analysis of historical data reveals intriguing patterns: prior to approximately 1750, mid-childhood to adolescent mortality rates were lower among the ducal class, while early-childhood mortality was higher compared to the general population. Notably, this early-childhood mortality began to experience a sharp decline around the 1750s (Kendall et al., 2021). For better or worse, the significance of social inequalities became evident at an early stage in the annals of modern medicine's development (Mackenbach, 2009).

Mackenbach (2019, p. 4) notes that during the 1960s and 1970s, there was a prevailing belief across Europe that modern welfare states would alleviate health inequalities. However, these notions were challenged by the 'rediscovery' of inequalities, prominently highlighted in reports such as the Black Report in 1980 and the Whitehall study (Lucyk & McLaren, 2017; Marmot et al., 1978). In addition, it was a surprise that the Nordic countries do not exhibit lower levels of inequality than the rest of Europe, despite their generous welfare systems. This intriguing observation is sometimes referred to as the Nordic paradox (Mackenbach, 2017a; Vagerö & Lundberg, 1989).

Since the 1990s, the framework of social determinants of health (SDH) has played a pivotal role in population and public health research and policy, highlighting the

profound influence of social factors on health and disease outcomes, as well as the societal origins of health disparities (Braveman & Gottlieb, 2014; CSDH, 2008; Wilkinson & Marmot, 2003). The World Health Organization (WHO) defines SDH as "the non-medical factors that influence health outcomes. They are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems" (WHO, 2023). Key concepts within the SDH framework include health equity and inequity, and the social gradient in health. Inequity, as stated in a renowned definition by Whitehead (1992), pertains to "health differences that are avoidable, unnecessary, unfair, and unjust", whereas social gradient in health refers to the stepwise relationship between health and social position across the social stratum (Arcaya et al., 2015; Lucyk & McLaren, 2017; Marmot et al., 2008).

On the other hand, the concept of SDH has been criticized for being confusing, by mixing up determinants of health and determinants of health inequalities and individual level risk factors and social structures, and by expanding over too broad range of possible determinants, among other things (Alderwick & Gottlieb, 2019; Islam, 2019).

2.1.2 Social determinants of mental health

Social factors related to mental health have long been a subject of study, but the SDH framework expands the scope beyond individual-level social risk factors to encompass a public and population-based approach (Allen et al., 2014; Compton & Shim, 2015; World Health Organization, 2014). The intricate link between mental and physical health is well established, with a significant overlap in shared social determinants (Barnett et al., 2012; Kivimäki et al., 2020; Skou et al., 2022). The historical evolution of psychiatric services, transitioning from institutions to deinstitutionalization, is a central theme influencing the social factors shaping mental disorders. Additionally, as mental disorders frequently manifest during childhood, adolescence, or early adulthood (McGrath et al., 2023), they inherently possess the potential to subsequently impact various socioeconomic dimensions in the lives of affected individuals (Alegría et al., 2023; Jeste & Pender, 2022). This reciprocal relationship has spurred discussions concerning issues of selection and causation, which will be further explored in the following section, although it is now widely

recognized within the field that these mechanisms are not mutually exclusive (World Health Organization, 2014).

Recent conceptualizations within the US context have identified key categories of social determinants influencing mental health. These include factors such as socioeconomic status and opportunities for accruing wealth, including education, employment and job security; poverty, income inequality, and neighborhood deprivation; basic needs in terms of housing, food, transportation, and health care; immediate and global physical environment; exposure to violence, conflict, and war in childhood or adulthood, discrimination and social exclusion; sexism and other forms of non–race-based discrimination; criminal justice involvement; stigma related to mental illness and substance use disorders; lack of mental health parity; lack of social connection and loneliness; harmful communication through social media; stresses and traumas associated with immigration, social despair and hopelessness; and psychosocial strengths such as resilience, empathy, solidarity, emotional literacy, compassion, and secure attachments (Alegría et al., 2023; Compton & Shim, 2015; *Final Report of the Presidential Task Force on Social Determinants of Mental Health*, 2022). In this perspective, these acknowledged factors act as foundational elements for linking social norms and policies with both mental and physical health. They exert influence over the distribution of opportunities, health behaviors, biological causes, and social and economic resources, among other things (Compton et al., 2015; Compton & Shim, 2015).

2.1.3 Income measures

Income is an important social determinant of mental health and health in general (Marmot, 2005; Marmot et al., 2012; World Health Organization, 2014). It is a traditional indicator of socioeconomic position, reflects the economic resources an individual has, and is amenable to policy and interventions (Diez Roux, 2022; Galobardes et al., 2006a).

Measuring income encompasses diverse approaches. Individual-level income underscores personal status or material prosperity, while household income mirrors the collective status and resources of all household members (Geyer, 2011). Further complexity emerges from income variations rooted in the types of income and associated taxes accounted for in the calculation. Household income necessitates adjustments to account for household size, often accomplished using the Organisation for Economic Co-operation and Development–modified equivalence

scale (Förster & d'Ercole, 2009). Ecological analyses frequently employ area-level mean income metrics or the Gini coefficient (Lynch et al., 2004). Measurement of income remains a challenging endeavor in surveys. The availability of comprehensive register data is limited to specific countries such as the Nordic nations and the Netherlands(Mackenbach, 2019, p. 16).

In register-based research in the Nordic countries, equivalized household income is commonly used. Income assessment can occur at specific times or ages, or it can be averaged over periods (Benzeval & Judge, 2001). Values may be categorized in multiple ways, as illustrated by Kinge et al. (2019) and Mok et al. (2018).

Incorporating a temporal gap between the income measurement and the outcome of interest may be essential, considering potential reverse causation on income stemming already from the processes eventually leading to the outcome of interest (Rehnberg et al., 2021). An alternative approach involves measuring income change, which itself may significantly impact mental health and overall well-being (Thomson et al., 2022).

Limitations exist within the register-based income data. Notably, income data fails to encompass wealth, savings, subjective factors tied to economic conditions, or income security. Furthermore, equivalized household income measurement may overestimate the standard of living achieved by disabled people and does not account for the distribution of money within the household (Chanfreau & Burchardt, 2008).

2.1.4 Income and mental disorders

Several reviews have pointed out a robust connection between individual-level income and a range of mental disorders (Cooper & Stewart, 2021; Fryers et al., 2003, 2005; Lorant et al., 2003; Lund et al., 2010; Muntaner et al., 2004; Reiss, 2013; Schneider et al., 2022; Thomson et al., 2022). Likewise, the association between income inequality and mental disorders has been reviewed several times (Burns et al., 2014; Layte, 2012; Patel et al., 2018; Pickett & Wilkinson, 2015; Ribeiro et al., 2017; Tibber et al., 2022; Yu, 2018).

Classically, two main explanations, social causation and social selection, have been put forward to elucidate the connection between income and mental health. The social causation perspective suggests that the level of income or poverty impacts mental health through various pathways. By contrast, the selection hypothesis proposes that mental disorders might lead to downward social mobility within and across generations. Selection can be dissected into direct and indirect forms. Direct selection involves reverse causation, where health issues result in lowered social

mobility, income loss, or other disadvantages. Indirect selection pertains to scenarios where a third factor concurrently influences both health and socioeconomic status. It is now widely acknowledged that causal links are bidirectional, albeit their manifestation varies across disorders, contexts, and the life-course (Braveman & Gottlieb, 2014; Deaton, 2003; Dohrenwend, 1990; Dohrenwend et al., 1992; Hudson, 2005; Miech et al., 1999; Oversveen et al., 2017; Reiss, 2013; Ridley et al., 2020). However, the precise magnitudes of distinct mechanisms remain unclear. For example, the extent to which household income exerts an autonomous, direct effect on children's mental health, and the degree to which this association is confounded by factors such as parental education, parental health, social or cultural capital, and unmeasured variables such as genetic risk, remain subjects of debate (Cooper & Stewart, 2021; Ejlskov et al., 2023; Sariaslan et al., 2021).

Several theories have been proposed to explain health inequalities and can be useful to elaborate on the mechanisms linking income and mental health. These theories fall into four main groups, each emphasizing a distinct aspect: selection into socioeconomic groups, differential health progress, social disadvantage, and social production of disease (Mackenbach, 2019, p. 86).

Reverse causation is quite clearly observable, as measuring and comprehending the findings on future income, employment, and education after the onset of mental disorders is relatively straightforward (Hakulinen, Elovainio, et al., 2019; Hakulinen, McGrath, et al., 2019; Hakulinen, Musliner, et al., 2019). However, untangling indirect effects poses greater challenges, as mentioned above.

Within the differential health progress theory, two concepts—diffusion of innovation and inverse equity—assert that higher socioeconomic positions lead to the earlier adoption of novel behaviors and interventions across health and other aspects of life. Cultural capital theory, on the other hand, posits that one's lifestyle acts as a marker of social class, prompting individuals to adopt healthier habits due to the norm within their societal stratum and as a means of expressing their status.

Social disadvantage theories encompass concepts such as the psychosocial theory and neo-material theory. The psychosocial theory posits that adversity and stress linked to lower income elevate the risk of diverse conditions. This theory delves into relative disadvantage, which operates alongside the direct impacts of poverty or absolute resources (Marmot & Wilkinson, 2001). Although the welfare state has been effective in curbing inequalities in material living conditions, disparities in status and power persist, resulting in insecurity, lack of control, and anxiety, among other factors that correlate with diminished mental well-being. Within this framework, status anxiety contributes to distress stemming from concerns about individuals'

social standing and status competition. Notably, status anxiety tends to be more pronounced in countries characterized by higher income inequality.

Neo-materialism theory underscores the continued significance of material living conditions as pivotal determinants of health. This theory accentuates the adverse exposures and deficiencies in resources prevalent in individual circumstances as well as within broader social systems and policies at the macro level.

The social production of disease encompasses the fundamental causes framework and the political economy of health. The fundamental causes framework reframes the problem on a general level and emphasizes that the social forces underlying social stratification are the ultimate causes of health inequalities. This perspective emphasizes upstream factors more than the quantified individual-level characteristics (Phelan et al., 2004). According to this view, health inequality will persist as long as social inequality persists.

The political economy of health framework shifts the focus towards human agency, an aspect often overlooked in other theories. It raises the question of whose interests are served by the inequalities in health and the inequalities in its determinants.

In the context of depression, potential mechanisms have been reviewed in detail (Patel et al., 2018; Ridley et al., 2020). Factors encompassing worries and uncertainty, environmental influences, physical health status, early-life conditions, experiences of trauma, violence, and crime, as well as aspects related to social status, shame, and isolation, have all been identified as potential mediators through which the impact of low income on depression might operate.

In Finland, several observational studies have been conducted on the association between income and mental health (Hakulinen, Elovainio, et al., 2019; Hakulinen et al., 2020, 2023; Laaksonen et al., 2007; Lahelma et al., 2006; Moustgaard et al., 2014; Pulkki-Råback et al., 2011; Sariaslan et al., 2021; Vaalavuo et al., 2022; Virtanen et al., 2008), some of which have not detected an association after adjustments (Junna et al., 2019; Markkula et al., 2017).

Experimental evidence, and randomized controlled trials (RCTs) in particular, have commonly been considered ideal for causal reasoning (Murad et al., 2016). However, RCTs do exhibit limitations in terms of generalizability, especially when assessing intricate causal constructs such as public health interventions, or policies and their connections to population mental health. In such cases, natural experiments emerge as a valuable supplementary source of information, aiding in the synthesis of diverse types of evidence (Deaton & Cartwright, 2018; Diez Roux, 2022; Ogilvie et al., 2020).

A notable natural experiment concerning income transfers and mental health emerges from North Carolina, USA. The opening of a casino provided an opportunity to investigate distinct effects on children whose families received an exogenous income supplement compared to those who did not. In the initial analysis, the incidence of conduct and oppositional disorders decreased among the recipients of the income supplement, whereas depression and anxiety did not show significant changes (Costello et al., 2003). In a subsequent follow-up study conducted two decades later, positive adult functioning was observed, along with reduced levels of anxiety, depressive symptoms, and symptoms linked to cannabis use (Copeland et al., 2022).

A limited number of universal basic income experiments have been carried out in high-income countries, providing interventional data on the subject. Two recent reviews examining the effects of these experiments have clearly pointed towards improvements in mental health outcomes with little effect on employment (Gibson et al., 2020; Wilson & McDaid, 2021). Similarly, cash transfer programs implemented in low- and middle-income countries have demonstrated favorable impacts on mental well-being (McGuire et al., 2022; Ridley et al., 2020; A. Zimmerman et al., 2021).

In Finland, an RCT on basic income was conducted from 2017 to 2018 (Hiilamo, 2022). However, the experiment was significantly compromised due to the introduction of a new sanctioning model in 2018, during the course of the trial. The results indicated that the experiment did not yield improvements in employment rates and was not deemed successful. Nonetheless, the mental well-being of the participants did in fact increase, although the methodological limitations of the survey assessing this aspect were acknowledged. Although mental health status was not the main outcome of the trial, the compromised results are in line with the findings from the reviews (Gibson et al., 2020; Wilson & McDaid, 2021).

2.2 Regional and urban-rural variation in mental disorders

Mental disorders exhibit variations in both prevalence and burden across continents, countries, and even within regions within countries (GBD 2019 Mental Disorders Collaborators, 2022; Jongsma et al., 2018). Schizophrenia and other psychotic disorders serve as intriguing examples due to the prior suggestion that the incidence of schizophrenia might be environment-independent and not subject to geographical variation (McGrath, 2005; Stilo & Murray, 2010). Since the landmark meta-analyses,

however, recognition of incidence and prevalence differences in schizophrenia has become apparent (McGrath et al., 2004; Saha et al., 2005). Numerous environmental risk factors have been identified, including complications in early development, childhood adversity, immigration, being born or raised in cities, medical conditions such as infections or brain injuries, or cannabis use in adolescence (Owen et al., 2016; Robinson & Bergen, 2021).

Living in or growing up in an urban environment are associated with elevated prevalence of a variety of mental disorders (Krabbendam et al., 2021). A significant portion of research on this topic has focused on schizophrenia spectrum psychotic disorders and has shown constant associations in Northern Europe (Abrahamyan Empson et al., 2020; Castillejos et al., 2018; Fett et al., 2019; Heinz et al., 2013; Jongsma et al., 2018; McGrath et al., 2004; Pedersen et al., 2022; Vassos et al., 2016). However, in Southern Europe, the USA, and the Global South, the correlation between urbanicity and psychosis risk does not appear to be uniform (J. DeVylder et al., 2023; J. E. DeVylder et al., 2018; Jongsma et al., 2018).

The underlying mechanisms for urban-rural differences or the above-mentioned geographical variations in the associations are not well understood. Several hypotheses have been postulated. It has been suggested that humans may not have been properly equipped to cope with urban environments given the relatively short urban evolutionary history, and that urban life may be stressful in a way that may lead to cognitive overload, for example (Krabbendam et al., 2021). More specifically, factors such as pollution, lack of green space, social deprivation, social stress or selective migration, as well as population density as such have been linked to increased risk (Abrahamyan Empson et al., 2020; Logeswaran et al., 2023; Song et al., 2023; Yang et al., 2021).

2.2.1 Regional and urban-rural variations in Finland

In Finland, there is a well-documented pattern of higher prevalence of schizophrenia and other psychotic disorders in the east and of mood and anxiety disorders in the south (Haukka et al., 2001; Hovatta et al., 1997; Korkeila et al., 1998; Lehtinen et al., 1990; Perälä et al., 2008; J. Suvisaari et al., 2014). In schizophrenia, regional differences have been more significant than urban–rural variations, and this geographical east–west pattern in schizophrenia prevalence coincides with schizophrenia polygenic risk scores, leading to the hypothesis that population

genetics may play a role (Haukka et al., 2001; Kerminen et al., 2019; Kurki et al., 2019; Perälä et al., 2008).

Research on population genetics in Finland has attracted a great deal of interest, and there is a well-documented north-south and east-west genetic differentiation within the population (Kerminen et al., 2017; Kurki et al., 2019, 2023). These variations have been explained by substantial Scandinavian gene flow into south-western, but not into the eastern Finland, since deglaciation around 11 00 years ago, and series of population bottlenecks over the last few thousand years (Hovatta et al., 1997; Martin et al., 2018; Palo et al., 2009). A remarkable consequence of this population history is called the Finnish disease heritage, including almost 40 rare monogenic, usually autosomal-recessive, diseases that are over-represented in Finland (Norio, 2003; Uusimaa et al., 2022). Furthermore, the recognition of population isolates with small ancestor populations and higher prevalence of schizophrenia than in the general population (Hovatta et al., 1997) has motivated psychiatric genetic research in Finland (Hennah et al., 2006; Lähteenvuo et al., 2023; Stoll et al., 2013).

On the other hand, social determinants of mental health, such as the proportion of low-income earners, level of education, unemployment, migration, or household structure also vary across the country, with less favorable compositions often seen in the eastern parts of the country. Urban areas, on the other hand, are more common in southern and western regions. The role of these factors in the geographical variations in mental disorders within the country is not clear.

2.3 Excess mortality in individuals with primary or secondary care treatments for mental disorders

Excess mortality among people with mental disorders is a well-known phenomenon (Chesney et al., 2014; Erlangsen et al., 2017; Firth et al., 2019; Oslo, 1936; Plana-Ripoll et al., 2019; Walker et al., 2015b). The highest mortality rates have been observed in individuals with inpatient treatments, but excess mortality has been observed even in sub-clinical mental health disturbances, for example in sub-clinical forms of depression (Crump et al., 2013; Cuijpers & Smit, 2002; Walker et al., 2015b).

Depression and anxiety are among the top 10 most common reasons for visits to primary care (Finley et al., 2018), but excess mortality is usually studied in secondary care settings. The few population-based studies that have examined the overall mortality of individuals with treatments for mental disorders both in primary and

secondary care have suggested that an ascertainment bias may occur when only secondary care cohorts are used (John et al., 2018; Kisely et al., 2005). To the best of this author's knowledge, there is no published research on the mortality risk over a full spectrum of mental disorders treated both in primary and secondary care on a nationwide level.

Integration of mental health care in primary care services is considered a priority in low-, middle- and high-income countries (Thornicroft et al., 2016; World Health Organization, 2019). In Finland, it is more common to have a contact relating to mental disorders in primary than in secondary care (Forsell & THL, 2022). The overall shortage of mortality data concerning mental disorders in primary care may lead to overestimated conceptions of the population-wide burden of the full spectrum of treated mental disorders.

2.4 Healthcare registers in Finland

The Finnish Hospital Discharge Register (FHDR) has continuous nationwide data with coverage since 1969, making it the first in the Nordic countries (Laugesen et al., 2021; Maret-Ouda et al., 2017). In its early stages, the FHDR was composed of separate sub-registers for diverse hospital types, encompassing general, tuberculosis, psychiatric, and other categories. Subsequently, these separate sub-registers were amalgamated into a unified system (Sund, 2012). The Finnish Care Register for Health Care (FCRHC) replaced the FHDR starting from 1994.

Data on specialized outpatient care in the public sector have been collected since 1998. According to the Quality description of the FCRHC, data on specialized outpatient care are comparable across time and service providers only from 2006 onwards (The Finnish Institute for Health and Welfare, 2020).

Public primary care has been included since 2011 and substantially widens the coverage of mental disorders in the registers, as depression, for example, is commonly not treated in secondary care, as noted recently also in Denmark (Weye et al., 2023). Private and employer-paid outpatient care are specific components of the Finnish health care system but are covered in the registers only from the year 2019.

In general, the accuracy of mental health diagnoses in the registers is considered to be good, although there has been a noted limitation in the recording of subsidiary diagnoses (Isohanni et al., 1997; Mäkikyrö et al., 1998; Pihlajamaa et al., 2008; Sund, 2012). To the best knowledge of this author, however, studies on the accuracy of

mental disorder diagnoses specifically from primary care have not hitherto been published.

One remarkable study indicated that although the Finnish healthcare registers are effective in screening for possible psychotic disorders, they may not be optimal for complete case ascertainment (Perälä et al., 2007). On the other hand, it has been recognized that there is a tendency towards a narrow definition of schizophrenia in clinical practice in Finland, which could result in false negative diagnoses but very few false positive ones (Isohanni et al., 1997). Overall, healthcare registers, as well as population registers in Finland and other Nordic countries, are population-based with virtually complete follow-up. Originally, they were mainly intended for administrative purposes and the validity and completeness of individual variables may vary (Laugesen et al., 2021). This needs to be carefully considered in register-based research.

2.4.1.1 Identifying treatment episodes in the registers

In the Finnish healthcare registers, a single hospital stay may generate multiple register entries (Pirkola & Sohlman, 2005, p. 16). A few research projects, such as the CEPHOS-LINK project (Katschnig & Stra, 2017) or the REDD project (Kajantie et al., 2006), have addressed the importance of the procedures for identifying treatment episodes from the partly overlapping healthcare register data. The CEPHOS-LINK project, for example, indicated that as much as 25% of the register entries associated with psychiatric inpatient care are related to transfers that take place during an ongoing hospitalization (Katschnig & Stra, 2017, p. 29).

In the context of the FCRHC, a single hospitalization event can yield multiple register entries. These entries arise when there are intra-hospital transfers or shifts between distinct specialties within the same facility. Moreover, entries are generated for outpatient and emergency visits that may transpire at the outset or during the hospitalization. Consequently, the amalgamation of multiple register entries might be essential to correctly identify hospital admissions, discharges, and the corresponding discharge diagnoses encompassed within the registers.

Moreover, the initiation of inpatient care often originates from an emergency clinic setting, and outpatient appointments might take place during the tenure of a patient's stay in a psychiatric ward. FCRHC records these appointments along with possible preliminary diagnoses at the time of these appointments. As a result, combining multiple register entries of different treatment modalities and recognizing the potential preliminary diagnoses becomes necessary in order to accurately identify

the most reliable estimates of actual discharges, discharge diagnoses, and independent outpatient visits that are not part of inpatient events.

A standardized consensus regarding best practices for handling inpatient episodes has not been established, leading to variations in criteria adopted by different study projects. For example:

- The CEPHOS-LINK project required that a hospital stay should start and end on distinct calendar days, essentially requiring an inpatient episode to span overnight (Katschnig & Stra, 2017), whereas others do not have this criterion.
- The REDD project introduced a condition according to which a new treatment period could only commence after a full calendar day spent outside the hospital. Any entries within the register prior to this transition were amalgamated. This approach aimed to create a clearer distinction between inter-hospital transfers and subsequent rehospitalizations(Kajantie et al., 2006).

To the best knowledge of this author, these approaches have not been compared. Furthermore, the methodologies employed for pre-processing healthcare registers have typically not previously been disclosed to the public.

3 AIMS OF THE STUDY

In order to gain a deeper understanding of the evolving landscape of mental disorders, their social determinants, and healthcare systems in Finland, a register-based epidemiological study was conducted. The specific research questions addressed were as follows:

1. To assess the incidence, temporal trends, and risk factors, including household income, of lifetime first psychiatric hospital treatments; to investigate whether there is an income gradient in the incidence and to identify the temporal trends in the overall and income-specific incidence of first psychiatric hospital treatments (Study I).

2. To determine the prevalence of treated mental disorders within a one-year period (Study III) and throughout the register (Study II) in both primary and secondary care settings.

3. To explore regional and urban-rural variations in the prevalence of psychotic disorders and all mental disorders in Finland, considering both primary and secondary care registers; to evaluate the influence of sociodemographic and economic factors on the geographical distributions; to compare the distribution of the prevalence of different psychotic disorders with different levels of adjustments to the previously known geographical distribution of schizophrenia polygenic risk scores in Finland (Study II).

4. To examine the impact of including primary care treatments on estimates of excess mortality related to mental disorders (Study III).

4 MATERIALS AND METHODS

4.1 Data sources and ethical considerations

This study is a component of the TRIAD ("Unfortunate Trio - Mental Disorders, Somatic Morbidity, and Social Exclusion Across the Lifespan") study, in which various national registers were pseudonymized and combined at an individual level. Data were available from the beginning of the registers until the end of the year 2014 (Study I), and until the end of 2017 (Studies II and III). The following registers were utilized in this study:

1. Healthcare register, including The Finnish Care Register for Health Care (FCRHC), formerly known as the Hospital Discharge Register (FHDR), covering the period from 1969 to 1993, administered by The Finnish Institute for Health and Welfare (THL).

2. Population registers and the Finnish Causes of Death Register, administered by Statistics Finland.

The Research Ethics Committee of the Finnish Institute for Health and Welfare approved the study protocol (decision #10/2016§751). Data were linked with permission from Statistics Finland (TK-53-1696-16) and the Finnish Institute of Health and Welfare. Informed consent is not required for register-based studies in Finland.

4.2 Data collection procedures and study variables

Healthcare registers include data on service provider, access to care, medical procedures, and the end of the care, among other things. Detailed descriptions are available in Finnish in the register manuals (Häkkinen et al., 2019).

Statistics Finland offers readily available population register data for research purposes, known as the FOLK modules. These data are typically compiled at the end of each year and align with the official data released at that time. For more

information, please refer to the Taika catalogue by Statistics Finland, which can be accessed at https://taika.stat.fi/en/.

4.2.1 Treated mental disorders

4.2.1.1 Coverage and contents of the healthcare registers

Information on mental healthcare was obtained from the FCRHC and the FHDR. The FHDR has continuous nationwide data since 1969 (Sund, 2012). For the years 1969-1974, however, the classification of medical specialties is unclear in some of the sub-registries. Hence, people with a history of mental health-related contact with psychiatric inpatient care was evaluated in this study since 1975.

Data on specialized outpatient care in the public sector have been collected since 1998, but according to the Quality description of the FCRHC, the data are comparable across time and service providers starting from 2006 onwards (The Finnish Institute for Health and Welfare, 2020). As regional comparisons were the main aim in Study III, data since 2006 was used throughout.

All public primary care has been included in the FHRHC since 2011. Private and employer-paid outpatient care are specific components of the Finnish health care system but are covered in the registers starting from 2019, and hence are not included in the current study.

4.2.1.2 Diagnostic classifications

The Finnish version of the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) has been used in the Finnish healthcare registers since 1996 (*Tautiluokitus ICD-10*, n.d.), ICD-9 between the years 1987 and 1995, and ICD-8 between 1969 and 1986.

In this study, psychiatric diagnoses recorded using ICD-8 and ICD-9 classifications were rerecorded into corresponding ICD-10 codes using the Conversion Tables by the WHO (1994). Specific disorders with the ten-level ICD-10 sub-chapter categories were described. Further categorizations for each study are described below.

In primary care, the ICPC-2 International Classification of Primary Care, instead of ICD-10, is used in some facilities, and ICPC-2 mental health-related diagnoses

were converted to corresponding ICD-10 sub-chapter categories when possible (WONCA International Classification Committee (WICC), 2005). Conditions listed in ICPC-2, chapter P: "Psychological" were included in this study. In the Finnish version of ICPC-2, the chapter P is translated to the Finnish equivalent of "mental health" not "psychological". The Finnish version was used throughout the conversion process (Kvist et al., 2010). The conversion codes from ICPC-2 to ICD-10 are provided in the ICPC-2 manual and were adopted in this study. ICPC-2 concepts not represented exactly in the ICD-10 sub-chapter categories were included as a separate group of their own and were not included in the ICD-10 sub-chapter categories.

4.2.1.3 Identification of treatment episodes

By combining the criteria outlined in Section 2.4.1.1, four distinct models for identifying treatment episodes from the healthcare registers can be derived (Table 1). In this study, a script utilizing the R programming language was developed for this purpose. The script has been made publicly available under the GNU General Public License v3.0, along with example synthetic data, in order to enable others to evaluate and benefit from this effort (Suokas, 2021).

For the purposes of this study, two preliminary comparisons were conducted to estimate the effects of the preprocessing on the total number of individuals recognized from the registers. First, the number of individuals with psychiatric inpatient treatments were estimated using the ICD-10 sub-chapter categories with the four models and were compared to the numbers derived from raw register data. Second, an analogous comparison was conducted for the total number of individuals with mental disorders treated in primary or secondary care.

Table 1. Possible models for identifying treatment episodes

Model	Description
1	A new hospitalization may begin on the day following a previous one, with no specific minimum length required for a hospitalization. This represents the most liberal approach
2	A new hospitalization may begin on the day following a previous one. Valid hospitalizations are those that extend over a minimum of two consecutive days, incorporating at least one overnight stay. If both admission and discharge take place on the same day, the visit is classified as an outpatient visit. This model was used in the CEPHOS-LINK project
3	A new hospitalization is allowed after a full day has been spent outside the hospital following the previous one. There is no specific minimum duration required for a hospitalization. This model was used in the REDD project
4	A new hospitalization is allowed after a full day has been spent outside the hospital following the previous one. Valid hospitalizations are those that extend over a minimum of two consecutive days, incorporating at least one overnight stay. If both admission and discharge take place on the same day, the visit is classified as an outpatient visit. This represents the most conservative model

4.2.2 Mortality

Information on date and cause of death was obtained from the Finnish Causes of Death Register, a national register maintained by Statistics Finland and rated as having high quality (Mikkelsen et al., 2015).

4.2.3 Household income

Equivalized household net income was calculated by adjusting the net income of a household dwelling unit for the size of the unit, using the Organisation for Economic Co-operation and Development–modified equivalence scale (Förster & d'Ercole, 2009). Equivalized income takes into account the differences in a household's size and composition, including age of the household members. In this study, net income was obtained by subtracting taxes from income subject to state taxation.

We calculated 10th percentiles (deciles) of the Finnish income distribution in order to categorize the population annually into 10 income groups based on the most recent data. Individuals registered as institutionalized, homeless, abroad, unknown, or residing in quarters that do not meet the definition of dwelling do not form household-dwelling units and are classified as non-dwelling. As a result, household income does not apply to this group of individuals. Instead of excluding them from the analyses, however, they were treated as a distinct income group on their own.

4.2.4 Regions and urban-rural classification

Finland consists of 19 administrative regions, each with a central town, possible other towns and surrounding areas with varying degrees of urbanicity (Statistics Finland, n.d.-a). The latest classification was used throughout the study period, which accounted for minor changes in the classification of regions during the period.

A seven-level urban-rural classification for the year 2010 issued by the Finnish Environment Institute was used to measure urbanicity for each individual's place of residence (Finnish Environment Institute, 2013). The classification is based on a nationwide grid of 250 x 250 m cells to measure urbanicity based on data concerning population, workforce, commuting and buildings, road network and land-cover (Figure 1).

In Study I, a three-level classification of urbanicity of residence municipality (urban, semiurban, or rural) was available for the whole study period and used instead.

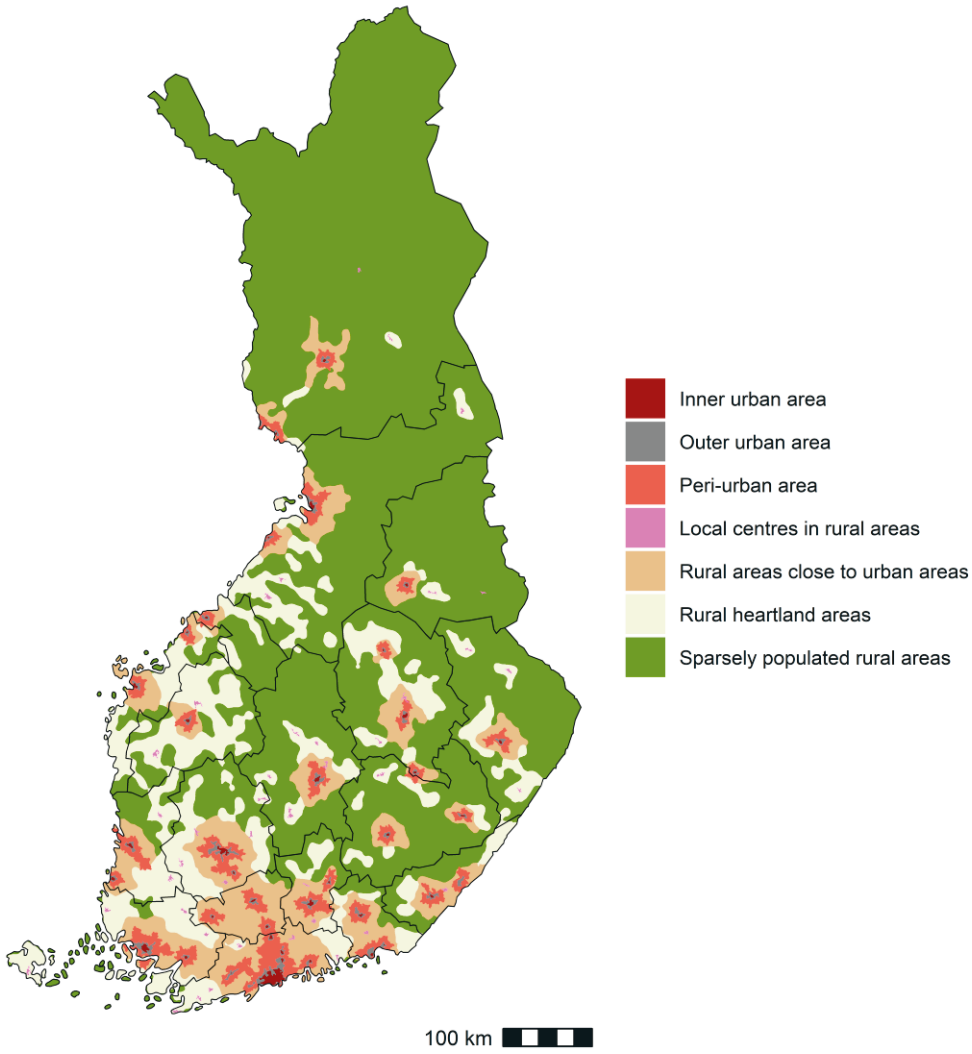

Figure 1. Urban-rural classification and administrative regions in Finland. Urban-rural classification from the Finnish Environment Institute (2013).

4.2.5 Sociodemographic variables

The following categorical individual-level data on the last day of each study year was extracted from the population registers: age (five-year intervals), recorded gender (man or woman), origin (Finnish background or not, determined based on the

country of birth data of the person's parents (Statistics Finland, n.d.-b)), nationality (Finnish citizen or not), currently inhabiting the region of birth (yes or no), economic activity (employed; unemployed; students; pensioners and others outside the labour force), level of educational attainment (less than upper secondary, upper secondary, or tertiary, a national classification based on the United Nations Educational, Scientific and Cultural Organization's International Standard Classification of Education 2011) (UNESCO Institute for Statistics, 2012), and living alone status (living alone or not).

4.2.6 Physical comorbidity

Physical comorbidity was assessed using the Charlson comorbidity index (CCI), a widely used comorbidity index with a weighted score of 17 comorbid conditions (Sundararajan et al., 2004). For every study year and for every individual in the study, the CCI score was calculated using available ICD-10 diagnoses of any actual treatment contacts in the health care registers from the beginning of the previous calendar year. Age was not included in the CCI scores, but adjusted in the main model (Bannay et al., 2016). CCI scores were categorized by previously used cut-points: none, 1-3, and ≥4 (Erlangsen et al., 2020).

4.3 Study designs and statistical analyses

4.3.1 Study I: Association of income with the incidence rates of first psychiatric hospital admissions in Finland, 1996-2014

4.3.1.1 Design

An open cohort study was conducted including the full dynamic population of Finland at risk of first admissions in Finland from 1996 through 2014 (Vandenbroucke & Pearce, 2012). All persons with first-time psychiatric hospital inpatient admissions were identified starting from the year 1976. Hence, the shortest definitive clearance period to define a first admission (i.e., the time with no previous inpatient treatments before the first admission) was 20 years (January 1, 1976, through December 31, 1995). In order to cover the whole study period and facilitate

the evaluation of temporal trends, we used a 20-year clearance period for each study year.

For identifying inpatient episodes and discharge diagnoses, Model 3 (Table 1) was employed. The primary outcome of interest was the first admission, irrespective of the duration of the treatments, and thus overnight stay was not required. Discharge diagnoses were labeled based on the ICD-10 sub-chapter categories. In addition, disorders with major psychotic features were identified using the following ICD-10 codes: F20, F22-F29, F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, F32.3, F33.3, F1x.5 and F1x.7.

4.3.1.2 Statistical analysis

Stratum-specific incidence rates of the first psychiatric hospital admissions for every calendar year were calculated by dividing the number of first admissions by the person-years at risk in the following strata: recorded gender, 5-year age groups, nationality, income decile, decrease in income decile in the previous three years, urbanicity of the residential municipality, educational level, and living alone status. Age-standardized incidence rates with 95% CIs were calculated by applying direct age standardization to the 2013 Revision of the European Standard Population (Eurostat, 2013). Analyses were conducted separately for the main ICD-10 categories of psychiatric diagnoses.

Every person in the population register with no previous hospital admissions within the clearance period of 20 years contributed to the person-time at risk. Exact dates of immigration to and from the country, moves between municipalities, or changes in household composition were not available, and therefore changes were assumed to occur on average in midyear. Non-Finnish citizens had a high rate of missing data, for example, 13.2% of the person-years at risk had missing income data, compared with only 0.9% in the case of Finnish citizens. Hence, all analyses included Finnish citizens only.

A joinpoint regression model was used to analyze changes in trends in age-standardized incidence rates (Kim et al., 2000). Gender-, income decile–, and diagnosis-specific trends were analyzed separately. A model with a maximum of 3 joinpoints requiring at least 2 observations between joinpoints, a log-linear regression model, and the Bayesian information criterion method to assess significant changes in time trends were used. Annual percentage changes (APCs), the estimated annual changes in rates from one joinpoint to the next in percentage, and

weighted means of combined APCs were calculated. The 2-sided α level was set at .05.

To account for potential confounders, multivariable Poisson regression models were used to examine income decile-specific incidence rate ratios (IRRs) and corresponding 95% CIs. The incidence rates in the highest income decile were used as a reference. Analysis was conducted separately in 5 periods (1996-1999, 2000-2003, 2004-2007, 2008-2011, and 2012-2014) and in 3 age groups (5-19, 20-64, and ≥65 years). The division into 5 periods was used in order to summarize data and to make it easier to compare indicators. The models were adjusted for recorded gender, age group, urbanicity of residential municipality, decrease in income decile, and, in the groups aged 20 to 64 years and 65 years or older, educational attainment and living alone status. Separate analyses for all first admissions and for the main ICD-10 categories of psychiatric diagnoses were conducted. The analyses were replicated using the income decile 1, 3, and 5 years before the first admission, instead of the current income decile at the end of the previous year. This procedure accounted more strongly for the temporal order of having a certain level of income and the first hospital admission.

Python, version 2.7 (Python Software Foundation); R, version 3.5.1 (R Project for Statistical Computing); Stata, version 15.1 (StataCorp LLC); and Joinpoint Regression Program, version 4.6.0.0 (Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute) were used for data management and analysis.

4.3.2 Study II: Geographical variation in treated psychotic and other mental disorders in Finland by region and urbanicity

4.3.2.1 Design

A population-based register study was conducted including all individuals living in Finland from 2011 to 2017. The prevalence of people with a history of any mental health-related contacts in primary care (since 2011) or psychiatric secondary inpatient (since 1975) or outpatient care (since 2006) on the last day of each of the study years was calculated. In addition, all individuals living in Finland between 1996 and 2017 were followed up in the registers in order to identify the incidence of the first psychiatric inpatient admissions. These time limits were based on the coverage of the national health care registers.

Specific disorders were described with the ten-level ICD-10 sub-chapter categories and in the following categories: all psychotic disorders (ICD-10: F20-29, F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, F32.3, F33.3, F1x.5, F1x.7), mania and bipolar disorders with psychotic symptoms (F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6), psychotic depression (F32.3, F33.3), and substance-induced psychotic disorders (F1x.5, F1x.7). The diagnoses of schizophrenia and other primary psychotic disorders were classified in a particular order, with schizophrenia being the first (F20), followed by schizoaffective disorder (F25), delusional disorders (F22 and F24), brief psychotic disorders (F23), schizotypal disorder (F21), other nonorganic psychotic disorders (F28), and unspecified nonorganic psychosis (F29). If a person had more than one diagnosis from the schizophrenia spectrum, they were classified under the first group of disorders in the order presented above. ICPC-2 diagnoses were converted to corresponding ICD-10 sub-chapter categories as described in Section 4.2.1.2.

Based on the previously published distribution of the schizophrenia polygenic risk score (Kurki et al., 2019), the administrative regions of Finland were grouped into three aggregate regions: coastal, inland, and eastern and northern (Figure 2). The region of residence on the last day of each study year was used for the main analysis. The seven-level scale was used to measure urbanicity for each individual's place of residence. In order to show geographical variation by region and urbanicity, maps with region-urbanicity subregions were created (Figure 1).

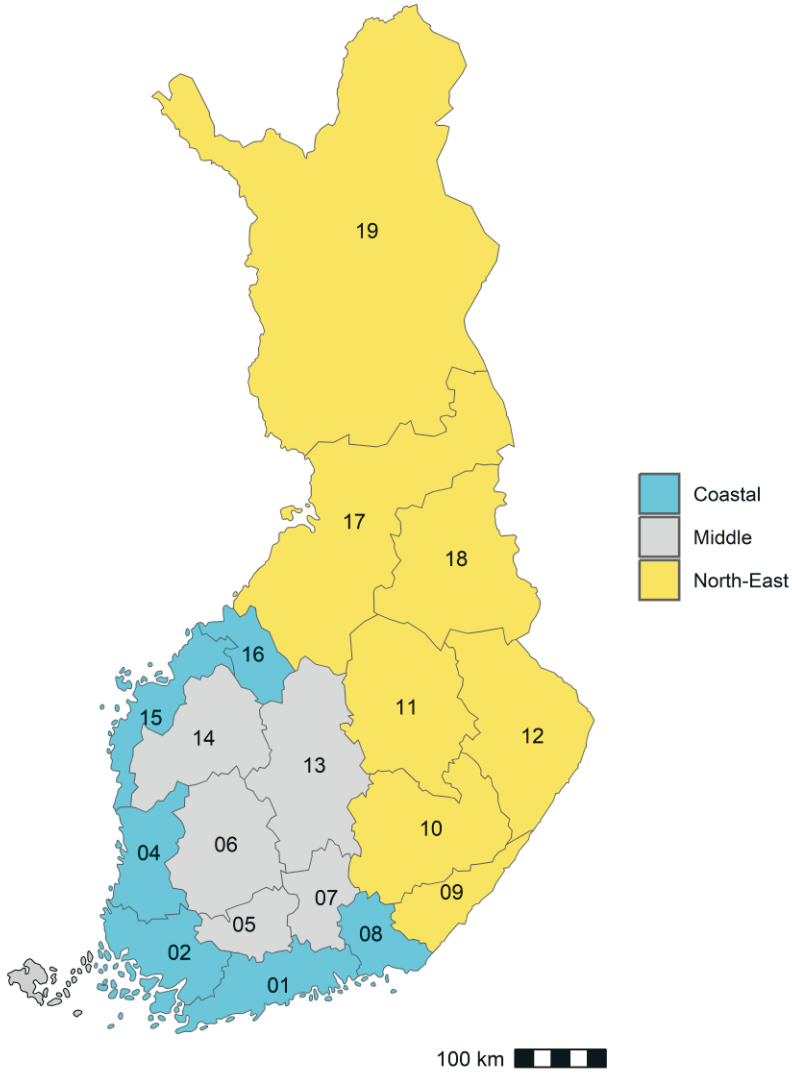

Figure 2. Aggregate regions based on the previously published distribution of the schizophrenia polygenic risk score (Kurki et al., 2019): coastal, inland, and eastern and northern. Regions: 01 Uusimaa, 02 Varsinais-Suomi, 04 Satakunta, 05 Kanta-Häme, 06 Pirkanmaa, 07 Päijät-Häme, 08 Kymenlaakso, 09 South Karelia, 10 Etelä-Savo, 11 Pohjois-Savo, 12 North Karelia, 13 Central Finland, 14 South Ostrobothnia, 15 Ostrobothnia, 16 Central Ostrobothnia, 17 North Ostrobothnia, 18 Kainuu, 19 Lapland.

The following categorical individual-level demographic and socioeconomic data was collected on the last day of each study year from the population registers: age

group (five-year intervals), recorded gender, origin, currently inhabiting the region of birth (yes or no), economic activity, and equivalized household net income deciles. Physical comorbidity was assessed using the Charlson comorbidity index (CCI).

4.3.2.2 Statistical analysis

The prevalence of a history of mental disorders was calculated for the last day of each calendar year of the study by summing the number of people with a history of mental health treatments in each region divided by the number of inhabitants in the region. Data were aggregated by strata defined by all possible combinations of cofactors. Prevalence ratios were examined using a Poisson regression model with a robust sandwich variance estimator. The strata in the aggregated data were taken as the unit of analysis and the log of population size of the strata was used as an offset term.

Regional prevalence ratios were adjusted for recorded gender, age, and calendar year (basic adjustment). Additional adjustments for origin, residential history, urbanicity, household income, economic activity, and CCI were also made. Bayesian information criteria were used for the model selection.

For a fine-scale view of the variability of prevalence by region and urbanicity, the average marginal effects for each region-urbanicity subregion were predicted using a Poisson regression model that included a region-urbanicity interaction term. The predicted prevalence in each region-urbanicity subregion was calculated while holding the other predictors constant as observed (Williams, 2012).

The sensitivity to definitions of the outcome and explanatory variables was investigated by alternative definitions and comparison of results across the following additional analyses: The prevalence of all treated mental disorders and inpatient treatments only were compared; the incidence and prevalence of regional inpatient treatments were compared; and the current living region and the region of birth were compared. For data management and analyses, we used R, version 3.6.3 (R Project for Statistical Computing), and Stata, version 17.1 (StataCorp LLC).

4.3.3 Study III: Mortality in persons with recent primary or secondary care contacts for mental disorders in Finland

4.3.3.1 Design

An open cohort study was performed including all citizens with Finnish background aged at least 20 years and living in Finland at some point between January 1, 2011, and December 31, 2017. This age limit was chosen because before this age most young adults in Finland live with their parents, which directly affects their measured socioeconomic position. The study population was observed from 2011 through 2017 using individual-level register data to identify all deaths, the dynamic population at risk of death, and all mental health treatments during this period.

Deaths and person-time at risk were labelled based on the one-year history of mental health treatments. Individual follow-up time was allocated dynamically between primary and secondary care and the reference population based on the actual dates. All variables were treated as time-varying factors. If the exact time of change in covariate status was not known, mid-year was assumed.

A history of mental health treatments was defined as having any medical contact with secondary care psychiatric inpatient or outpatient services, or with primary care with a diagnosis of any mental disorder (i.e. ICD-10 Chapter V: Mental and behavioural disorders (F00-F99), or ICPC-2 chapter P: Psychological) within the previous year.

Three sets of data were defined and analyzed separately:

1. Primary and secondary care combined: mortality in individuals with any mental health-related treatment episodes within the previous year was compared with that in individuals without such treatments.

2. Primary and Secondary care separately: individual follow-up time was labelled as secondary care if at least one secondary care inpatient or outpatient episode had occurred within the previous year (despite possible primary care appointments). Follow-up time was labelled as primary care if at least one primary care appointment with a diagnosis of mental disorders had occurred within the previous year with no secondary care during that period. Mortality in both groups was compared to that in the group including individuals without primary or secondary mental health care.

3. Secondary care only: In order to compare mortality estimates with primary and secondary care data to traditional analyses utilizing secondary care data only, individual follow-up time was labeled as secondary care if at least one secondary care inpatient or outpatient episode had occurred within the previous year. The

comparison population included all individuals without a history of secondary mental health treatments (including individuals with possible primary care treatments).

Details about allocation of person time: Time spent in psychiatric inpatient care and the following year after the discharge date, and one year after any secondary care psychiatric outpatient visits, was labeled as follow-up time with a one-year history of secondary mental health care. From exactly one year after the latest discharge, or the latest secondary care outpatient contact, if still at risk of death, the individual no longer contributed to the secondary care population and returned to either the population with a one-year history of primary care, or the reference population with no one-year history of mental health treatments.

One year following any primary care visit with a diagnosis of mental disorder was labeled as follow-up time with a one-year history of primary mental health care. Exactly one year after the latest primary care contact, if still at risk of death and with no new secondary care contacts, the individual returned to contributing to the reference population with no one-year history of mental health treatments. If a contact to secondary care occurred during the follow-up time with a one-year history of primary care, the individual's follow-up time was relabeled to secondary care based on the date of the secondary care contact. If a primary care contact emerged less than one year after the latest secondary care contact, the follow-up time was relabeled to primary care one year after the latest secondary care contact, until one year had passed since the latest primary care contact.

4.3.3.2 Statistical analysis

The number of deaths and person-years at risk were aggregated according to calendar year, treatment history, and the following covariables: recorded gender, age group (5-year intervals), urbanicity of residence area (a seven-level classification), region of residence, living alone, level of educational attainment, economic activity, and equivalized household net income deciles. Age- and stratum-specific mortality rates were calculated. The 2013 Revision of the European Standard Population was used for direct age standardization.

Mortality rate ratios (MRRs) were examined using a Poisson regression model with a robust variance estimator. The cells in the aggregated data were taken as the unit of analysis, with the logarithms of the aggregated person-years counts set as an offset variable. Bayesian information criteria were used for model selection. Men and

women were analyzed separately. We adjusted the models for the most recent values of calendar year, age group, urbanicity, region, education, living alone, household income, economic activity and the CCI. To investigate the association between physical comorbidities and mortality, a stratified analysis for the CCI categories was performed.

In addition, the ICD-10 diagnostic sub-chapter categories were analyzed separately. Individuals who presented with certain sub-chapter diagnoses were compared with individuals without any history of mental health treatments.

Due to the starting of the primary care data only in the year 2011, we performed sensitivity analyses using three- and five-year histories of mental health treatments. For data management and analyses, we used R, version 3.6.3 (R Project for Statistical Computing), and Stata, version 16.1 (StataCorp LLC).

5 RESULTS

5.1 Identification of individuals with medical contacts related to mental disorders

5.1.1 Identification of psychiatric hospital treatment episodes

Altogether, there were 506 903 register entries in the Hospital Discharge register and The Finnish Care Register for Health Care related to psychiatric inpatient care in the years between 1975 and 2019 ("Raw" in Table 2). Almost all register entries related to inpatient care included an overnight stay (503 033 [99.24%] to 503 006 [99.23%], Model 2 and Model 4, respectively, in Table 2). In the raw psychiatric inpatient data, 478 335 (94.36%) of the entries contained a diagnosis of a mental disorder.

The identification of the episodes described here included 1) combining of the (partly) overlapping register entries based on the dates of admission and discharge, and 2) recognition of the discharge diagnoses only after the first step, in order to discard preliminary diagnoses that are present only during the episode but not at the time of discharge.

Of the five first ICD-10 Mental and Behavioural Disorders main groups, the biggest effect of the identification of the inpatient episodes was in the group F00-09: organic, including symptomatic, mental disorders, where the number of individuals with a hospitalization with such a diagnosis was 1.82-2.61% smaller compared to the numbers in raw data (Table 2).

Table 2. Number of individuals (%) by diagnosis with a first psychiatric inpatient care covered in the Hospital Discharge register or The Finnish Care Register for Health Care between 1975 and 2019. Identification of inpatient treatment episodes with four different models.

		Number of individuals (%)			
	Raw[a]	Model 1[b]	Model 2[c]	Model 3[d]	Model 4[e]
All admissions[f]	506 903	506 903 (100.00)	503 033 (99.24)	506 903 (100.00)	503 006 (99.23)
Mental disorders[g]	478 335	477 946 (99.92)	474 414 (99.18)	477 893 (99.91)	474 336 (99.16)
F00-09	58 089	57 029 (98.18)	56 672 (97.56)	56 917 (97.98)	56 572 (97.39)
F10-19	131 794	131 074 (99.45)	129 394 (98.18)	130 938 (99.35)	129 260 (98.08)
F20-29	150 845	148 760 (98.62)	148 208 (98.25)	148 498 (98.44)	147 961 (98.09)
F20	39 673	39 055 (98.44)	38 981 (98.26)	38 999 (98.30)	38 927 (98.12)
F30-39	179 356	178 177 (99.34)	176 616 (98.47)	177 982 (99.23)	176 423 (98.36)
F40-48	120 403	119 997 (99.66)	118 329 (98.28)	119 766 (99.47)	118 097 (98.08)
Psychoses[h]	131 815	130 575 (99.06)	129 915 (98.56)	130 426 (98.95)	129 774 (98.45)

[a]Raw data: Initial quality check only. Includes every entry related to inpatient care.

[b]Model 1: A new hospitalization may begin on the day following a previous one, with no specific minimum length required for a hospitalization. This represents the most liberal approach.

[c]Model 2: A new hospitalization may begin on the day following a previous one. Valid hospitalizations are those that extend over a minimum of two consecutive days, incorporating at least one overnight stay. If both admission and discharge take place on the same day, the visit is classified as an outpatient visit.

[d]Model 3: A new hospitalization is allowed after a full day has been spent outside the hospital following the previous one. There is no specific minimum duration required for a hospitalization.

[e]Model 4: A new hospitalization is allowed after a full day has been spent outside the hospital following the previous one. Valid hospitalizations are those that extend over a minimum of two consecutive days, incorporating at least one overnight stay. If both admission and discharge take place on the same day, the visit is classified as an outpatient visit. This represents the most conservative model.

[f]All admission including those with a discharge diagnosis of any mental disorder, some other diagnosis or missing diagnosis.

[g]Inpatient care with any mental disorder as discharge diagnosis. In addition, selected ICD-10 Mental and Behavioural Disorders Main groups are presented: F00-09 Organic, including symptomatic, mental disorders; F10-19 Mental and behavioural disorders due to psychoactive substance use; F20-29 Schizophrenia, schizotypal and delusional disorders; F30-39 Mood disorders; F40-48 Neurotic, stress-related and somatoform disorders. F20 refers to schizophrenia. ICD-8 and ICD-9 diagnoses are converted to corresponding ICD-10 codes (World Health Organization. Division of Mental Health, 1994).

[h]Any disorder with major psychotic features, including ICD-10 diagnoses: F20, F22-F29, F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, F32.3, F33.3, F1x.5 and F1x.7

5.1.2 Identification of individuals with mental disorders treated in primary or secondary care

Altogether, there were 2 130 468 register entries in the Hospital Discharge Register and The Finnish Care Register for Health Care related to psychiatric secondary inpatient or outpatient care, or primary care with a diagnosis of any mental disorder in the years between 1975 and 2019 (Table 3). In the raw data, 1 789 736 (84.01%) of the entries contained a diagnosis of a mental disorder.

The identification of the episodes described here included the same process as in Section 5.1.1: to recognize psychiatric inpatient episodes and after that, exclusion of outpatient and primary care visits that took place during inpatient care before the date of discharge. Of the five first ICD-10 Mental and Behavioural Disorders main groups, the biggest effect of the identification of the episodes was in group F20-29: schizophrenia, schizotypal and delusional disorders, where the number of individuals with a diagnosis was 3.70-3.81% smaller compared to the numbers in raw data (Table 3).

Table 3. Number of individuals (%) by diagnosis with the first mental health related medical contact, covered in the Hospital Discharge register or The Finnish Care Register for Health Care between 1975 and 2019. Identification of treatment episodes with four different models.

	Raw[a]	Model 1[b]	Model 3[c]
All contacts[d]	2 130 468	2 130 209 (99.99)	2 130 204 (99.99)
Mental disorders[e]	1 789 736	1 788 443 (99.93)	1 788 396 (99.93)
F00-09	197 915	195 538 (98.80)	195 403 (98.73)
F10-19	286 587	284 724 (99.35)	284 626 (99.32)
F20-29	186 718	179 822 (96.31)	179 599 (96.19)
F20	53 985	52 933 (98.05)	52 893 (97.98)
F30-39	654 874	650 547 (99.34)	650 408 (99.32)
F40-48	760 972	757 739 (99.58)	757 572 (99.55)
Psychoses[f]	187 033	180 362 (96.43)	180 240 (96.37)

In this analysis, outpatient and primary care diagnoses during inpatient care are excluded if not present at the time of discharge. Models 2 and 4 give identical results to those of Models 1 and 3, respectively, because they would alter the definition of inpatient and outpatient care in the same proportion, but do not alter the total number of episodes.

[a]Raw data: Initial quality check only. Includes all register entries related to psychiatric inpatient or outpatient care and primary care visits with any diagnosis of a mental disorder.

[b]Model 1: A new hospitalization may begin on the day following a previous one, with no specific minimum length required for a hospitalization.

[c]Model 3: A new hospitalization is allowed after a full day has been spent outside the hospital following the previous one. There is no specific minimum duration required for a hospitalization.

[d]All admissions including those with a discharge diagnosis of any mental disorder, some other diagnosis or missing diagnosis.

e Inpatient care with any mental disorder as discharge diagnosis. In addition, selected ICD-10 Mental and Behavioural Disorders Main groups are presented: F00-09 Organic, including symptomatic, mental disorders; F10-19 Mental and behavioural disorders due to psychoactive substance use; F20-29 Schizophrenia, schizotypal and delusional disorders; F30-39 Mood disorders; F40-48 Neurotic, stress-related and somatoform disorders. F20 refers to schizophrenia. ICD-8 and ICD-9 diagnoses are converted to corresponding ICD-10 codes (World Health Organization. Division of Mental Health, 1994).

[f]Any disorder with major psychotic features, including ICD-10 diagnoses: F20, F22-F29, F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, F32.3, F33.3, F1x.5 and F1x.7

5.2 Incidence of first psychiatric hospital admissions (Study I)

Between the years 1996 and 2014, a total of 6 258 033 Finnish citizens contributed 96 184 614 person-years at risk of first inpatient treatment for mental disorders. Of those at risk, 186 082 persons (93 431 men [50.2%] and 92 651 women [49.8%]) had

their first admission to psychiatric inpatient care. Mood disorders (ICD-10 codes F30-F39) was the most common diagnostic main group, present in 80 548 cases (43.3%), whereas any disorders with major psychotic features was observed in 53 744 (28.9%) of first admissions (Table 4).

Table 4. Categories of Psychiatric Discharge Diagnoses of First Psychiatric Hospital Treatments

Variable	No. of first hospital treatments (%)
ICD-10 Mental and Behavioural Disorders Main groups	
F30-39 Mood disorders	80 548 (43.3)
F10-19 Mental and behavioural disorders due to psychoactive substance use	42 233 (22.7)
F20-29 Schizophrenia, schizotypal and delusional disorders	35 675 (19.2)
F40-48 Neurotic, stress-related and somatoform disorders	33 078 (17.8)
F60-69 Disorders of adult personality and behaviour	12 387 (6.7)
F90-98 Behavioural and emotional disorders with onset usually occurring in childhood and adolescence	10 204 (5.5)
F00-09 Organic, including symptomatic, mental disorders	8 371 (4.5)
F50-59 Behavioural syndromes associated with physiological disturbances and physical factors	5 021 (2.7)
F80-89 Disorders of psychological development	2 302 (1.2)
F70-79 Mental retardation	1 395 (0.7)
F99 Unspecified mental disorder	176 (0.09)
Any disorder with major psychotic features[a]	53 744 (28.9)
Diagnoses from two or more diagnostic main groups recorded	43 439 (23.3)
Total number of first hospital treatments	186 082 (100.0)
[a]ICD-10 diagnoses: F20, F22-F29, F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, F32.3, F33.3, F1x.5 and F1x.7	

The annual age-standardized incidence rate of first psychiatric hospital admissions per 1000 person-years varied from 1.59 (95% CI, 1.56-1.63) in 2014 to 2.11 (95% CI, 2.07-2.15) in 2008 (Figure 3A). Men had higher incidence rates in the beginning of the study period (2.15 [95% CI, 2.09-2.22]) compared with women (1.61 [95% CI, 1.56-1.66]), whereas women had higher rates at the end (1.65 [95% CI, 1.60-1.70] vs 1.54 [95% CI, 1.49-1.59]) (Figure 3B).

Much of the variation in the overall trends occurred in the incidence rates of substance use and mood disorders, with the highest percentage increase of 4.53% (95% CI, 2.27%-6.84%) in mood disorders from 1996 through 1999 and the highest

percentage decrease of 8.8% (95% CI, 9.69%-7.91%) in substance use disorders from 2008 through 2014 (Figures 3C and 3D).

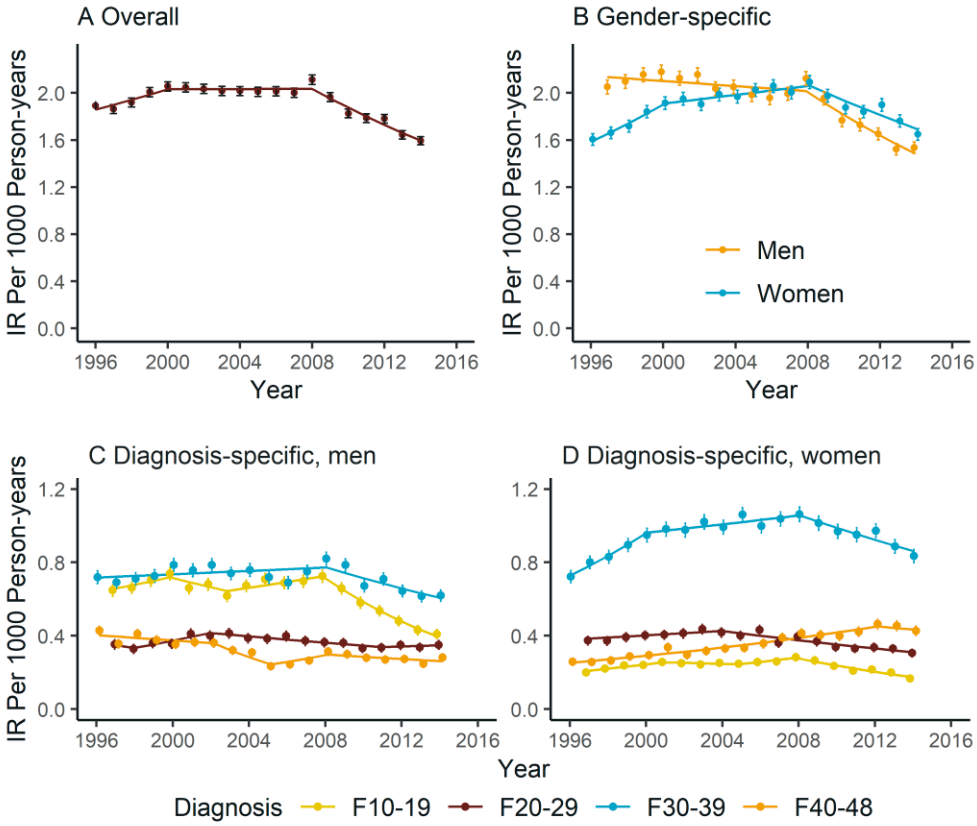

Figure 3. Trends in age-standardized incidence rates (IRs) of first psychiatric hospital admissions. Lines represent results of the joinpoint regression model. Rates have been standardized to the 2013 European Standard Population by 5-year age groups. Codes F10 to F19 refer to mental and behavioural disorders due to psychoactive substance use; F20 to F29, schizophrenia, schizotypal, and delusional disorders; F30 to F39, mood disorders; and F40 to F48, neurotic, stress-related, and somatoform disorders.

5.2.1 Income-specific temporal trends in incidence rates

Opposite trends in the age-standardized rates between different income deciles were observed between the years 1996 and 2008 (Figure 4). Increasing trends (i.e. positive APC with 95% CIs not including 0) occurred in the 7 lowest income deciles in women and in the 3 lowest deciles in men. After the peak in incidence rates in 2008, the trends turned to a decrease. In the highest income deciles, on the other hand, a

continuous mean decrease of 3.71% (95% CI, 2.82%-4.59%) per year in men and 0.91% (95% CI, 0.01%-1.80%) per year in women occurred throughout the study period.

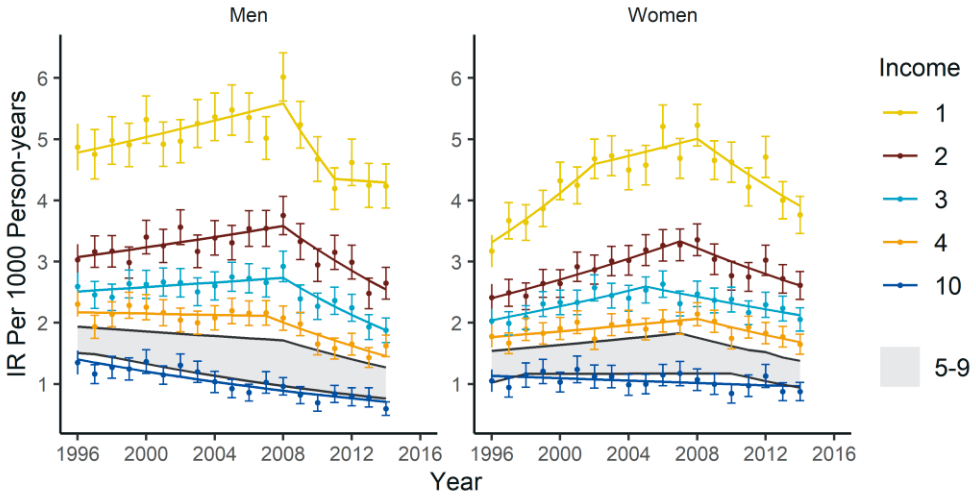

Figure 4. Trends in income decile and gender-specific age-standardized incidence rates of first psychiatric hospital admissions. Data markers denote the annual age-standardized incidence rates, lines represent the results of the joinpoint regression model. Rates have been age standardized to the 2013 European Standard Population by 5-year age groups. Income is equivalized household net income deciles, with 1 indicating the lowest income decile and 10 the highest.

5.2.2 Income gradients in adjusted incidence rate ratios (IRRs)

A negative income gradient was observed in the IRRs of the first hospital admissions for mental disorders in adults aged 20 to 64 years: the lower the income decile, the higher the IRR compared with the highest decile. In adults, the IRR of the lowest income decile in different periods varied from 2.94 (95% CI, 2.78-3.11) to 4.46 (95% CI, 4.17-4.76) (Figure 5B). In children and adolescents, a constant gradient in the IRRs was observed in the 5 lowest deciles (Figure 5A). In children and adolescents, the highest IRRs compared with the highest-income decile were observed among non-dwelling individuals, varying from 6.76 (95% CI 5.75-7.94) to 8.83 (95% CI 7.56-10.32). In persons 65 years and older, no clear gradient was observed, but the

IRRs were highest in the lowest income decile, varying from 1.93 (95% CI, 1.55-2.41) to 3.56 (95% CI, 2.83-4.47) (Figure 5C).

If income decile statuses 1, 3, and 5 years before the first admissions were used instead, the observed income gradients decreased but did not disappear (Figure 6). In diagnosis-specific comparison of IRRs predicted over the whole study period in individuals aged 20-64 years, the steepest income gradient was observed related to schizophrenia and other psychotic disorders (ICD-20 codes F20-29) (Figure 7).

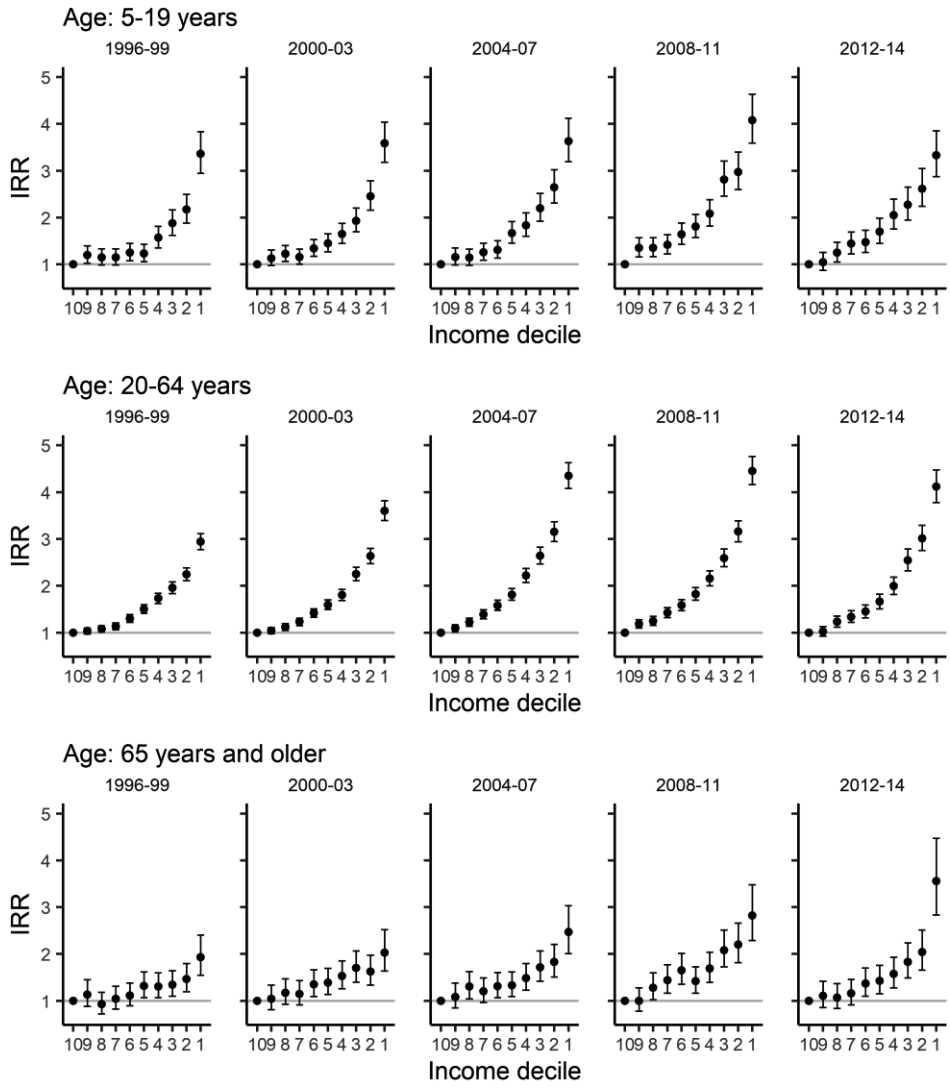

Figure 5. Income gradients in the first psychiatric hospital admissions. Incidence rate ratios (IRRs) by income decile compared with the highest decile. Error bars, 95% Cis. Household

income deciles: 1 the lowest income decile, 10 the highest decile (reference group). The model is adjusted for age group, recorded gender, urbanicity, and decrease in income decile among those aged 5 to 19 years and for age group, recorded gender, urbanicity, decrease in income decile, educational level, and living alone in those aged 20 to 64 years and 65 years or older.

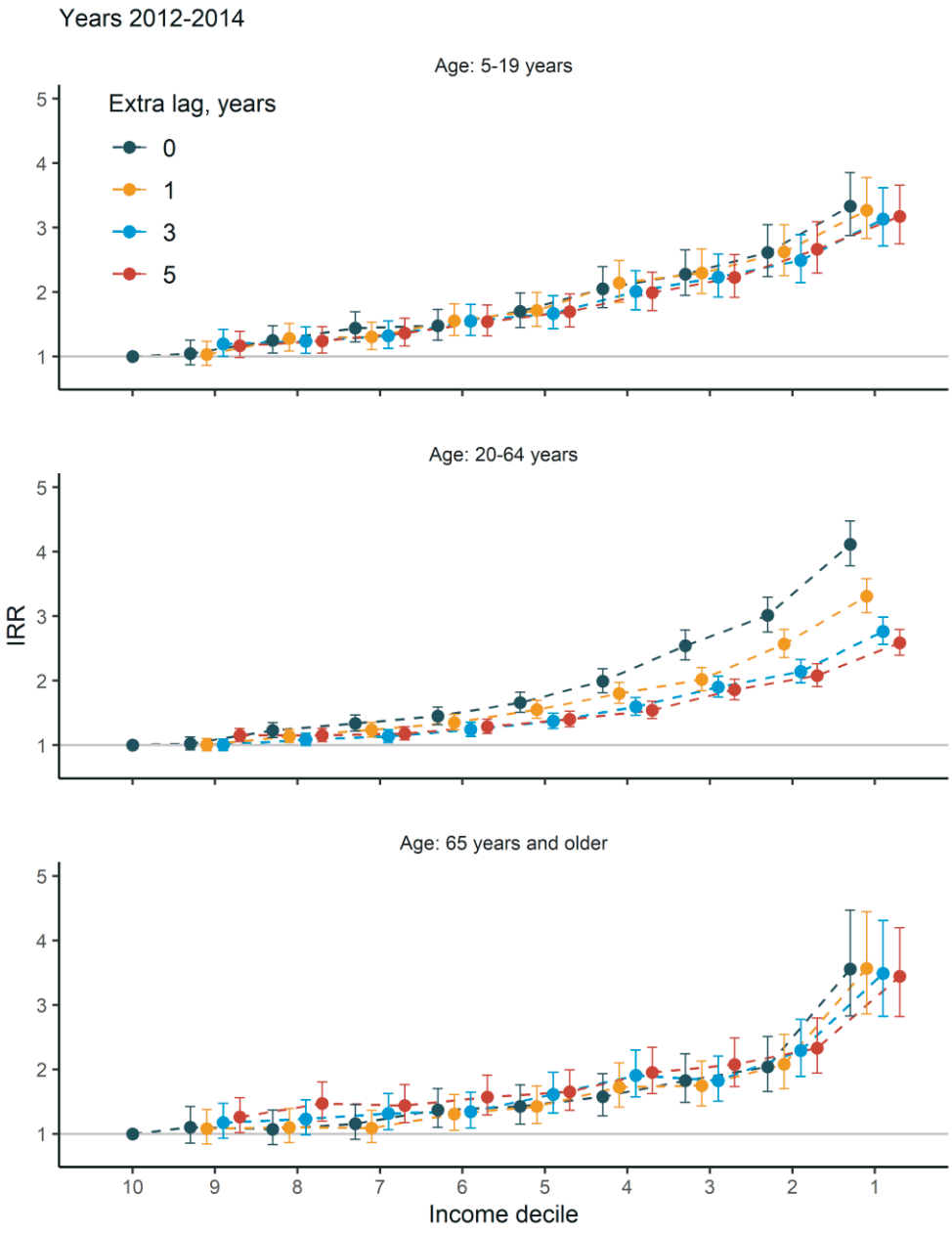

Figure 6. Income gradients in the first psychiatric hospital admissions with income decile determined with individuals' most recent status (extra lag 0) or 1, 3, or 5 years before the observed year. Incidence rate ratios (IRRs) by household income decile compared with the highest decile. Error bars, 95% Cis. The model is adjusted for age group, recorded gender, urbanicity, decrease in income decile, educational level, and living alone.

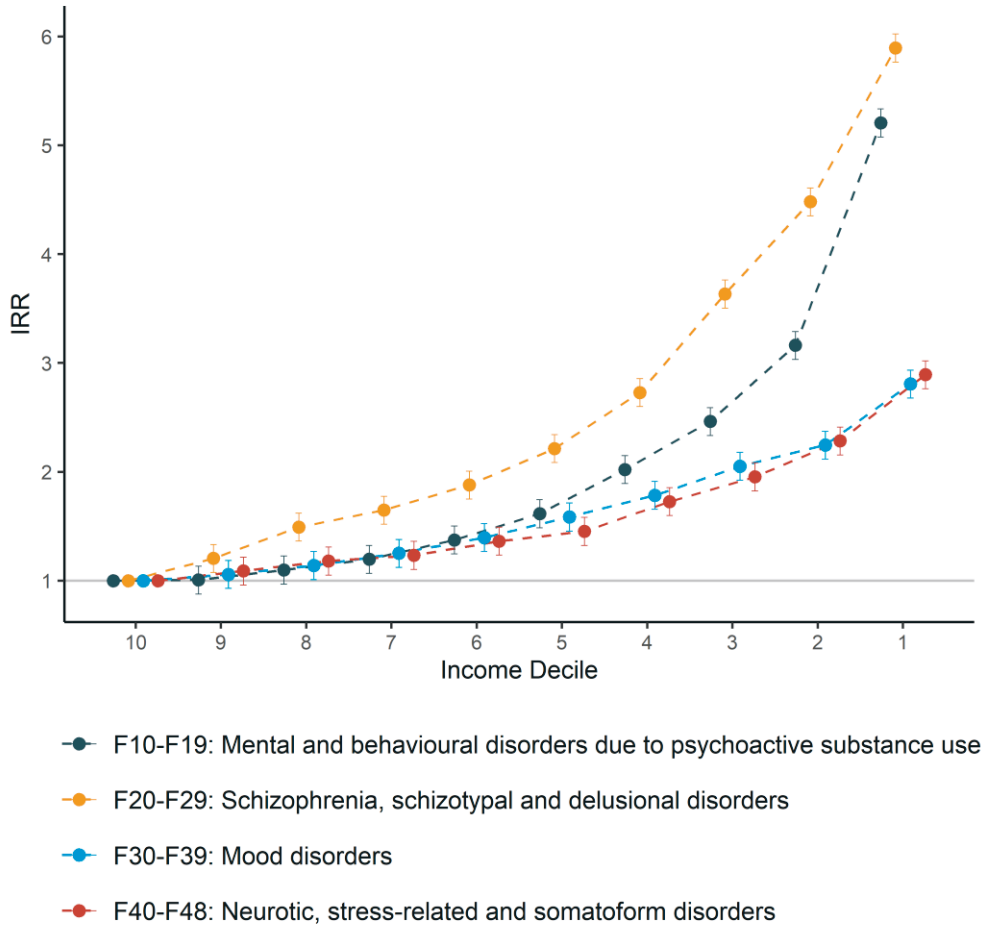

Figure 7. Predicted incidence rate ratios (IRRs) for the first psychiatric hospital admissions in different diagnostic groups in individuals aged 20-64 years, by household income decile compared with the highest decile. Data markers denote the average marginal effects for diagnosis income interaction; bars present 95 % confidence intervals, adjusted for age group, period, recorded gender, urbanicity, decrease in income decile, education and living alone.

5.3 Geographical variation in treated psychotic and other mental disorders by region and urbanicity (study II)

Between the years 2011 and 2017, a total of 5 898 180 individuals contributed to the study population. Altogether, 1 197 690 individuals of the total of 5 512 745 at the end of 2017 had a history of some medical contact in primary care with a diagnosis of any mental disorder, or in secondary care psychiatric services. This resulted in a crude prevalence rate of 21.73% (24.07% in women and 19.32% in men).

5.3.1 Regional variation in prevalence of mental disorders

The crude prevalence of all psychotic disorders, schizophrenia, and most of the other psychotic disorders was higher in the eastern and northern than in the coastal regions (Table 5). However, unspecified psychosis, bipolar disorder and substance-induced psychotic disorders, as well as mood disorders and neurotic disorders, were more common in the coastal region, resulting in only a minimal difference in the prevalence ratios of all mental disorders after basic adjustments (Table 6).

Table 5. Prevalence of mental disorders by place of residence on 31st Dec 2017.

	Number of diagnosed individuals (prevalence %)			
	Whole country 5 512 745 (100%)[a]	Coastal 2 808 181 (50.9%)[a]	Inland 1 352 887 (24.5%)[a]	East-north 1 351 677 (24.5%)[a]
Any mental disorder (F00-99)	1 197 690 (21.7)	599 739 (21.4)	302 794 (22.4)	295 157 (21.8)
All psychotic disorders[b]	112 318 (2.0)	55 722 (2.0)	26 456 (2.0)	30 140 (2.2)
Schizophrenia spectrum (F20-29)[c]	93 182 (1.7)	44 537 (1.6)	22 448 (1.7)	26 197 (1.9)
Schizophrenia (F20)	34 269 (0.6)	16 567 (0.6)	7 821 (0.6)	9 881 (0.7)
Schizoaffective disorders (F25)	6 720 (0.1)	3 141 (0.1)	1 645 (0.1)	1 934 (0.1)
Delusional disorders (F22, F24)	11 092 (0.2)	5 156 (0.2)	2 972 (0.2)	2 964 (0.2)
Brief psychotic disorders (F23)	8 830 (0.2)	4 459 (0.2)	2 303 (0.2)	2 068 (0.2)
Schizotypal disorder (F21)	2 458 (0.0)	1 070 (0.0)	583 (0.0)	805 (0.1)
Other (F28)	1 009 (0.0)	441 (0.0)	269 (0.0)	299 (0.0)
Unspecified (F29)	17 238 (0.3)	8 953 (0.3)	4 062 (0.3)	4 223 (0.3)
Bipolar disorder[d]	44 890 (0.8)	24 438 (0.9)	10 512 (0.8)	9 940 (0.7)
Psychotic depression[e]	22 167 (0.4)	10 929 (0.4)	4 869 (0.4)	6 369 (0.5)
SIPD[f]	9 672 (0.2)	5 295 (0.2)	2 101 (0.2)	2 276 (0.2)
Substance use disorders (F10-19)	161 307 (2.9)	81 372 (2.9)	38 485 (2.8)	41 450 (3.1)

Mood disorders (F30-39)	416 542 (7.6)	214 956 (7.7)	105 926 (7.8)	95 660 (7.1)
Neurotic disorders (F40-48)	460 247 (8.3)	239 839 (8.5)	115 580 (8.5)	104 828 (7.8)

The aggregate regions are described in Figure 2.
[a]Total population in the region (percent of whole country population).
[b]All psychotic disorders included the following disorders:
[c]schizophrenia spectrum disorders (F20-29),
[d]bipolar disorder: mania and bipolar disorder with psychotic symptoms (F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6),
[e]psychotic depression (F32.3, F33.3), and
[f]SIPD: substance induced psychotic disorders (F1x.5, F1x.7).

Table 6. Prevalence ratios of mental disorders by place of residence. Higher prevalence ratios indicate higher risk compared to coastal regions.

	Prevalence ratio (95 % CI)			
	Inland vs. coastal[a]		East-north vs. coastal[a]	
	Basic	Additional	Basic	Additional
Any mental disorder (F00-99)	1.03 (1.03-1.04)	0.97 (0.97-0.97)	1.03 (1.02-1.03)	0.95 (0.95-0.96)
All psychotic disorders[b]	0.96 (0.95-0.97)	0.89 (0.89-0.90)	1.11 (1.10-1.12)	1.00 (0.99-1.01)
Schizophrenia spectrum (F20-29)[c]	1.02 (1.01-1.03)	0.95 (0.94-0.95)	1.20 (1.19-1.21)	1.06 (1.06-1.07)
Schizophrenia (F20)	0.95 (0.93-0.96)	0.89 (0.88-0.90)	1.19 (1.17-1.21)	1.03 (1.02-1.04)
Schizoaffective disorders (F25)	1.06 (1.03-1.08)	0.96 (0.94-0.99)	1.29 (1.25-1.32)	1.11 (1.08-1.13)
Delusional disorders (F22, F24)	1.08 (1.06-1.10)	1.04 (1.02-1.06)	1.07 (1.05-1.09)	1.06 (1.04-1.08)
Brief psychotic disorders (F23)	1.11 (1.09-1.14)	1.03 (1.01-1.05)	1.04 (1.02-1.06)	0.94 (0.92-0.96)
Schizotypal disorder (F21)	1.11 (1.06-1.15)	0.95 (0.91-0.99)	1.68 (1.62-1.74)	1.40 (1.35-1.46)
Other (F28)	1.12 (1.05-1.20)	1.00 (0.93-1.07)	1.38 (1.29-1.46)	1.20 (1.12-1.27)
Unspecified (F29)	0.95 (0.93-0.97)	0.91 (0.89-0.92)	1.02 (1.00-1.04)	0.95 (0.94-0.97)
Bipolar disorder[d]	0.88 (0.87-0.89)	0.79 (0.78-0.80)	0.85 (0.84-0.86)	0.75 (0.74-0.76)
Psychotic depression[e]	0.88 (0.87-0.89)	0.82 (0.81-0.83)	1.20 (1.18-1.21)	1.09 (1.08-1.11)
SIPD[f]	0.79 (0.77-0.81)	0.74 (0.73-0.76)	0.90 (0.88-0.92)	0.83 (0.81-0.85)
Substance use disorders (F10-19)	0.96 (0.95-0.97)	0.86 (0.86-0.87)	1.04 (1.03-1.05)	0.91 (0.90-0.91)
Mood disorders (F30-39)	1.01 (1.00-1.01)	0.92 (0.91-0.92)	0.94 (0.94-0.95)	0.85 (0.85-0.85)
Neurotic disorders (F40-48)	1.00 (0.99-1.01)	0.92 (0.92-0.93)	0.92 (0.92-0.93)	0.85 (0.84-0.85)

In the basic adjustment, prevalence ratios are adjusted for age, recorded gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, recorded gender, calendar time, urbanicity, origin, residence history, household income, economic activity, and Charlson comorbidity index.
[a]The aggregate regions are described in Figure 2.
[b]All psychotic disorders included the following disorders:
[c]schizophrenia spectrum disorders (F20-29),
[d]bipolar disorder: mania and bipolar disorder with psychotic symptoms (F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6),
[e]psychotic depression (F32.3, F33.3), and
[f]SIPD: substance induced psychotic disorders (F1x.5, F1x.7).

When additional adjustments for indicators of socioeconomic position and comorbidities were included in the models, the eastern and northern prominence in psychotic disorders disappeared, with a PR of 1.00 (0.99-1.01). PRs of 1.06 (1.06-1.07) for schizophrenia spectrum, 1.03 (1.02-1.04) for schizophrenia, and 0.75 (0.74-0.76) for bipolar disorder were observed. The PR for all mental disorders was 0.95 (0.95-0.96) (Table 6 and Figure 8). The comparison of inland versus coastal regions is visualized in Figure 9. Adding income to the models caused a major change in the PR estimates, and the effect of each of the additional covariates is shown in Figure 10.

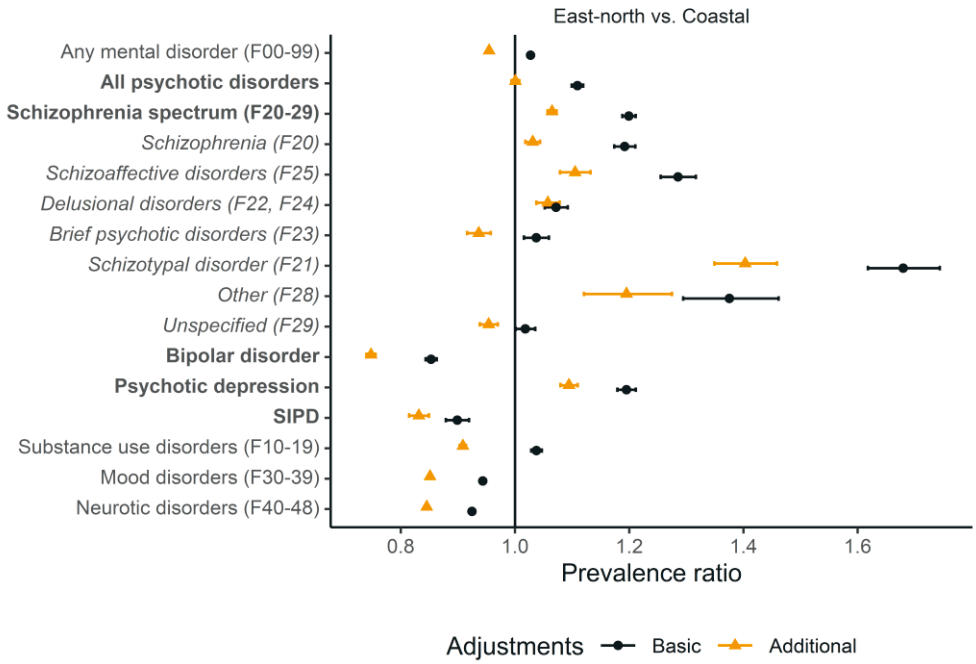

Figure 8. Prevalence ratios of mental disorders by place of residence. Higher prevalence ratios indicate higher risk in eastern and northern regions compared to coastal regions. Coastal, inland, and east-north regions are described in Figure 2. In the basic adjustment, prevalence ratios are adjusted for age, recorded gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, recorded gender, calendar time, urbanicity, origin, residence history, household income, economic activity, and Charlson comorbidity index. Error bars indicate 95% Cis. Subgroups of all included psychotic disorders are highlighted in bold. Bipolar disorder included ICD-10 codes F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, psychotic depression codes F32.3 and

F33.3, and substance-induced psychotic disorders (SIPD) codes F1x.5 to F1x.7. Schizophrenia spectrum diagnoses (in italic) were categorized in the order presented in the figure.

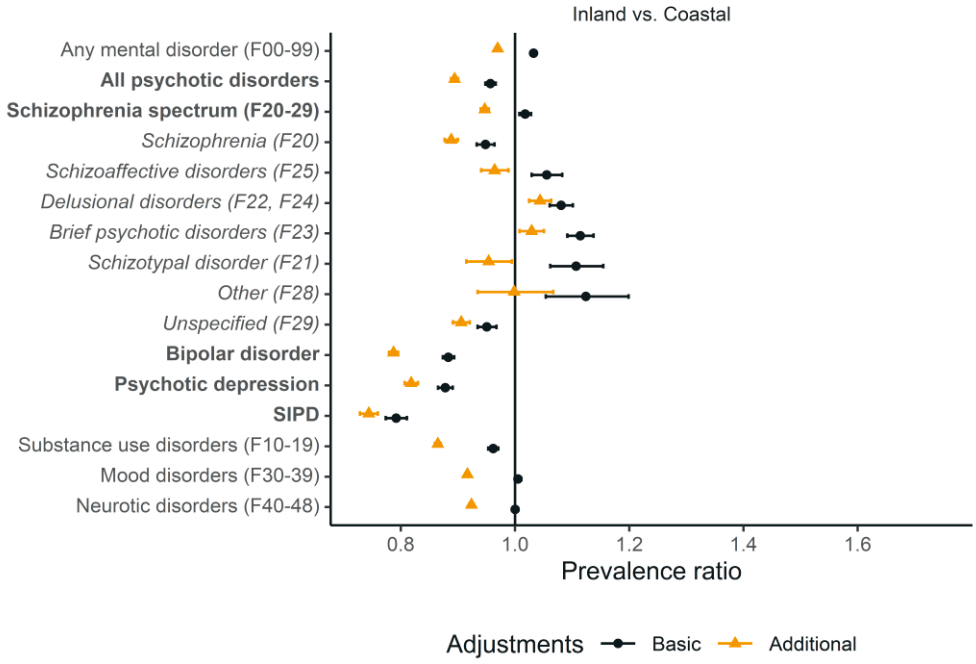

Figure 9. Prevalence ratios of mental disorders by place of residence. Higher prevalence ratios indicate higher risk in inland regions compared to coastal regions. Coastal, inland, and east-north regions are described in Figure 2. In the basic adjustment, prevalence ratios are adjusted for age, recorded gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, recorded gender, calendar time, urbanicity, origin, residence history, household income, economic activity, and Charlson comorbidity index. Error bars indicate 95% Cis. Subgroups of all included psychotic disorders are highlighted in bold. Bipolar disorder included ICD-10 codes F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, psychotic depression codes F32.3 and F33.3, and substance-induced psychotic disorders (SIPD) codes F1x.5 to F1x.7. Schizophrenia spectrum diagnoses (in italic) were categorized in the order presented in the figure.

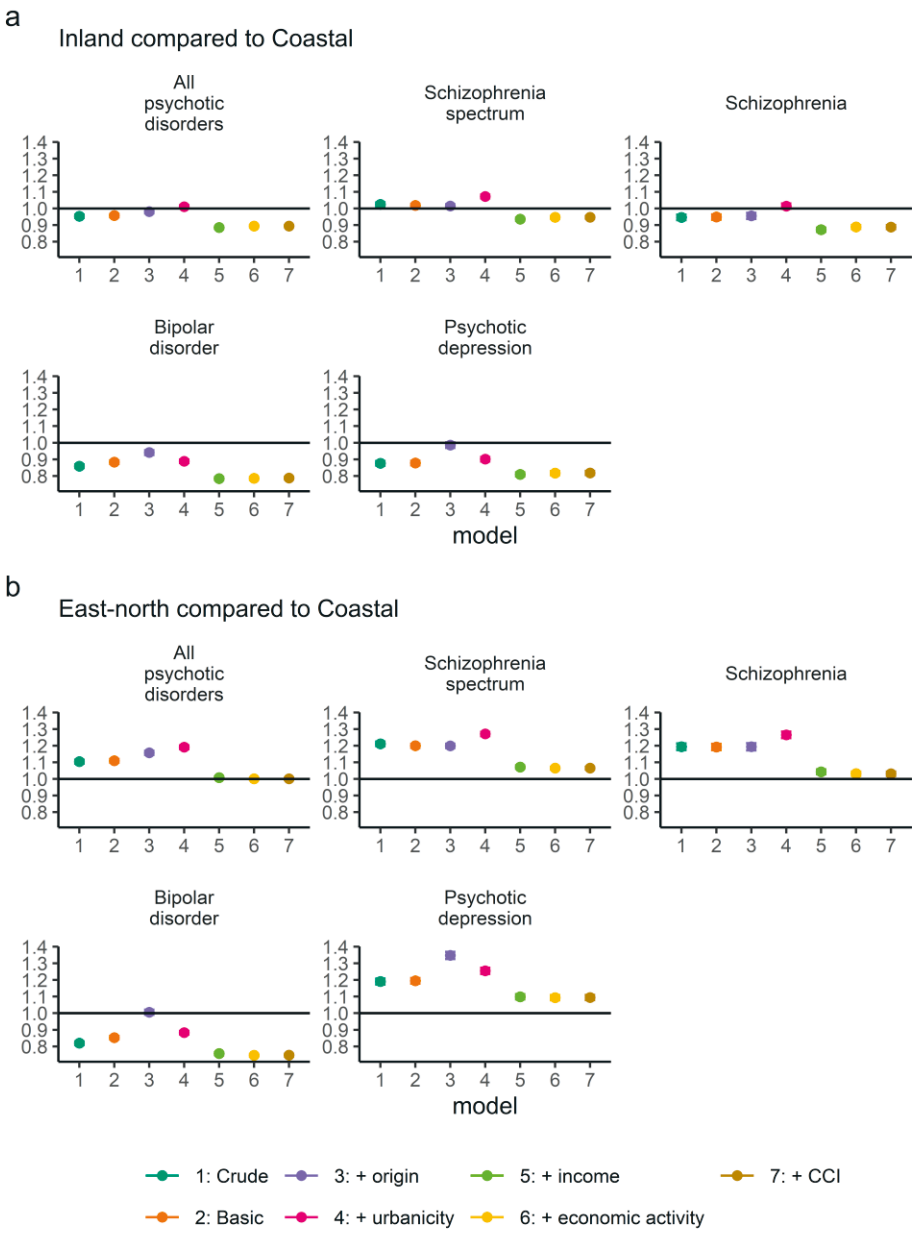

Figure 10. Prevalence ratios of selected mental disorders by place of residence with different levels of adjustment. Coastal and east-north regions are described in Figure 2. In the basic adjustment, prevalence ratios are adjusted for age, recorded gender, and calendar time. Each covariable is added to the previous model. Origin refers to persons living in their region of birth. CCI refers to Charlson comorbidity index. Error bars indicate 95% Cis.

5.3.2 Urban-rural variation in prevalence of mental disorder

Residence in inner urban areas or in the local centres in rural areas was clearly associated with increased prevalence of all mental disorders and major psychotic disorders in both levels of adjustment (Figure 11). The additional adjustments changed the prevalence ratios in some levels of urbanicity, although the link between urbanicity and psychotic disorders remained clear. In inner urban areas, PRs of 1.10 (1.10-1.10) for all mental disorders and 1.21 (1.20-1.22) for psychoses, compared to the whole national mean with additional adjustments, were observed.

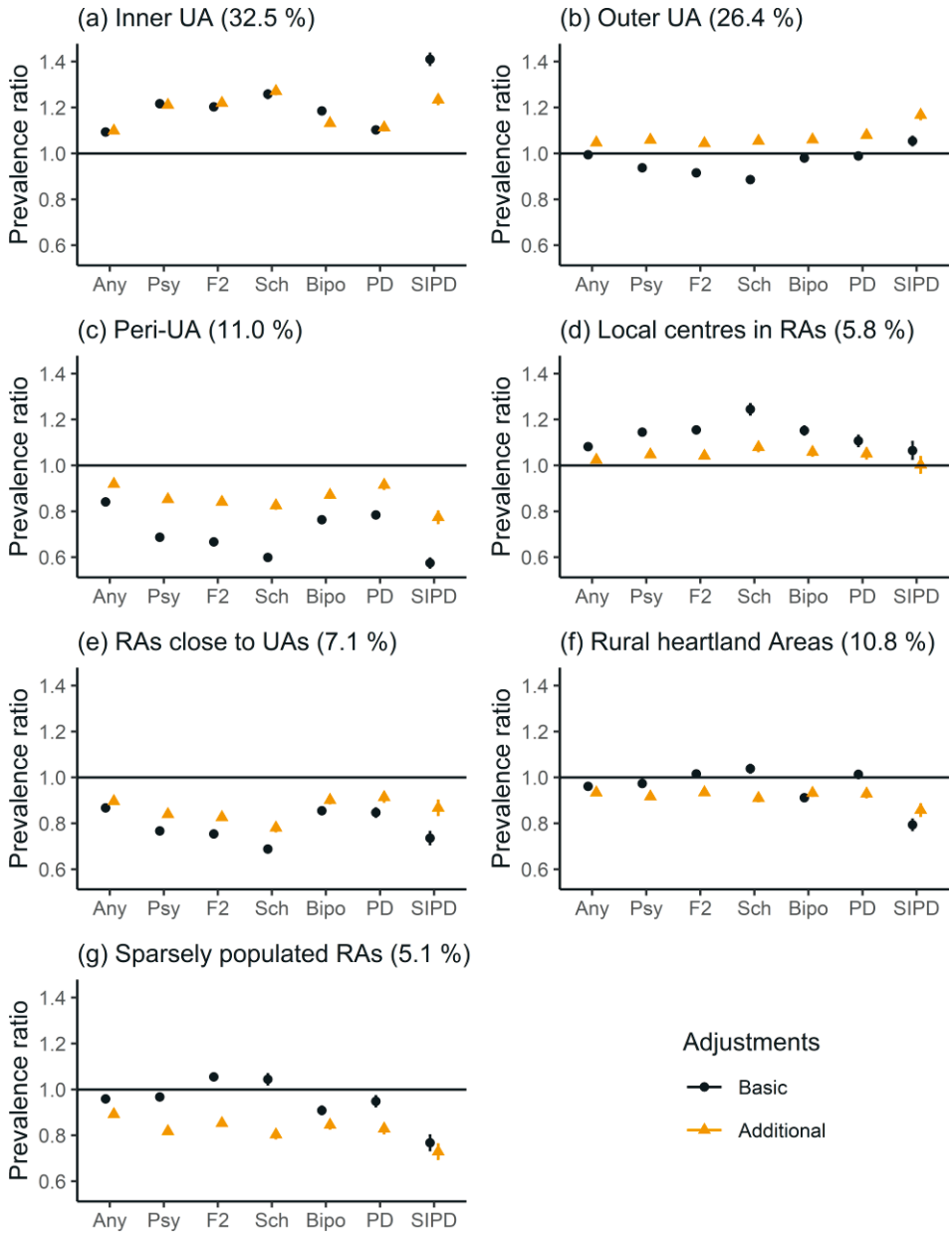

Figure 11. Prevalence ratios of selected mental disorders by urbanicity of the place of residence, compared to the national mean. The proportion of population living in each level of urbanicity is given in parentheses. UA refers to urban area, RA to rural area. Any refers to any mental disorder, Psy to all psychotic disorders, F2 to schizophrenia spectrum, Sch to schizophrenia, Bipo to bipolar disorder, PD to psychotic depression, and SIPD refers to substance-induced psychotic disorders. In the basic adjustment, prevalence ratios were

adjusted for age, recorded gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, recorded gender, calendar time, region, origin, residence history, household income, economic activity, and Charlson comorbidity index. Error bars indicate 95% Cis.

5.3.3 Prevalence of mental disorders by region and urbanicity

The analysis of prevalence of mental disorders by region of residence and urbanicity with basic adjustments showed an eastern and northern prominence in the prevalence of all mental disorders and psychotic disorders in all levels of urbanicity. After the additional adjustments, prominence of the inner urban area in the coastal regions became evident across any mental disorders, all psychotic disorders, and schizophrenia. Furthermore, after the additional adjustments, bipolar disorder come up in the coastal regions in all levels of urbanicity (Figure 12). The average marginal effects of prevalence for each region-urbanicity subregion are visualized in the maps (Figures 13 and 14).

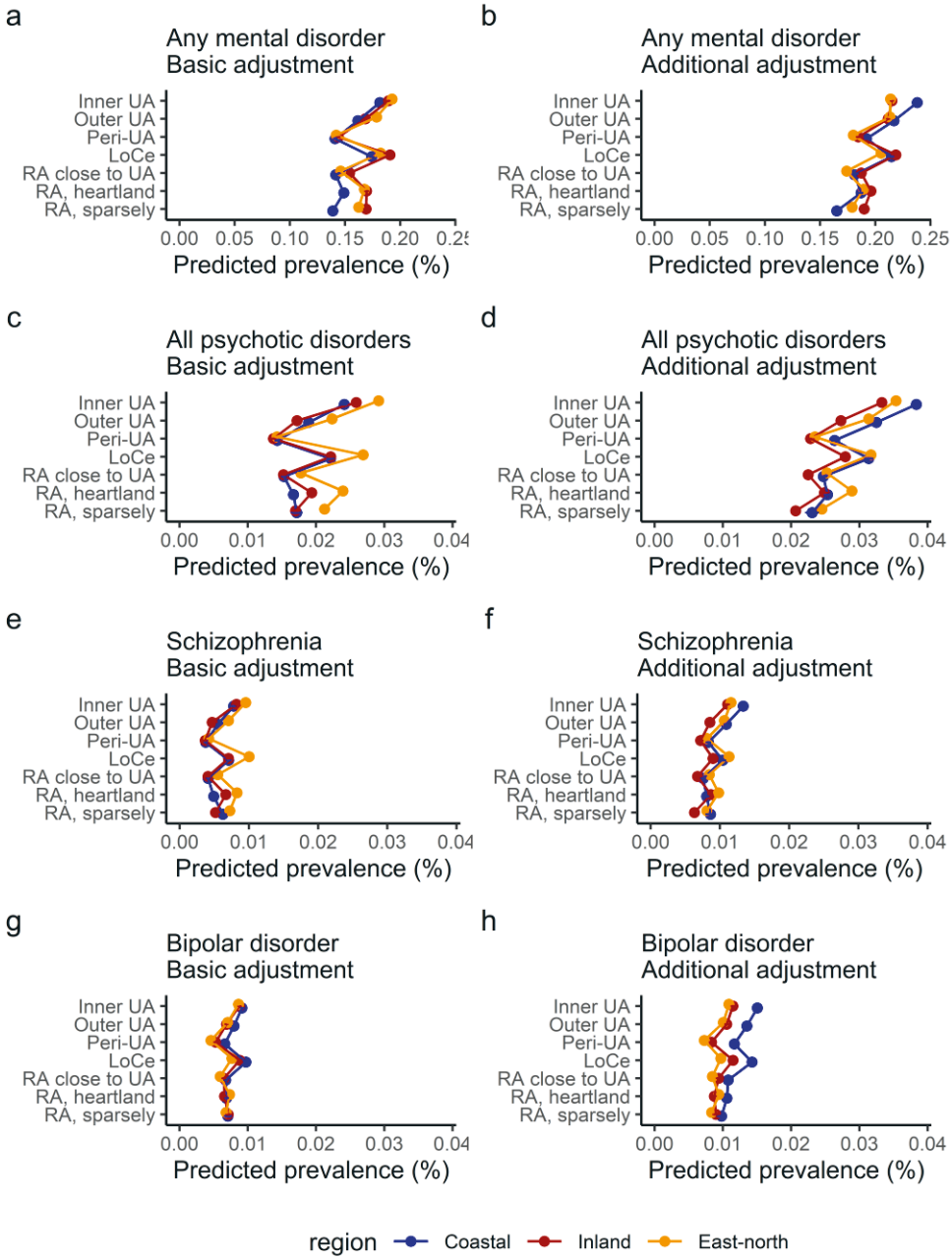

Figure 12. Average marginal effects of aggregated region of residence and urbanicity on the prevalence of mental disorders. Predicted prevalence in each region-urbanicity subregion was calculated while holding the other predictors constant as observed. In the basic adjustment, prevalence ratios are adjusted for age, recorded gender, and calendar time. In

the additional adjustment, prevalence ratios are adjusted for age, recorded gender, calendar time, region, origin, residence history, household income, economic activity, and Charlson comorbidity index. Error bars indicate 95% CIs. UA refers to urban area, RA to rural area, LoCe to Local centres in rural areas. Coastal, inland, and east-north regions are described in Figure 2.

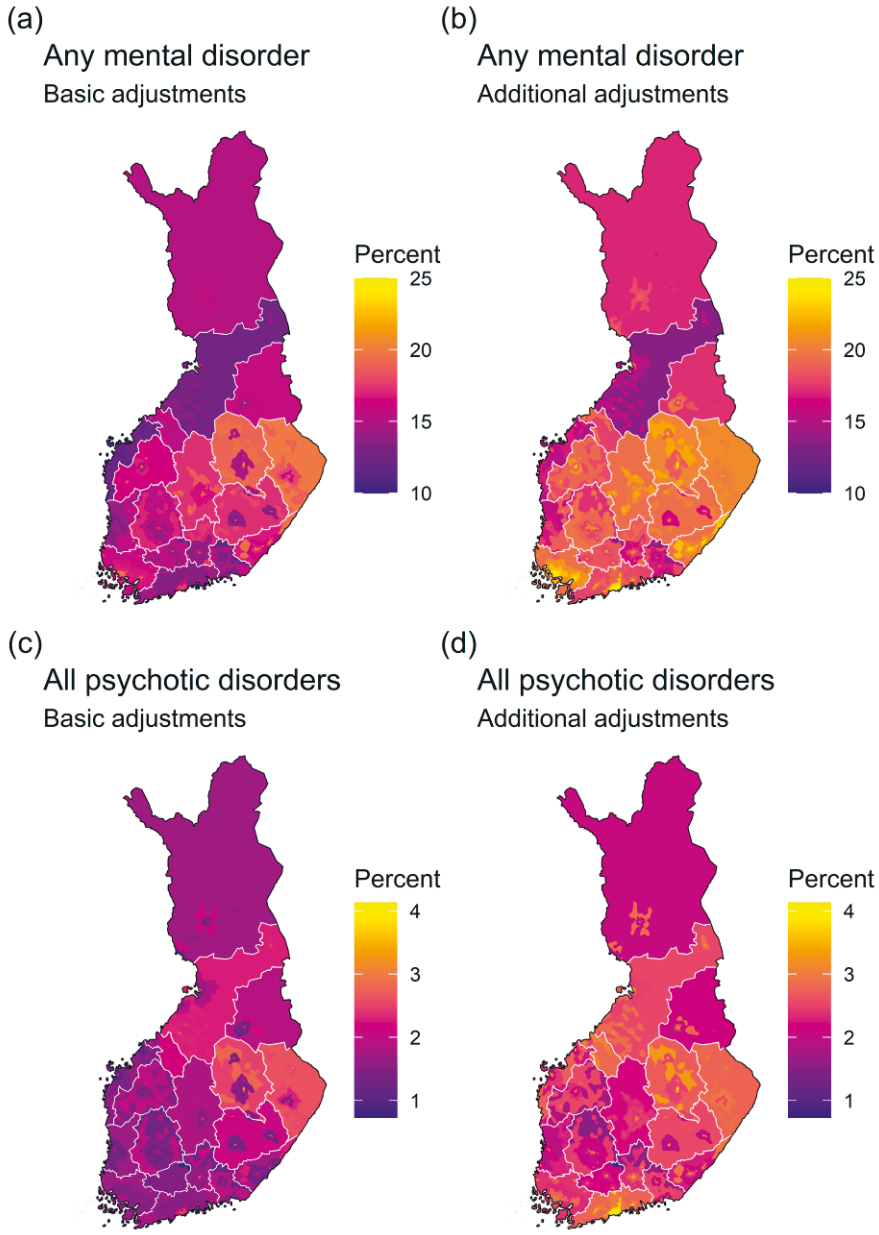

Figure 13. Average marginal effects of region of residence and urbanicity on the prevalence of any mental disorder and all psychotic disorders. Predicted prevalence in each region-urbanicity subregion was calculated while holding the other predictors constant as observed. In the basic adjustment, prevalence ratios were adjusted for age, recorded gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, recorded gender, calendar time, origin, residence history, household income, economic activity, and Charlson comorbidity index.

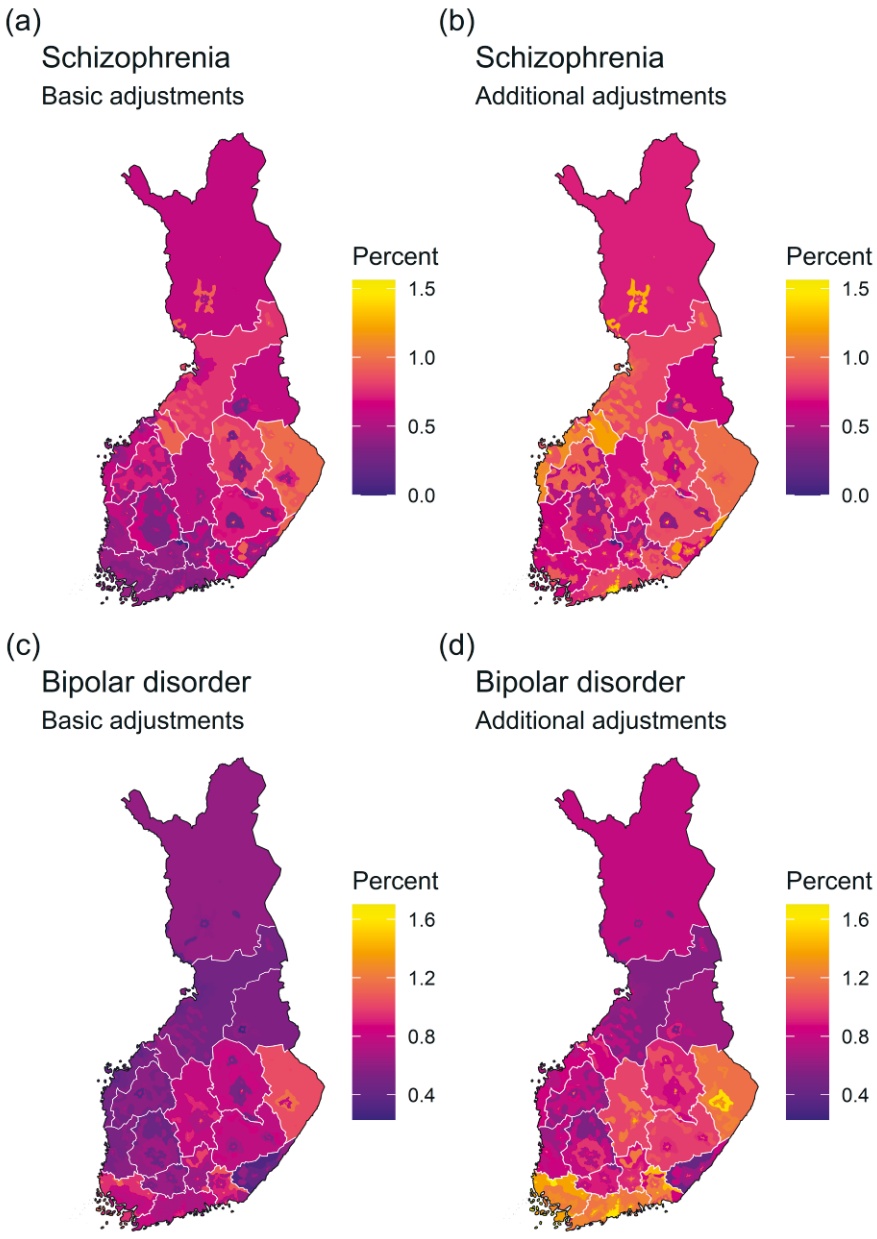

Figure 14. Average marginal effects of region of residence and urbanicity on the prevalence of schizophrenia and bipolar disorder. Predicted prevalence in each region-urbanicity subregion was calculated while holding the other predictors constant as observed. In the basic adjustment, prevalence ratios were adjusted for age, recorded gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, recorded

gender, calendar time, origin, residence history, household income, economic activity, and Charlson comorbidity index.

5.4 Mortality in persons with recent primary or secondary care contacts for mental disorders (Study III)

Between the years 2011 and 2017, a total of 4 417 635 individuals aged at least 20 years (2 267 449 [51.33%] women) contributed 28 049 912 person-years at risk of death. During the study period, 860 287 (19.5%) of all observed individuals had a mental health related healthcare contact, and 357 119 persons died (179 645 [50.30%] women). A one-year history of mental health related healthcare contacts was present in 6.0% of observed person-time (5.1% in men and 7.0% in women), and it was more common to have contact only to primary care, as can be seen in Table 7. Among those who died, 44 364 (12.42 %) had had some contact with psychiatric secondary or primary care within the previous one year.

Table 7. Number of deaths, person-years at risk, and age-standardized mortality rates (ASMRs) in individuals with and without a one-year history of mental health treatments, primary and secondary care combined.

	Deaths, n (%)	Person-years (%)	ASMR per 1 000 person-years (95% CI)[a]
Men			
No treatments	154 350 (87.0)	12 917 461 (94.9)	14.0 (13.9–14.0)
Primary and secondary care combined	23 124 (13.0)	691 572 (5.1)	37.7 (37.2–38.2)
Primary care	14 473 (8.2)	394 116 (2.9)	32.9 (32.3–33.4)
Secondary care	8 651 (4.9)	297 456 (2.2)	51.5 (50.2–52.9)
Women			
No treatments	158 405 (88.2)	13 436 464 (93.0)	9.0 (8.9–9.0)
Primary and secondary care combined	21 240 (11.8)	1 004 415 (7.0)	18.5 (18.2–18.8)
Primary care	13 659 (7.6)	582 123 (4.0)	14.3 (14.0–14.6)
Secondary care	7 581 (4.2)	422 292 (2.9)	26.7 (26.1–27.4)
[a]Standardized to the 2013 European Standard Population by 5-year age groups.			

The overall most common diagnostic category was mood disorders, with 37.0% and 44.5% of person-time labeled with a one-year history of mood disorders related healthcare contacts in men and women, respectively (Table 8). Among those who died, organic mental disorders were present the most commonly in both men (7 986 [34.5%] deaths) and women (10 094 [47.5%] deaths).

Table 8. Number of deaths, person-years at risk, and age-standardized mortality rates (ASMRs) in individuals with and without a one-year history of mental health treatments, stratified by diagnosis, primary and secondary care combined.

	Deaths, n (%)	Person-years (%)	ASMR per 1 000 person-years (95% CI)[a]
Men			
None	154 350 (87.0)	12 917 461 (94.9)	14.0 (13.9–14.0)
Any disorder	23 124 (13.0)	691 572 (5.1)	37.7 (37.2–38.2)
Organic disorders (F0)	7 986 (34.5)	64 017.98 (9.3)	48.7 (46.2–51.5)
Substance use disorders (F1)	6 729 (29.1)	193 077.67 (27.9)	45.8 (44.3–47.4)
Schizophrenia spectrum (F2)	2 600 (11.2)	123 110.84 (17.8)	34.4 (32.7–36.3)
Mood disorders (F3)	4 289 (18.5)	255 685.83 (37.0)	27.2 (26.1–28.2)
Neurotic disorders (F4)	2 568 (11.1)	212 799.79 (30.8)	24.8 (23.4–26.2)
Physiological disturbances (F5)	2 081 (9.0)	108 262.24 (15.7)	22.2 (21.3–23.3)
Personality disorders (F6)	692 (3.0)	55 187.92 (8.0)	26.3 (22.3–31.4)
Mental retardation (F7)	268 (1.2)	12 065.27 (1.7)	37.1 (31.8–43.4)
Behavioural disorders (F9)	415 (1.8)	36 185.55 (5.2)	32.3 (28.3–36.7)
Organic and substance use excluded	6 684 (3.8)	424 681.97 (3.1)	24.9 (24.2–25.7)
Women			
None	158 405 (88.2)	13 436 463 (93.0)	9.0 (8.9–9.0)
Any disorder	21 240 (11.8)	1 004 415 (7.0)	18.5 (18.2–18.8)
Organic disorders (F0)	10 094 (47.5)	103 630.55 (10.3)	27.1 (25.2–29.3)
Substance use disorders (F1)	1 982 (9.3)	99 502.51 (9.9)	24.6 (23.4–25.8)
Schizophrenia spectrum (F2)	2 410 (11.3)	123 999.50 (12.3)	18.7 (18.0–19.5)
Mood disorders (F3)	4 184 (19.7)	447 298.65 (44.5)	13.5 (13.0–13.9)
Neurotic disorders (F4)	2 832 (13.3)	424 205.02 (42.2)	12.3 (11.8–12.8)
Physiological disturbances (F5)	1 290 (6.1)	175 266.55 (17.4)	8.2 (7.7–8.7)
Personality disorders (F6)	578 (2.7)	93 159.85 (9.3)	15.1 (13.3–17.1)
Mental retardation (F7)	216 (1.0)	11 562.00 (1.2)	26.1 (22.5–30.1)
Behavioural disorders (F9)	283 (1.3)	42 982.61 (4.3)	14.9 (13.1–17.0)
Organic and substance use excluded	7 023 (3.9)	779 006.85 (5.4)	12.4 (12.1–12.7)

[a]Standardized to the 2013 European Standard Population by 5-year age groups.

5.4.1 Adjusted mortality rate ratios (MRRs)

When primary and secondary care were combined, individuals with a one-year history of mental health treatments had MRRs of 2.83 (95% CI, 2.79-2.89) and 1.79 (1.76-1.82) for men and women, compared to those without treatments. After adjusting for indicators of socioeconomic position, MRRs of 2.17 (95% CI, 2.13-2.20) and 1.71 (1.68-1.74) for men and women respectively were observed, and after further adjustments for physical comorbidities, the estimates decreased (1.63 [1.60-

1.65] and 1.20 [1.18-1.22], respectively), see Table 9. Age-specific MRRs can be seen in Figure 15. After the age of 34 years, the age-specific MRRs began to decrease in both men and women.

Table 9. Mortality rate ratios in individuals with a one-year history of mental health treatments compared to those without such a history.

	Mortality rate ratio (95% CI)			
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
Men				
Model accounting for primary and secondary care				
No treatments	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Primary and secondary care combined	2.83 (2.79–2.87)	2.17 (2.13–2.20)	2.00 (1.97–2.03)	1.63 (1.60–1.65)
Primary care	2.26 (2.22–2.31)	1.87 (1.84–1.91)	1.60 (1.57–1.63)	1.39 (1.37–1.42)
Secondary care	4.78 (4.67–4.89)	3.01 (2.93–3.08)	3.36 (3.28–3.44)	2.32 (2.27–2.38)
Model accounting for secondary care only[e]				
No treatments	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Secondary care	4.58 (4.47–4.68)	2.83 (2.76–2.90)	3.25 (3.18–3.33)	2.24 (2.19–2.30)
Women				
Model accounting for primary and secondary care				
No treatments	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Primary and secondary care combined	1.79 (1.76–1.82)	1.71 (1.68–1.74)	1.24 (1.22–1.26)	1.20 (1.18–1.22)
Primary care	1.40 (1.38–1.43)	1.42 (1.39–1.44)	0.97 (0.95–0.99)	0.98 (0.96–1.00)
Secondary care	3.51 (3.42–3.60)	2.79 (2.72–2.87)	2.50 (2.43–2.56)	2.06 (2.01–2.12)
Model accounting for secondary care only[e]				
No treatments	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Secondary care	3.44 (3.35–3.52)	2.72 (2.65–2.79)	2.51 (2.44–2.57)	2.07 (2.01–2.12)

[a]Model 1: adjusted for calendar year and age group (5-year intervals).
[b]Model 2: adjusted for calendar year, age group, urbanicity, region, education, living alone, household income, and economic activity.
[c]Model 3: adjusted for calendar year, age group, and Charlson comorbidity index (CCI).
[d]Model 4: adjusted for calendar year, age group, urbanicity, region, education, living alone, household income, economic activity, and CCI.
[e]Mortality in individuals with secondary care treatments compared to individuals without secondary care treatments (primary care ignored).

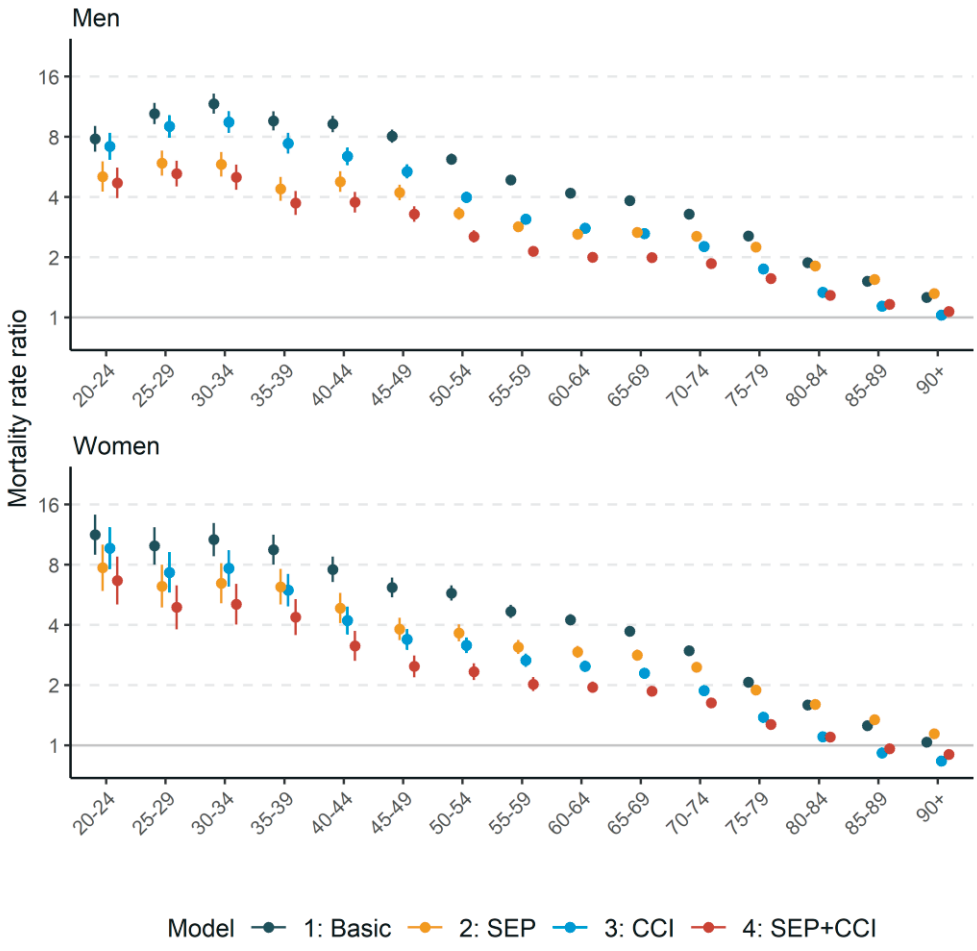

Figure 15. Age-specific mortality rate ratios in individuals with a one-year history of primary or secondary care mental health treatments compared to those without such history, adjusted for indicators of socioeconomic position (SEP) and Charlson Comorbidity Index (CCI). Mortality rate ratios are shown on a log scale. Model 1 was adjusted for calendar year. Model 2 was adjusted for calendar year, urbanicity, region, education, living alone, household income, and economic activity. Model 3 was adjusted for calendar year, and CCI. Model 4 was adjusted for calendar year, urbanicity, region, education, living alone, household income, economic activity, and CCI. Error bars represent 95% CIs.

In diagnosis-specific analysis, the highest fully adjusted MRRs were observed in disorders related to substance use (Figure 16). Excess mortality was reduced but still present in all levels of adjustments when organic and substance-use related disorders were excluded.

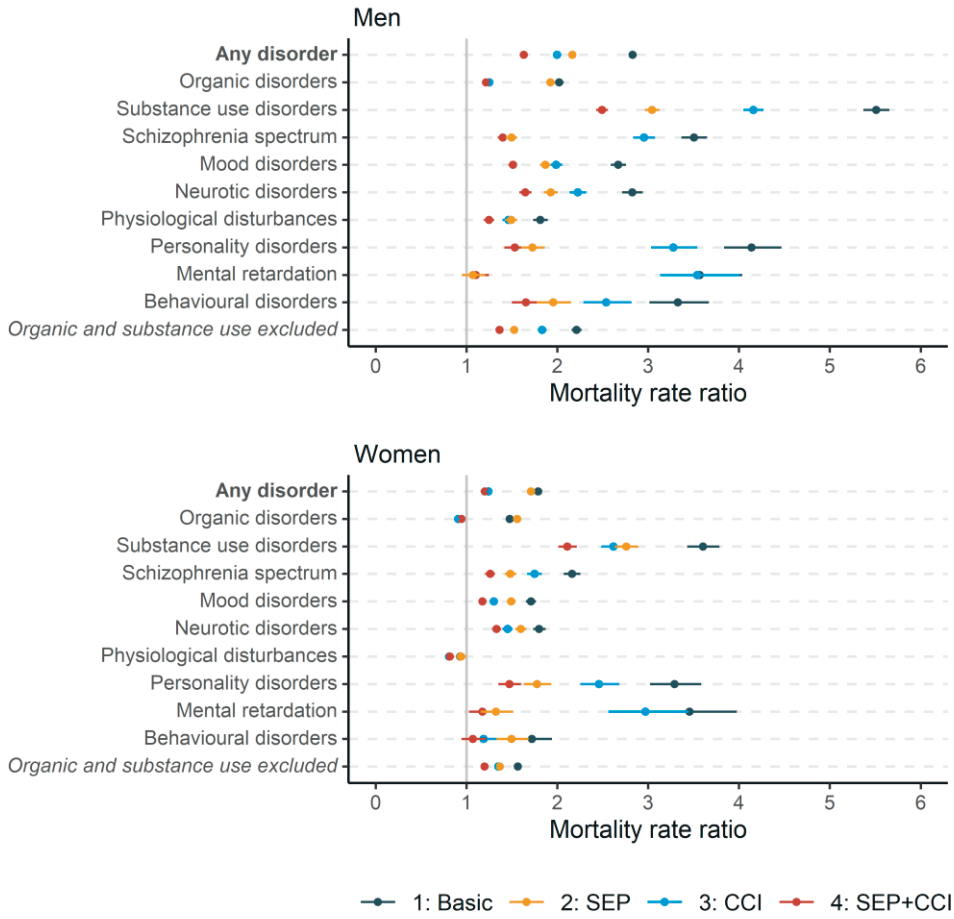

Figure 16. Mortality rate ratios in individuals with a one-year history of primary or secondary care mental health treatments compared to individuals without such a history, stratified by mental disorder, adjusted for indicators of socioeconomic position (SEP) and Charlson Comorbidity Index (CCI). Mental disorders are presented based on ICD-10 sub-chapter categories; the group "organic and substance use excluded" presents all mental disorders excluding the ICD-10 sub-chapters F0 "Organic, including symptomatic, mental disorders" and F1 "Mental and behavioural disorders due to psychoactive substance use". Category F8 "Disorders of psychological development" is not shown due to the low number of deaths (on average less than 10 per year in women). Model 1 was adjusted for Model 1: adjusted for calendar year and age group (5-year intervals). Modle 2 was adjusted for Model 2: adjusted for calendar year, age group, urbanicity, region, education, living alone, household income, and economic activity. Model 3 was adjusted for Model 3: adjusted for calendar year, age group, and CCI. Model 4 was adjusted for Model 4: adjusted for calendar year, age group, urbanicity, region, education, living alone, household income, economic activity, and CCI. Error bars represent 95% CIs.

5.4.2 Sensitivity analysis

Sensitivity analysis with three- or five-year histories of treated mental disorders, instead of one year, showed a maximum of 22.6% difference in the adjusted MRRs in women in primary care, and 13.4% in men in secondary care (Table 10). In the data with primary and secondary care combined, only 7.8% and 1.0% differences were observed in women and in men. This suggests that during the dynamic, but relatively short follow-up, some people moved between treatment facilities.

Table 10. Mortality rate ratios in individuals with a one-, three-, or five-year history of mental health treatments compared to those without.

History of Mental Health Treatments	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
Men				
Primary and secondary care combined				
1 Year	2.83 (2.79–2.87)	2.17 (2.13–2.20)	2.00 (1.97–2.03)	1.63 (1.60–1.65)
3 Years	2.65 (2.60–2.69)	2.05 (2.02–2.08)	2.02 (1.99–2.06)	1.63 (1.60–1.66)
5 Years	2.59 (2.53–2.65)	1.99 (1.95–2.04)	2.07 (2.03–2.12)	1.65 (1.61–1.68)
Primary care				
1 Year	2.26 (2.22–2.31)	1.87 (1.84–1.91)	1.60 (1.57–1.63)	1.39 (1.37–1.42)
3 Years	2.26 (2.22–2.30)	1.86 (1.83–1.90)	1.75 (1.72–1.78)	1.49 (1.46–1.52)
5 Years	2.24 (2.19–2.30)	1.84 (1.79–1.88)	1.82 (1.78–1.87)	1.53 (1.49–1.57)
Secondary care				
1 Year	4.78 (4.67–4.89)	3.01 (2.93–3.08)	3.36 (3.28–3.44)	2.32 (2.27–2.38)
3 Years	4.13 (4.03–4.23)	2.70 (2.62–2.77)	3.00 (2.93–3.08)	2.09 (2.03–2.14)
5 Years	3.82 (3.70–3.94)	2.52 (2.43–2.60)	2.90 (2.81–2.99)	2.01 (1.94–2.08)
Women				
Primary and secondary care combined				
1 Year	1.79 (1.76–1.82)	1.71 (1.68–1.74)	1.24 (1.22–1.26)	1.20 (1.18–1.22)
3 Years	1.75 (1.72–1.79)	1.59 (1.56–1.62)	1.34 (1.32–1.37)	1.23 (1.20–1.25)
5 Years	1.83 (1.78–1.87)	1.58 (1.54–1.62)	1.49 (1.46–1.53)	1.30 (1.27–1.33)
Primary care				
1 Year	1.40 (1.38–1.43)	1.42 (1.39–1.44)	0.97 (0.95–0.99)	0.98 (0.96–1.00)
3 Years	1.52 (1.49–1.55)	1.43 (1.41–1.46)	1.17 (1.14–1.19)	1.11 (1.08–1.13)
5 Years	1.62 (1.58–1.66)	1.45 (1.41–1.49)	1.33 (1.30–1.37)	1.20 (1.17–1.23)
Secondary care				
1 Year	3.51 (3.42–3.60)	2.79 (2.72–2.87)	2.50 (2.43–2.56)	2.06 (2.01–2.12)
3 Years	2.85 (2.77–2.93)	2.24 (2.18–2.31)	2.15 (2.10–2.22)	1.72 (1.67–1.77)
5 Years	2.70 (2.61–2.80)	2.06 (1.98–2.13)	2.15 (2.08–2.23)	1.65 (1.59–1.71)

[a]Model 1: adjusted for calendar year and age group (5-year intervals).
[b]Model 2: adjusted for calendar year, age group, urbanicity, region, education, living alone, household income, and economic activity.
[c]Model 3: adjusted for calendar year, age group, and Charlson comorbidity index (CCI).

[d]Model 4: adjusted for calendar year, age group, urbanicity, region, education, living alone, household income, economic activity, and CCI.

6 DISCUSSION

The present series of studies aimed to update some basic epidemiological observations of treated mental disorders in Finland. The main findings are the following:

First (Study I), the incidence of first psychiatric hospital admissions was evaluated over a 19-year population-based follow-up between 1996 and 2014 and was approximately 1.6 per 1 000 person-years in 2016. A clear negative income gradient in the incidence rates of first hospital admissions in the adult population was observed, even after adjusting for potential confounders. In addition, income-specific trends in incidence showed temporal changes in disparities within the population. It was found that the trends decreased throughout the entire study period only in the high-income groups. This study contributes to the current literature by demonstrating the presence of a robust income gradient in the incidence rates of first hospitalizations due to mental disorders.

Second (Studies II and III), the crude prevalence of any history of mental health related healthcare contacts in 2017 was 21.7% (24.1% in women and 19.3% in men). A one-year history of such contacts was present in 6.0% of observed person-time (5.1% in men and 7.0% in women) in individuals aged 20 years or above. These estimates were calculated using both primary and secondary care data, using the coverage available in the Finnish healthcare registers. These assessments allowed for the examination of regional differences, including urban-rural disparities, as there are regional variations in the demarcation of primary and secondary care.

Third (Study II), this study adduced the significance of social determinants of mental health in the geographical distribution of mental disorders in the Finnish context. Prevalence of all mental disorders and psychotic disorders treated in both primary and secondary care were higher in the eastern and northern regions of the country compared to coastal regions, as expected based on previous research. However, after adjusting for sociodemographic and economic factors, the geographical difference was no longer evident. By contrast, urban-rural differences persisted throughout the country, even after the adjustments. Interestingly, previous research in Finland has shown that regional differences in the occurrence of psychotic disorders are more pronounced than urban-rural variation, and urban birth

was linked to a reduced risk of these disorders. The current results indicated a shift in this pattern, suggesting that Finland is no longer an exception in terms of urban-rural differences in the occurrence of psychotic disorders in Northern Europe.

Fourth (Study III), excess mortality in individuals with mental disorders is a well-known fact, but previous studies have not extensively explored this phenomenon using healthcare registers containing all treated disorders in both primary and secondary care. As expected, excess mortality in individuals with a recent history of mental health-related healthcare contacts was observed. However, the novel finding of this study was that even when considering both primary and secondary care and adjusting for sociodemographic and economic factors as well as physical comorbidity, excess mortality persists, although to a significantly reduced extent.

Finally, detailed preprocessing of the partly overlapping register entries in the Finnish national healthcare registers helped mitigate probable false positive cases in different diagnostic categories. After the preprocessing, preliminary psychiatric diagnoses during hospital treatments that were no longer present at discharge were excluded, and the greatest change in the number of affected individuals was seen in schizophrenia, schizotypal and delusional disorders, where up to 3.81% of the register entries were preliminary diagnoses during hospitalizations and were not present at discharge or later in the registers.

In the following sections, these results will be discussed.

6.1 Incidence of first psychiatric hospital admissions (Study I)

This study is one of only a few studies reporting incidence rates in all first psychiatric admissions (Daly & Walsh, 2015; Joensen & Wang, 1983), and to the best knowledge of this author, it is the first national-level study showing that a robust income gradient is present in the incidence rates of first hospitalizations due to mental disorders.

6.1.1 Trends in incidence rates

6.1.1.1 Comparison with previous research and implications of the findings

Between 1994 and 2014 in Finland, the age-standardized annual incidence rate of first hospital admissions peaked in 2008 and subsequently began to decline. The

observed incidence rate was 1.6 per 1 000 person-years in 2014. First psychiatric hospital admission rates are seldom reported: The incidence rate in this study was slightly higher than the rate (1.3 per 1 000) reported from Ireland, where the number of first admissions has steadily decreased since the 1970s (Daly & Walsh, 2015). In the present study, an increasing trend was observed between 1996 and 2000, followed by stability until 2008 and a subsequent decrease thereafter. However, gender differences emerged, with women having a more pronounced increase until 2008.

Following this study, two other Finnish papers have reported similar findings of increasing first admissions among adolescents (Holttinen et al., 2021) and in children, adolescents and young adults using a series of birth cohorts (Kerkelä et al., 2021). The deinstitutionalization of mental health care in Finland has been considered successful in terms of increased life expectancy and reduced post-discharge suicides (Pirkola et al., 2007; Westman et al., 2012). However, in a recent Finnish systematic concept analysis, it was highlighted that mental health policy in Finland has undergone substantial changes since the 1970s (Ahonen, 2020): The focus on well-being and preventive healthcare has shifted attention away from improving the situation of individuals with severe mental illness. The current observed increase in first admissions, which has subsequently been replicated, during a time when outpatient-centered services dominate, raises concerns about the effectiveness of outpatient care in managing acute and severe mental disturbances, although it is also possible that ultrashort inpatient crisis episodes are preferred more than previously and partly explain this pattern.

A noteworthy strength of this study was the analysis of income-specific trends in incidence rates. Increasing trends were observed in the seven lowest income deciles among women and the three lowest deciles among men. Conversely, in the highest income deciles, a consistent decrease was observed for both men and women throughout the entire study period. These diverging trends at the beginning of the study period indicate a growing disparity between the highest and lowest income groups and provide new insights into the observed increasing trends in incidence rates.

Individuals with higher income might be in more stable and secure positions that make them more willing to undergo or more capable of receiving more intense outpatient care and avoiding first hospitalizations. This possibility is in convergence with the diffusion of innovations and cultural capital explanations of health inequalities, which propose that adoption of new behaviors and the earlier uptake of

new interventions, in this case outpatient care, occur earlier in higher socioeconomic positions (Mackenbach, 2012).

The present findings suggest that, in general, the policy of deinstitutionalization and outpatient-focused mental health services may not have been fully successful in reducing the need for first hospital treatments; only the highest income groups demonstrated a consistent decrease in first admissions. However, data on the first outpatient contacts throughout the study period were not available.

There are no apparent reasons for the trends observed in the data. The disparities in admission rates reached their peak in 2008 and subsequently declined. In an editorial by Vikram Patel (2020), these trends were discussed as follows:

> "It seems too much of a coincidence that the upward trend in the poorest individuals occurred during a period of growing financial uncertainty, peaking with the global financial crisis of 2008, often thought of as the most serious financial crisis (at least in Western economies) since the Great Depression of the 1930s. The richest persons appear to have had a greater capacity to cope with this catastrophic economic crisis, perhaps due to their greater ability to leverage resources, such as educational attainment, financial savings, and health care."

It is quite likely that some systematic differences in access to care or the quality of care exist across the income strata (Keskimaki et al., 2019; Tynkkynen et al., 2022). Regarding mental health services, these results indicate that in a Nordic welfare system, equity in access to and quality of health care cannot be assumed to be an inherent component but rather needs to be a focal point in all policies and should be actively monitored.

Another noteworthy observation is the overall distribution of diagnoses in first hospitalizations. Mood disorders were the most common diagnostic group throughout the study period, accounting for 43 % of first hospitalizations, whereas 29 % of discharge diagnoses included major psychotic features. It is commonly recognized that inpatient psychiatry primarily focuses on severe mental disorders, such as schizophrenia and bipolar disorder, although not exclusively (Stein et al., 2022). Diagnoses often change during follow-up after the first hospitalization due to various reasons (Baca-Garcia et al., 2007; Bromet et al., 2011; Kampman et al., 2004; Köhler-Forsberg et al., 2023; Niemi-Pynttari et al., 2013), but it is common for individuals at clinical high risk of psychosis not to transition to a first episode of psychosis (Solmi et al., 2023). Therefore, traditional conceptualization of "severe" and "common" mental disorders based solely on diagnostic classification, rather than on individual clinical evaluation, may be of limited utility when communicating about mental disorders.

6.1.2 Income gradient in the incidence of first hospital admissions

6.1.2.1 Comparison with previous research and implications of the findings

A clear negative income gradient was observed in the incidence rates of first hospital admissions for mental disorders in the adult population, even after adjusting for potential confounders such as education level, urbanicity, living alone, and recent income decrease within the previous 3 years. Low household income was associated with higher incidence rates throughout the entire study period across different age groups, although the differences between the highest deciles diminished among individuals aged 19 or younger and 65 or older. The income gradient in the adult population was evident across all levels of household income in overall and ICD-10 diagnostic main category-specific incidence rates.

Negative income gradients have been observed in various mental health outcomes (Ding et al., 2020; Kinge et al., 2021). The current study demonstrated a clear curvilinear income gradient in overall first psychiatric admissions. First admissions were selected as the primary outcome of interest as they provide an overall perspective on the emergence of severe mental health conditions and facilitate comparisons between income groups, irrespective of diagnostic procedures, as discussed in the previous section.

The observation that income gradient is seen across income strata is in line with the psychosocial theory of health inequalities, which states that adversity and stress associated with lower relative income increase the risk of a variety of illnesses, rather than poverty itself (Mackenbach, 2017b; Marmot & Wilkinson, 2001). The discussion of selection versus causation has garnered significant interest previously (Dohrenwend et al., 1992; Hudson, 2005; Kröger et al., 2015). It is now widely accepted that the association between income and poor mental health is bidirectional, although the relative importance of different mechanisms remains a subject of debate (Deaton, 2016; Patel, 2020; Ridley et al., 2020). The current findings provide a concrete population-wide observation of a nonlinear income gradient in the incidence of severe mental disorders that spans across income distribution.

6.1.3 Methodological considerations

First psychiatric hospital admissions were identified with adequate accuracy based on the registers, and first admissions with a 20-year clearance period were selected

as the primary outcome of interest. The clearance period was used to define the first hospital admission considering the time covered by the registers. This is a relatively short period of time particularly in the age-groups 65 years and older. However, this approach facilitates comparisons in equality of the trends between income groups but offers limited means to interpret the population's mental health in general, as there are no comprehensive data on outpatient treatments before the first inpatient treatments, or population mental health in general, for the study period.

This study focused on all first inpatient treatments rather than on diagnosis-specific treatments, to avoid potential confounding from gender, income, or race/ethnicity-related differences or variations in the temporal stability of recorded diagnoses. Diagnosis-specific additional analysis, on the other hand, offers insight into temporal variations in the overall trends. Decreasing trends in first admission rates of individual disorders, such as schizophrenia, have been associated with increased outpatient care and variations in diagnostic practices (Chiang et al., 2017; Kendell et al., 1993; J. M. Suvisaari et al., 1999).

Diagnosis-specific income gradient was steepest in schizophrenia and related psychotic disorders. Differences in gradients between disorders should be interpreted with caution, however, because help-seeking patterns and the proportion of outpatient care may have varied among income groups, disorders, and time. In substance use disorders, social consequences, rather than severity of dependence, may be associated with treatment entry and may partly explain the gradient (Weisner et al., 2002). Changes in the health care system are another potential source of variation in diagnosis-specific trends. For example, during the deinstitutionalization process, inpatient treatment shifted to other facilities in Finland, which may at least partly explain the reduction in the rate of substance use–related first admission in men (Kaltiala-Heino et al., 2001). These other facilities, however, are not fully covered in the data available for this study.

Not all monetary income and no wealth are captured with the national income statistics, and individual household members of different ages contribute differently to their household income. In Finland, children and adolescents have few possibilities of contributing to their families' income, but family income is associated with many aspects of health (Noble et al., 2015; Patton et al., 2016; Reiss, 2013). Severe economic hardship can also affect children in affluent countries (Brooks-Gunn & Duncan, 1997; Clark et al., 2020). The current findings may suggest that when family income is above the median, relative income becomes less influential in children compared to adults. However, it is important to note that this aspect was

not the primary focus of the current study, and potential confounders such as parental education or health were not adjusted for.

It is worth mentioning that non-dwelling children and adolescents had high incidences of hospitalizations throughout the study period, and being institutionalized under out-of-home care is probably the most common reason for their non-dwelling status. Those who are non-dwelling do not contribute to the dwelling population and hence do not have household income data in the statistics.

In individuals aged 65 years and older, the differences between the income deciles above median also diminished; however, those in the lowest income decile had the highest incidence rate ratios compared to the highest income decile. This finding is in line with some previous research (Huisman et al., 2003). In these age groups, economic circumstances are influenced not only by income but also by factors such as pension systems, household composition, wealth, and savings. It is important to note that comorbid medical conditions are associated with both mental disorders and low income, which may partly explain the observed association. However, the current study did not evaluate physical comorbidities.

Mental disorders in Finland have been strongly associated with low future income (Hakulinen et al., 2020), although changes in income after the first admissions were not evaluated in the present study. The disorder leading to the first hospital treatment may have already affected the individual's ability to earn or maintain their income prior to the admission (Agerbo et al., 2004). Previous research has demonstrated a rapid decrease in average earnings between 1 and 3 years before the first inpatient diagnosis of severe mental disorder in Finland (Hakulinen et al., 2020). Therefore, controlling for income changes within the 3-year period preceding the first admission was considered appropriate. Moreover, a recent meta-analysis indicated that income changes probably have a causal effect on the mental health of working-age adults (Thomson et al., 2022). However, it is important to acknowledge that the exact timing of the onset of a mental disorder cannot be determined from register data, as individuals often delay seeking healthcare for their symptoms, and there may also be delays within the healthcare system (Kessler et al., 2007). Even if the exact date when symptoms cross the diagnostic threshold were known, there might have been prodromal symptoms that could have already caused socioeconomic consequences at an earlier stage.

It has been argued that association between income and mental health is primarily due to stable individual characteristics or other socioeconomic indicators besides income (Junna et al., 2019; F. J. Zimmerman & Katon, 2005). Furthermore, it has been argued that the link between family income and subsequent risks of mental

disorders may be explained by unmeasured familial factors, particularly in sibling-comparison designs (Sariaslan et al., 2021). However, this approach has been criticized for potentially over-adjusting the analysis (Keyes & Susser, 2023; Villadsen et al., 2023). It is reasonable to acknowledge that income and other socioeconomic indicators are interconnected and influenced by various factors throughout the life course (Galobardes et al., 2006a, 2006b); in the Nordic welfare state, income is not predetermined at birth, and multiple factors can affect both income and health outcomes. Finally, it is important to recognize that the relative income measure used in this study does not capture changes in income inequalities, which are likely to have an impact on population health (*Income Differentials Grew in 2021 - Statistics Finland*, 2022; Pickett & Wilkinson, 2015).

6.2 Regional and urban-rural variation in mental disorders (Study II)

This study aimed to assess the prevalence of mental disorders across different regions and levels of urbanicity. The key findings are as follows: As anticipated, the prevalence of psychotic disorders treated in primary or secondary care was higher in the eastern and northern regions of Finland compared to the coastal regions. However, after accounting for sociodemographic and economic factors, this geographical difference was no longer evident. By contrast, urban-rural differences, measured using a detailed seven-level classification of current residency, persisted even after adjusting for confounding variables, which aligns with previous findings from other Northern European studies. The urban effect was consistently observed throughout the country and across various diagnostic categories. Nonetheless, some regional variations were noted in specific diagnostic subgroups, such as schizophrenia and bipolar disorders.

6.2.1 Regional variations

6.2.1.1 Comparison with previous research and implications of the study

To the best knowledge of this author, this is the first comprehensive study demonstrating the associations between the within-country distribution of

socioeconomic and demographic factors and the prevalence of mental disorders treated with either primary or secondary care. Since the 1930s, several epidemiological studies in Finland have investigated regional and urban-rural variations in mental disorders (Haukka et al., 2001; Hovatta et al., 1997; Korkeila et al., 1998; Lehtinen et al., 1990; *Mielisairaat ja vajaamieliset*, 1940; Perälä et al., 2007; J. Suvisaari et al., 2014). These studies have consistently observed east-west differences in psychotic disorders. However, a recent study reported significant regional variation in mental disorder disability pensions that did not follow the traditional east-west health differences (Karolaakso et al., 2021). Previous studies did not extensively account for socioeconomic factors, although they are suspected to be a potential source of regional variations (Haukka et al., 2001; Perälä et al., 2008). Thus, the current study highlights that within-country geographical differences in mental health are sensitive to a range of social determinants, suggesting a more complex picture of the issue compared to previous reports.

Although the use of polygenic risk scores to explain geographic differences in phenotypes is currently not recommended due to methodological limitations, the resemblance between the prevalence of schizophrenia and polygenic scores has been suggested as an example of the potential of polygenic risk scores to explain geographical health differences (Kerminen et al., 2019). Our results showed that after adjusting for sociodemographic and economic factors, the prevalence of all psychotic disorders did not display statistically significant east-west differences and did not align with the geographical gradient of schizophrenia polygenic scores. Although the diagnosis of schizophrenia was slightly more prevalent in eastern parts of the country, it did not follow a gradient that was comparable to that of schizophrenia polygenic scores.

No individual level genetic data was used in this work and thus the comparison between the results of our study and the distribution of polygenic risks is indirect (Kerminen et al., 2019; Kurki et al., 2019). Mental disorders are highly polygenic and pleiotropic, and most of their genetic common variant architecture has not been identified (Andreassen et al., 2023). Schizophrenia polygenic risk scores are associated with a variety of traits, adding complexity to the concept. Therefore, future investigations into geographical disparities in mental health in Finland may benefit from considering neighborhood contextual factors, socioeconomic composition, and individual-level social determinants together with biological and genetic information.

6.2.2 Urbanicity

6.2.2.1 Comparison with previous research and implications of the study

Previous studies examining the relationship between urbanicity and mental disorders in Finland have produced mixed findings. Early studies suggested an association between living in cities and schizophrenia (*Mielisairaat ja vajaamieliset*, 1940), while more recent investigations have yielded inconsistent results (Haukka et al., 2001; Perälä et al., 2008; J. Suvisaari et al., 2014). Current results align with previous studies in Northern Europe, demonstrating an association between variety of psychotic disorders and urbanicity (Krabbendam et al., 2021; Plana-Ripoll et al., 2018; Vassos et al., 2016). Structural changes in demography, employment and services have affected particularly eastern rural parts of the country in recent decades, and probably affect the temporal differences in the link between urbanicity and psychotic disorders in Finland (Haukka et al., 2001; Makkonen et al., 2022).

Selective migration can affect regional composition and socioeconomic contexts, and also affects the associations between urbanicity and psychotic disorders (Colodro-Conde et al., 2018; Krabbendam et al., 2021; Logeswaran et al., 2023; Pedersen, 2015; Sariaslan et al., 2016). In Finland, however, it has been suggested that individuals with mental disorders are not particularly likely to move to the most urban centers (Vaalavuo & Sihvola, 2021). In a recent study, travel time in rural areas negatively associated with the use of primary care mental health services (Kotavaara et al., 2021; Lankila et al., 2022).

Contrary to the regional differences, urban-rural variation did not disappear after socioeconomic adjustments. Urban environments in a sparsely populated country such as Finland may vary greatly within the country in terms of potential urban risk attributes such as nature spaces, migration, social stress, or demographical and socioeconomic composition. Current analysis of the urbanicity-region interaction with socioeconomic adjustments showed that urbanicity is a relevant factor for mental health in all regions of the country, regardless of the size of the regional urban center, from Kajaani with a population of 36,000 to Helsinki with a population of 665,000. To conclude, Finland no longer appears to be an exception regarding urbanicity and mental disorders.

6.2.3 Methodological considerations

6.2.3.1 Quality of data

One of the main strengths of the current study is the use of interlinked Finnish national registers, which provide comprehensive data on both primary and secondary care treatments for mental disorders across the entire country. The inclusion of primary care treatment data is important, as primary care mental health treatment is common in Finland, and as shown in Study III, inclusion of primary care may alter findings substantially compared to analysis of secondary care alone.

However, it is important to note that there are no studies on the accuracy of primary care psychiatric diagnoses in the Finnish registers, and the coverage of recording of primary care diagnoses is still not complete (Hauhio et al., 2021). The relatively high prevalence of bipolar disorder with psychotic features in southern urban areas and the comparatively high prevalence of schizophrenia spectrum diagnoses in eastern and northern areas emphasize the importance of considering different register-based diagnoses side by side.

Although the Finnish registers generally exhibit good consistence (Sund, 2012), there is a recognized tendency towards a narrow definition of schizophrenia in clinical practice in Finland (Isohanni et al., 1997). Whether there are differences in diagnostic practices in primary or secondary care mental health services across the country has not been evaluated recently. It would be valuable to assess the consistency and reliability of diagnostic practices in primary and secondary care mental health services across the country in order to ensure scientific and clinical accuracy.

Additionally, private and employer-paid mental health outpatient care, which are significant components of the Finnish healthcare system and potentially more common in urban settings, were not covered in the registers for the study period. This may limit our understanding of the full scope of mental health treatments received by individuals in different regions and urban settings.

Furthermore, there is no universal definition of urbanicity, and characterization of the urban environment in more detail was encouraged in one recent review (Krabbendam et al., 2021). The current seven-level classification with 250 × 250 m pixels has not been used before in this context and is more detailed than previous classifications in Finland. The current classification has only been available since 2010, and therefore historical changes in urban effects cannot be evaluated, and individual-level residence history by urbanicity cannot be traced with this level of

detail. We evaluated regional differences and urbanicity based on current residency while controlling for living in the birth region, which allowed for some consideration of within-country migration.

6.2.3.2 Analysis

Primary care data is available only from 2011 onwards, which limits the ability to identify the dates of first presentations in healthcare. As a result, the study focused on evaluating the prevalence of a history of treated mental disorders rather than estimating incidence. Prevalence studies face challenges in determining the temporal order of events, and there is a potential for length-bias sampling. Given the typical young age of onset and chronic nature of mental disorders, as well as the influence of selective migration and structural changes in demography, the study aimed to assess the overall prevalence of mental disorders and examine adjusted prevalence ratios. This approach provides a rational starting point for further investigation (Pearce, 2004). Therefore, understanding the causal relationships between socioeconomic factors and mental health at an individual level, as well as the within-country differences in these associations, requires additional research.

On the regional level of aggregated observations, household income was a significant cofactor in the models. This finding is consistent with previous research that has highlighted the strong links between income inequality, low individual income, and mental disorders through complex pathways (Hakulinen et al., 2020, 2023; Pickett & Wilkinson, 2015; Ridley et al., 2020). Arguably, income was a relevant cofactor, rather than a mediator, as it is unlikely that the within-country distribution of income was determined by the regional prevalence of mental disorders. However, the study aimed to account for both direct and indirect effects of income in conjunction with regional mental health patterns (VanderWeele & Robinson, 2014). Household income and its distribution within the country are subjects to policies and experimental manipulation (Galea & Hernán, 2020; Vandenbroucke et al., 2016). While multilevel perspectives and contextual factors have provided valuable insights into understanding mental health, there is a growing emphasis on interventions and trials in social epidemiology (Diez Roux, 2022; Glass et al., 2013; Oakes, 2004). The current study aimed to comment on the complexities of the geographical distribution of mental health rather than making strong causal claims.

6.3 Mortality in persons with recent primary or secondary care contacts for mental disorders (study III)

In this study, the inclusion of individuals in both primary and secondary care settings revealed lower estimates of excess mortality in treated mental disorders compared to analyses that only considered secondary care data. The majority of individuals with recently treated mental disorders had contact only with primary care services. The current findings sharpen the established view of a dramatically shortened life-expectancy related to mental disorders.

The presence of physical comorbidities and adjustment for individual level indicators of socioeconomic position substantially attenuated the association between mortality and a history of mental health treatments. To the best knowledge of this author, this is the first nationwide study on mortality in treated mental disorders to include both primary and secondary care data.

6.3.1 Comparison with previous studies

In a 5-year follow-up study in Canada, Kisley et al. (2005) observed less elevated MRRs in primary care than in secondary care. They reported overall MRRs a little higher than the present ones, and they adjusted only for regional level socioeconomic factors and not for physical comorbidities. Similarly, John et al. (2018) examined mortality in psychotic and mood disorders in the UK over a 10-year period and found less elevated standardized mortality ratios when both primary and secondary care data were considered.

The previous meta-analysis of mortality among people with mental disorders included studies with a median follow-up of 10 years (Walker et al., 2015b). Four studies included a primary care sample and of those, only Kisley et al. (2005) included all mental disorders. Hence, our estimates are not directly comparable with those of previous research.

In a Danish study with a secondary care sample and 21 years follow-up, an overall MRR of 2.53 (95% CI, 2.52–2.54) was observed (Plana-Ripoll et al., 2019). The length of the follow-up period can influence the age-specific MRRs (Walker et al., 2015b). In the current study, higher MRR estimates were seen in young adults, reflecting the increased mortality risk after the first episode and in shorter follow-up periods. This finding is consistent with previous research (Cuijpers et al., 2014; Simon et al., 2018; Walker et al., 2015b).

6.3.2 Implications of the study

The current study has some important public health implications. The findings confirm those of the extensive previous literature on excess mortality in mental disorders, but also suggest that the previously published MRR estimates would have been lower if primary care had been included in the analyses. In Denmark, for example, it has been shown only recently that only a fraction of individuals with depressive symptoms are present in the secondary care registers (Weye et al., 2023).

These findings have the potential to mold attitudes towards people with mental disorders. Health care professionals may hold pessimistic views regarding outcomes related to mental disorders, and general practitioners often feel ill-equipped to manage mental health problems. (Henderson et al., 2014; Osborn et al., 2017). The current results were more favorable than previously reported, and therefore may encourage further integration of mental health services in primary care. Furthermore, as mental disorders are commonly treated in primary care (Finley et al., 2018; Forslund et al., 2020; Spiers et al., 2016), the current results are likely to have generalizability, particularly in the high-income countries.

As expected, higher prevalence of mental health treatments but lower MRRs were observed in women compared to men. Using administrative registers, it is challenging to determine the extent to which this difference is due to variations in seeking treatment, diagnostic thresholds, access to or intensity of care, or broader factors such as social inequalities or hormonal factors (Kuehner, 2017; Yu, 2018). Notably, the higher prevalence of substance use disorders in men appears to be a contributor to the gender disparity in excess mortality.

6.3.3 Methodological considerations

In this study, the prevalence of treated mental disorders was evaluated, and similar considerations about prevalence as mentioned earlier apply. Again, it is important to note that private and employer-paid mental health outpatient care, which are significant components of the Finnish healthcare system, were not covered in the registers used for this study. Therefore, the excess mortality may still be overestimated, as not all treated disorders among employed individuals, who generally have lower mortality rates, were captured in the data.

The study focused on a one-year history of treated mental disorders in order to ensure comparability between primary and secondary care populations. However, it should be acknowledged that interpretation of data from primary or secondary care

alone should be made with caution, as the demarcation between primary and secondary care in a complex healthcare system is not always straightforward. Additionally, practices in recording secondary diagnoses may vary between healthcare facilities, which could affect the accuracy and completeness of the data. It is also possible that individuals with mental disorders may not have their physical health conditions diagnosed and treated as effectively as those without mental disorders, leading to potential underestimation of physical disease burden among this population (Laursen et al., 2009).

6.3.3.1 Adjusting for socioeconomic position

Using the national registers, this study was able to adjust for more detailed individual-level indicators of socioeconomic position than previous studies on excess mortality across treated mental disorders (Erlangsen et al., 2017; John et al., 2018; Kisely et al., 2005; Plana-Ripoll et al., 2019; Walker et al., 2015b). Socioeconomic position is known to be associated with both mortality and mental disorders, and the causal pathways between them are complex, multidirectional, partially disorder-specific, and cause-of-death specific (Hakulinen et al., 2020; Hudson, 2005; Miech et al., 1999; Stringhini et al., 2017). The study findings showed that after adjusting for socioeconomic factors, the observed excess mortality among individuals with treated mental disorders persisted but was substantially attenuated, particularly in the working-age population. This suggests that socioeconomic position plays a role in the pathway between mental disorders and mortality, indicating that socioeconomic factors contribute to the association between mental disorders and increased mortality risk.

6.3.3.2 Adjusting for physical comorbidities

Physical diseases are more common among individuals with mental disorders and partially mediate the excess mortality (Firth et al., 2019). In one extensive meta-analysis, minimally adjusted risk ratios of mortality among those with mental disorders were reported (Walker et al., 2015b), and the authors argued that all physical diseases and socioeconomic factors are pure mediators of mortality, with no causal effect on mental disorders (Walker et al., 2015a). This approach may, however, lead to somewhat liberal estimates of excess mortality. For example, cancer and cancer treatments are thought to *cause* depression (Pitman et al., 2018), and

cardiac diseases have shown bidirectional associations with mental disorders (Kivimäki et al., 2020; Lichtman et al., 2014). By considering these complexities, it becomes necessary to account for both confounding and mediating effects of physical comorbidity and SEP on the association between mental disorders and mortality.

In this study, a more conservative approach was adopted by adjusting for physical comorbidity and socioeconomic factors in the analyses. This allowed for a comparison of mortality among individuals with recent mental disorders to those with a corresponding level of physical illness and socioeconomic disadvantage. Both approaches, whether adjusting for physical comorbidity and socioeconomic factors or not, showed excess mortality, except in women in the oldest age groups. Overall, this study acknowledges the complex role of physical diseases and socioeconomic factors on the excess mortality observed in individuals with mental disorders, while still highlighting the persistent association between mental disorders and increased mortality risk when accounting for these factors.

7 CONCLUSIONS

In this series of studies, a comprehensive exploration of epidemiology of treated mental disorders in Finland was conducted. The study made use of the social determinants of mental health framework to investigate differences in the prevalence of mental disorders within the Finnish population.

The analysis of first psychiatric hospital admissions revealed a noticeable income gradient that was present across income strata. This finding supplements a substantial body of literature on the correlation between income and mental health. However, the inherent limitations of traditional observational analyses, such as the challenge of disentangling selection-causation issues, were present. Nonetheless, by examining income-specific trends in incidence, this study contributed theoretical and practical insights. It underscored the dynamic nature of health inequalities and emphasized the potential role of diffusion of innovation and inverse equity theories in sustaining disparities in mental health. Moreover, this approach indirectly evaluated the successfulness of the deinstitutionalization process and equality as a dimension of healthcare quality. Lastly, the predominant occurrence of mood disorders in first hospitalizations, rather than schizophrenia spectrum disorders, holds significance for the organization of psychiatric care.

The intricate issue of geographical variation in mental disorders was addressed in this study, suggesting that regional variations are highly sensitive to sociodemographic and economic factors. The underlying mechanisms contributing to the urban-rural divide in mental disorders remain incompletely understood. Nonetheless, the study revealed that the urban-rural pattern in Finland has evolved compared to previous analyses, aligning with observations from other Northern European regions.

While the recognition of excess mortality related to mental disorders is long-standing, this study presented a novel perspective by analyzing all disorders treated in both primary and secondary care. The inclusion of primary care data indicated that estimates of excess mortality linked to mental disorders would notably decrease. This provides a more optimistic view of the burden of mental disorders and highlights the diversity of these disorders in the population. Given the common

treatment of mental disorders in primary care, this observation bears general significance for the healthcare.

This series of studies indicated that the infrastructure for register-based research in Finland could benefit from certain improvements. Preprocessing of the register data is laborious and commonly not in the core of scientific interest. As shown here, it is a potential source of minor imprecision. The current project contributed to this topic by providing an open-source code for others to evaluate and utilize.

Lastly, considering the variations in prevalence of certain psychiatric diagnoses across regions, it is suggested that future evaluation of the reliability of the register diagnoses could be of benefit in various applications of the registers.

7.1 Equality in mental health

Mental disorders are widespread and often manifest early in life, recurring throughout the life course. Consequently, establishing causal links between mental health and various socioeconomic factors is rather complex compared to the associations observed in other commonly studied domains, such as education and mortality (Lenthe & Mackenbach, 2021). While attention to health inequalities has grown over the past decades, progress in ameliorating them remains modest (Long et al., 2023; Mackenbach et al., 2019; Marmot, 2020; Vaccarella et al., 2023).

Rather than being fixated solely on theorizing about the societal and other risk factors underlying the onset of first mental disorders, it is imperative to emphasize the determinants of mental health and well-being before and after the initial incidence, spanning across lifetimes and generations. One observational approach is to follow individuals both prior to and post the occurrence of significant events (Hakulinen et al., 2020). While the extent of the importance of the social gradient across various social strata is debated, the consensus often centers around focusing on the most socioeconomically disadvantaged individuals (Thomson et al., 2022).

The current series of studies suggested that many of the inequalities in mental health are subject to variation over time, and there is no reason to believe that the current level of variation in mental health within social strata is necessary and unavoidable despite possible improvements in policies or healthcare services. Neither are there grounds to believe that the current state of affairs is the fairest and most just, despite the current level of welfare policies, to follow the prominent conceptualization of inequity by Whitehead (1992).

Employing modern statistical methods and refining observational research techniques are pivotal for advancing the field. Imperfections in achieving 'perfectly' adjusted regression models should not hinder efforts to enhance mental health or stimulate discussions on the ideal standards of welfare or mental healthcare, particularly within the Nordic countries. Encouraging interventions is vital, as they contribute to generating evidence on specific actions and enhancing causal inference in social epidemiology more broadly (Diez Roux, 2022). Such interventions could provide valuable insights into the intricate relationship between income and mental health (Sariaslan et al., 2021).

7.2 Implications for future research

Detecting temporal trends within administrative data puts forward the foundation for further investigation, to uncover the intricacies of causes and consequences of the trends. For example, factors affecting the peak in incidence in first hospital admission among individuals in the lowest income decile in 2008 are currently not understood.

Second, evaluation of the accuracy of the register data, particularly in terms of diagnoses, could benefit various applications of the registers. Additionally, there is a lack of established best practices for the pre-processing of the healthcare registers.

Third, with the accumulation of data in primary care, it becomes possible to calculate lifetime metrics for the prevalence and incidence of treated mental disorders.

Fourth, socioeconomic factors and mental health exhibit variations across time and the life-course. Advanced modeling of the dynamic interplay between socioeconomic factors and mental health over the life-course, and on multiple levels, could provide a deeper understanding of the social determinants of mental health. Likewise, studying geographical disparities in mental health in Finland could be enriched by conducting multilevel studies that incorporate genetic, biological, individual, and neighborhood-level data.

Finally, considering the prevalence of mental disorders and their substantial impact on individuals, their health and mortality, and on whole societies, there is a wealth of accumulated knowledge with relatively stabilized strengths and limitations. Experimental studies could offer a way to make progress in both understanding of the social determinants and improving population mental health.

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PUBLICATION I

Association of Income With the Incidence Rates of First Psychiatric Hospital Admissions in Finland, 1996-2014

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JAMA Psychiatry, 77(3):274–284
doi:10.1001/jamapsychiatry.2019.3647

JAMA Psychiatry | Original Investigation

Association of Income With the Incidence Rates of First Psychiatric Hospital Admissions in Finland, 1996-2014

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Editorial page 233

Supplemental content

IMPORTANCE The association between income and mental health has long been a question of interest. Nationwide register data provide means to examine trends and patterns of these associations.

OBJECTIVES To compare income-specific trends in the incidence rates of first psychiatric hospital admissions and to evaluate whether an income gradient exists in the incidence rates at all levels of household income.

DESIGN, SETTING, AND PARTICIPANTS This population-based open cohort study used linked registry data from nationwide Finnish Hospital Discharge and Statistics Finland population registers to determine annual incidence rates of first psychiatric hospital admissions. All Finnish citizens (N = 6 258 033) living in the country at any time from January 1, 1996, through December 31, 2014, contributed to 96 184 614 person-years at risk of first inpatient treatment for mental disorders. The analyses were conducted from August 1, 2018, through September 30, 2019.

EXPOSURES Equivalized disposable income, sex, age group, reduction in income decile in the previous 3 years, urbanicity, educational level, and living alone status.

MAIN OUTCOMES AND MEASURES Annual percentage changes in the age-standardized incidence rates and incidence rate ratios (IRRs).

RESULTS Altogether, 186 082 first psychiatric inpatient treatment episodes occurred (93 431 [50.2%] men), with overall age-standardized incidence rates per 1000 person-years varying from 1.59 (95% CI, 1.56-1.63) in 2014 to 2.11 (95% CI, 2.07-2.15) in 2008. In the highest income deciles, a continuous mean decrease per year of 3.71% (95% CI, 2.82%-4.59%) in men and 0.91% (95% CI, 0.01%-1.80%) in women occurred throughout the study period, in contrast to the lowest deciles, where the trends first increased (1.31% [95% CI, 0.62%-2.01%] increase in men from 1996 to 2007 and 5.61% [95% CI, 2.36%-8.96%] increase in women from 1996 to 2001). In the adult population, an income gradient was observed at all levels of household income: the lower the income decile, the higher the adjusted IRRs compared with the highest decile. The IRRs in the lowest decile varied from 2.94 (95% CI, 2.78-3.11) to 4.46 (95% CI, 4.17-4.76). In other age groups, the gradient did not persist at the highest income deciles. Diagnosis-specific income gradient was steepest in schizophrenia and related psychotic disorders, with estimated IRRs of the lowest income decile of 5.89 (95% CI, 5.77-6.02).

CONCLUSIONS AND RELEVANCE In this cohort study, clear negative income gradient in the incidence rates of first hospital-treated mental disorders was observed in the adult population of Finland. These findings suggest that reduction in the use of inpatient care has not taken place equally between different income groups.

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JAMA Psychiatry. 2020;77(3):274-284. doi:10.1001/jamapsychiatry.2019.3647
Published online December 18, 2019.

The negative association between household income and different mental health outcomes has been observed repeatedly,[1-8] but not always.[9-12] Significant differences in health and mortality are found between all socioeconomic levels of society, which is often referred to as the social gradient in health.[13,14] This pattern has its roots in childhood[15,16] and has been observed in some studies of common mental disorders.[8,17] However, some studies[18-20] argue that, after basic needs are met, additional income is not associated with increases in well-being. At present, whether there is an income gradient in the incidence rates of first hospital-treated mental disorders is unknown.

Explanations for the association between income and mental health fall into 2 categories.[21-24] According to social causation, income influences mental health through psychosocial pathways. The selection hypothesis, on the other hand, posits that mental disorders may cause downward social mobility within and across generations. These mechanisms are not mutually exclusive, but they vary between disorders and contexts and during the life course.[22,25-27] In addition to academic and ethical interest, these associations have practical implications for social policy in general and for the design of accessible health services.[28-30]

Psychiatric hospital treatment has been reduced in the era of deinstitutionalization.[31,32] In Finland, the annual population rates of psychiatric hospital care have decreased from 6.2 to 4.7 per 1000 inhabitants, and mean length of stay in inpatient care has reduced from 67 to 31 days from 1996 to 2014.[33] First psychiatric hospital admission rates are rarely reported[34,35] but present an overall perspective on the annual emergence of severe mental health conditions and can thus facilitate comparisons between income groups. Hence, whether the incidence of first-time hospital-treated mental disorders has been reduced in the era of outpatient-centered services and, if so, whether the reduction has occurred equally within population are unknown to date.

Using national individual-level register data, we investigated the associations between household income and the incidence rates of first hospital admissions for mental disorders in Finland from January 1, 1996, through December 31, 2014. We hypothesized that an income gradient exists in the incidence rate of first inpatient treatments for mental disorders on the national level and examined (1) how equally the income-specific trends in the incidence rates of first psychiatric hospital admissions have changed during the era of decreasing inpatient care and (2) whether the possible income-specific differences persist after adjusting for potential well-known confounding factors, including urbanicity of the living municipality,[36] educational attainment,[10] living alone,[37] and income reduction during the previous 3 years before the first admission.[5,38]

Key Points

Question Is household income associated with the incidence rates of first hospital admissions for mental disorders?

Findings In this nationwide open cohort study of more than 6.2 million persons, a clear income gradient was observed at all levels of income among adults, with adjusted incidence rate ratios varying from 2.94 to 4.46 in the lowest compared with the highest income deciles. This association varied over time, and a continuous decrease in the annual incidence rates emerged only in the high-income groups.

Meaning Household income appears to be an important risk factor for first hospital-treated mental disorders at all levels of income, and mechanisms linking income and mental health may be located partly within the health care system itself.

Methods

Data Sources and Study Population

Individual-level register data on hospital care and population registers were combined for this population-based open cohort study. We identified all first psychiatric hospital admissions and the dynamic population at risk of first admissions in Finland from 1996 through 2014. The ethical review board of the National Institute for Health and Welfare approved the study protocol. Informed consent is not required for register-based studies in Finland. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

The population register of Statistics Finland included data on the total population on the last day of each study year, with socioeconomic variables and time of birth and death. We collected the following individual-level data: sex (man or woman), nationality (Finnish citizen or not), urbanicity of residence municipality (urban, semiurban, or rural),[39] household net income, size of the household dwelling unit, and for persons 20 years or older, the level of educational attainment (less than upper secondary, upper secondary, or tertiary, a national classification based on the United Nations Educational, Scientific and Cultural Organization's International Standard Classification of Education 2011),[40] and living alone status (living alone or not).

The Finnish Hospital Discharge register (1969-1993), followed by the Care Register for Health Care, maintained by the National Institute for Health and Welfare, covers all inpatient hospital treatments in Finland, and displays good accuracy of mental health diagnoses.[41] We collected all admission and discharge dates and discharge diagnoses.

Assessment of the First Psychiatric Hospital Admissions and Diagnoses

We identified all persons with first-time psychiatric hospital inpatient admissions. Outpatient visits, day-hospital treatment in psychiatric hospitals, or treatments in other general hospital wards with psychiatric diagnoses were not included. Treatments in psychiatric facilities were reliably recognized starting from the year 1976. Hence, the shortest definitive clearance period to define a first admission (ie, the time with no previous inpatient treatments before the first admission) was 20 years (January 1, 1976, through December 31, 1995). To cover the whole study period and facilitate the evaluation of temporal trends, we used a 20-year clearance

period for every study year. The *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (*ICD-10*) has been used in Finland since 1996. For details, see the eMethods in the Supplement.

Assessment of Equivalized Disposable Income Deciles

We calculated the equivalized disposable income by adjusting the net income of a household dwelling unit for the size of the unit, using the Organisation for Economic Co-operation and Development–modified equivalence scale.[42] Net income is obtained after subtracting taxes from income subject to state taxation.[43] We calculated 10th percentiles (deciles) of the annual Finnish income distribution to categorize the population into 10 income groups. The income deciles 1, 3, and 5 years before the first psychiatric hospital admission were also calculated, and possible decrease in income decile in the previous 3 years was recorded.

Persons who are registered as institutionalized or who are homeless, abroad, registered as unknown, or living in quarters that do not meet the definition of dwelling do not constitute household-dwelling units and are categorized as nondwelling. Therefore, no income data are available for this nondwelling population. However, instead of leaving these persons out of the analyses, we analyzed them as a separate income group.

Statistical Analysis

We computed stratum-specific incidence rates of the first psychiatric hospital admissions for every calendar year by dividing the number of first admissions by the person-years at risk in the following strata: sex, 5-year age groups, nationality, income decile, decrease in income decile, urbanicity of the residential municipality, educational level, and living alone status. Age-standardized incidence rates with 95% CIs were calculated by applying direct age standardization to the 2013 Revision of the European Standard Population.[44] Analyses were conducted separately for the main *ICD-10* categories of psychiatric diagnoses.

Every person in the population register with no previous hospital admissions within the clearance period of 20 years contributed to the person-time at risk. Exact dates of immigration to and from the country, moves between municipalities, or changes in household composition were not available, and therefore changes were assumed to occur on average in midyear. Non-Finnish citizens had a high rate of missing data, for example, 13.2% of the person-years at risk had missing income data compared with 0.9% in the case of Finnish citizens. Hence, all analyses included Finnish citizens only.

We used a joinpoint regression model to analyze changes in trends in age-standardized incidence rates.[45] Sex-, income decile-, and diagnosis-specific trends were analyzed separately. We used a model with a maximum of 3 joinpoints requiring at least 2 observations between joinpoints, a log-linear regression model, and the bayesian information criterion method to assess significant changes in time trends. Annual percentage changes (APCs), the estimated annual changes in rates from one joinpoint to the next in percentage, and weighted means of combined APCs were calculated. The 2-sided α level was set at .05.

To account for potential confounders, we used multivariable Poisson regression models to examine income decile-specific incidence rate ratios (IRRs) and corresponding 95% CIs. We used the incidence rates in the highest income decile as a reference. Analysis was conducted separately in 5 periods (1996-1999, 2000-2003, 2004-2007, 2008-2011, and 2012-2014) and in 3 age groups (5-19, 20-64, and ≥65 years). The division into 5 periods was used to summarize data and to make it easier to compare indicators. We adjusted the models for sex, age group, urbanicity of residential municipality, decrease in income decile, and, in the groups aged 20 to 64 years and 65 years or older, educational attainment and living alone status. We conducted separate analyses for all first admissions and for the main *ICD-10* categories of psychiatric diagnoses. We replicated the analysis using the income decile 1, 3, and 5 years before the first admission, instead of the current income decile. This procedure accounted more strongly for the temporal order of having a certain level of income and the first hospital admission.

For data management and analyses, we used the following: Python, version 2.7 (Python Software Foundation); R, version 3.5.1 (R Project for Statistical Computing); Stata, version 15.1 (StataCorp LLC); and Joinpoint Regression Program, version 4.6.0.0 (Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute). The analyses were conducted from August 1, 2018, through September 30, 2019.

Results

First Admissions and the First Admission Rates

A total of 6 258 033 Finnish citizens contributed 96 184 614 person-years at risk of first inpatient treatment for mental disorders during the study period. Of those at risk, 186 082 persons (93 431 men [50.2%] and 92 651 women [49.8%]) had their first admission to psychiatric inpatient care. The most commonly presented diagnostic main group consisted of mood disorders (*ICD-10* codes F30-F39) in 80 548 cases (43.3%) (eTable 1 in the Supplement).

Table 1 contains annual incidence rates of first psychiatric hospital admissions in the first and last year of the study period. All years are presented in eTable 2 in the Supplement. The incidence rate per 1000 person-years varied from 1.59 (95% CI, 1.56-1.63) in 2014 to 2.11 (95% CI, 2.07-2.15) in 2008 (**Figure 1**A). Men had higher incidence rates in the beginning of the study period (2.15 [95% CI, 2.09-2.22]) compared with women (1.61 [95% CI, 1.56-1.66]), whereas women had higher rates in at the end (1.65 [95% CI, 1.60-1.70] vs 1.54 [95% CI, 1.49-1.59]) (Figure 1B and Table 1). Much of the variation in the overall trends occurred in the incidence rates of substance use and mood disorders, with largest percentage increase of 4.53% (95% CI, 2.27%-6.84%) in mood disorders from 1996 through 1999 and largest percentage decrease of 8.8% (95% CI, 9.69%-7.91%) in

Table 1. Age-Standardized Incidence Rates of First Psychiatric Hospital Admissions in the First and Last Year of the Study Period[a]

Variable	1996			2014		
	Admissions, No. (%)	Person-Years at Risk, Millions (%)	Incidence Rate (95% CI) per 1000 Person-Years	Admissions, No. (%)	Person-Years at Risk, Millions (%)	Incidence Rate (95% CI) per 1000 Person-Years
All population[b]	9713	5.12	1.9 (1.86-1.94)	8387	5.31	1.59 (1.56-1.62)
Finnish citizens	9547 (100)	5.05	1.89 (1.85-1.93)	8056 (100)	5.10	1.59 (1.56-1.63)
Sex						
Men	5423 (56.8)	2.46 (48.7)	2.15 (2.09-2.22)	3832 (47.6)	2.50 (49.0)	1.54 (1.49-1.59)
Women	4124 (43.2)	2.59 (51.3)	1.61 (1.56-1.66)	4224 (52.4)	2.60 (51.0)	1.65 (1.60-1.70)
Income decile and nondwelling population						
1 (lowest)	1870 (19.6)	0.47 (9.3)	3.92 (3.72-4.14)	1804 (22.4)	0.43 (8.5)	4.02 (3.79-4.26)
2	1206 (12.6)	0.49 (9.7)	2.71 (2.55-2.89)	1116 (13.9)	0.48 (9.4)	2.62 (2.45-2.79)
3	1047 (11.0)	0.49 (9.8)	2.31 (2.16-2.47)	909 (11.3)	0.49 (9.7)	1.95 (1.82-2.10)
4	933 (9.8)	0.49 (9.8)	2.06 (1.92-2.21)	776 (9.6)	0.50 (9.8)	1.63 (1.51-1.75)
5	816 (8.5)	0.50 (9.8)	1.75 (1.62-1.90)	662 (8.2)	0.50 (9.9)	1.32 (1.22-1.43)
6	747 (7.8)	0.50 (9.8)	1.63 (1.49-1.81)	579 (7.2)	0.51 (9.9)	1.15 (1.05-1.25)
7	674 (7.1)	0.50 (9.9)	1.38 (1.25-1.57)	564 (7.0)	0.51 (10.0)	1.11 (1.02-1.22)
8	668 (7.0)	0.50 (9.9)	1.36 (1.21-1.58)	482 (6.0)	0.51 (10.0)	0.97 (0.88-1.09)
9	639 (6.7)	0.50 (9.9)	1.32 (1.18-1.53)	382 (4.7)	0.52 (10.1)	0.79 (0.70-0.91)
10 (highest)	597 (6.3)	0.50 (9.9)	1.22 (1.09-1.41)	338 (4.2)	0.52 (10.1)	0.73 (0.64-0.84)
Nondwelling	256 (2.7)	0.07 (1.3)	4.37 (3.81-5.03)	323 (4.0)	0.09 (1.7)	4.59 (4.08-5.17)
Data missing	94 (1.0)	0.05 (1.0)	5.26 (4.05-7.36)	121 (1.5)	0.04 (0.8)	6.22 (4.96-9.58)
Income decreased in previous 3 y						
No	6034 (63.2)	3.26 (64.5)	1.78 (1.74-1.83)	5313 (66.0)	3.46 (67.7)	1.51 (1.47-1.56)
Yes	3309 (34.7)	1.54 (30.4)	2.07 (1.99-2.16)	2534 (31.5)	1.41 (27.7)	1.72 (1.65-1.79)
Data missing	204 (2.1)	0.26 (5.1)	5.21 (4.36-6.65)	209 (2.6)	0.24 (4.6)	4.93 (4.20-5.95)
Urbanicity of residence municipality						
Urban	6687 (70.0)	3.26 (64.6)	2.05 (1.99-2.10)	5727 (71.1)	3.48 (68.3)	1.63 (1.59-1.67)
Semiurban	1460 (15.3)	0.87 (17.3)	1.70 (1.61-1.79)	1249 (15.5)	0.85 (16.6)	1.55 (1.46-1.64)
Rural	1400 (14.7)	0.91 (18.1)	1.56 (1.48-1.64)	1080 (13.4)	0.77 (15.1)	1.49 (1.40-1.59)
Educational level[c]						
Lower	3795 (46.5)	1.54 (40.8)	3.06 (2.95-3.17)	1974 (32.1)	0.95 (24.1)	3.10 (2.94-3.27)
Secondary	3048 (37.4)	1.35 (35.8)	2.10 (2.00-2.21)	2913 (47.4)	1.70 (43.0)	1.62 (1.56-1.69)
Tertiary	1316 (16.1)	0.88 (23.4)	1.53 (1.42-1.65)	1259 (20.5)	1.30 (32.9)	0.98 (0.92-1.05)
Living alone[c]						
No	5105 (62.6)	2.88 (76.2)	1.73 (1.68-1.78)	3424 (55.7)	2.86 (72.2)	1.22 (1.18-1.26)
Yes	3054 (37.4)	0.90 (23.8)	3.59 (3.46-3.73)	2722 (44.3)	1.10 (27.8)	2.62 (2.51-2.73)

[a] Standardized to the 2013 European Standard Population by 5-year age groups.

[b] Contains data for all Finland; all other rows contain Finnish citizens only.

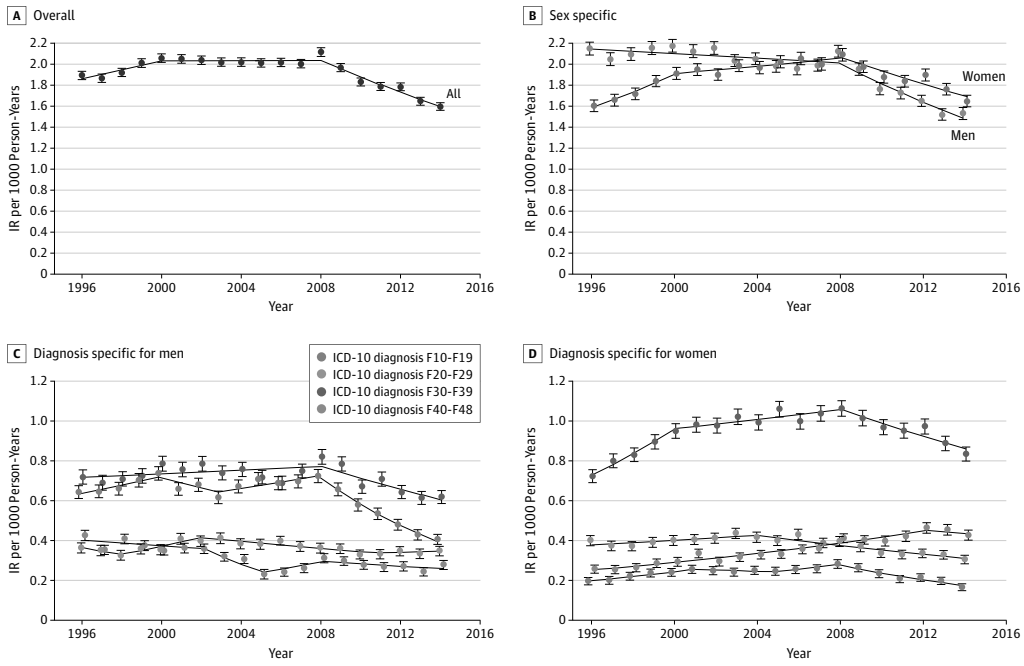
[c] Includes those 20 years or older.

substance use disorders from 2008 through 2014 (Figure 1C and D and eFigures 1-3 and eTables 3-6 in the Supplement).

Income-Specific Temporal Trends

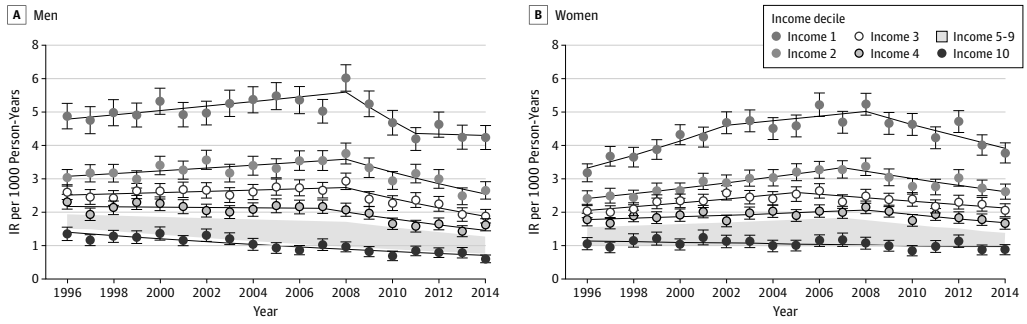
In the income-specific joinpoint regression analysis, opposite trends in the age-standardized rates between different income deciles were observed in the beginning of the study period (**Figure 2**, **Table 2**, and eFigure 4 in the Supplement for the nondwelling population). Increasing trends (ie, positive APC with 95% CIs not including 0) occurred in the 7 lowest income deciles in women and in the 3 lowest deciles in men. In the highest income deciles, a continuous mean decrease of 3.71% (95% CI, 2.82%-4.59%) per year in men and 0.91% (95% CI, 0.01%-1.80%) per year in women occurred throughout the study period (Table 2). Statistically significant increasing trends did not occur in any of the 4 most common main *ICD-10* categories of psychiatric diagnoses in the highest income decile in men or women, but occurred in all diagnostic categories in the lowest income decile, except in men with neurotic, stress-related and somatoform disorders (eFigures 5-8 in the Supplement). Age-specific annual incidence rates per 1000 person-years changed during the study period in girls and women aged 15 to 19 from 3.32 (95% CI, 2.62-4.15) to 7.83 (95% CI, 6.67-9.14) in the lowest income decile and 1.98 (95% CI, 1.22-3.02) to 2.74 (95% CI, 1.80-3.98) in the highest income deciles, whereas in in boys and men aged 15 to 19 years, they changed from 6.48 (95% CI, 5.39-7.71) to 5.81 (95% CI, 4.74-

Figure 1. Trends in Age-Standardized Incidence Rates of First Psychiatric Hospital Admissions



Data markers denote the annual age-standardized incidence rates per 1000 person-years; error bars, 95% CIs. Lines represent results of the joinpoint regression model. Rates have been age standardized to the 2013 European Standard Population by 5-year age groups. *ICD-10* indicates *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*; IR, incident rate. Codes F10 to F19 indicate mental and behavioral disorders due to psychoactive substance use; F20 to F29, schizophrenia, schizotypal, and delusional disorders; F30 to F39, mood disorders; and F40 to F48, neurotic, stress-related, and somatoform disorders.

Figure 2. Trends in Income Decile and Sex-Specific Age-Standardized Incidence Rates of First Psychiatric Hospital Admissions



Data markers denote the annual age-standardized incidence rates per 1000 person-years; error bars, 95% CIs. Lines represent the results of the joinpoint regression model. Rates have been age standardized to the 2013 European Standard Population by 5-year age groups. Income is equivalized disposable income deciles, with 1 indicating the lowest income decile and 10, the highest.

7.04) in the lowest income decile and 3.04 (95% CI, 2.13-4.21) to 1.42 (95% CI, 0.80-2.35) in the highest income decile (eFigures 9 and 10 in the Supplement).

Multivariable Analysis

In the Poisson regression model adjusted for potential confounders, a negative income gradient was observed in the IRRs

Table 2. Joinpoint Analysis of Sex- and Income-Specific Age-Standardized Incidence Rates of First Psychiatric Hospital Admissions[a]

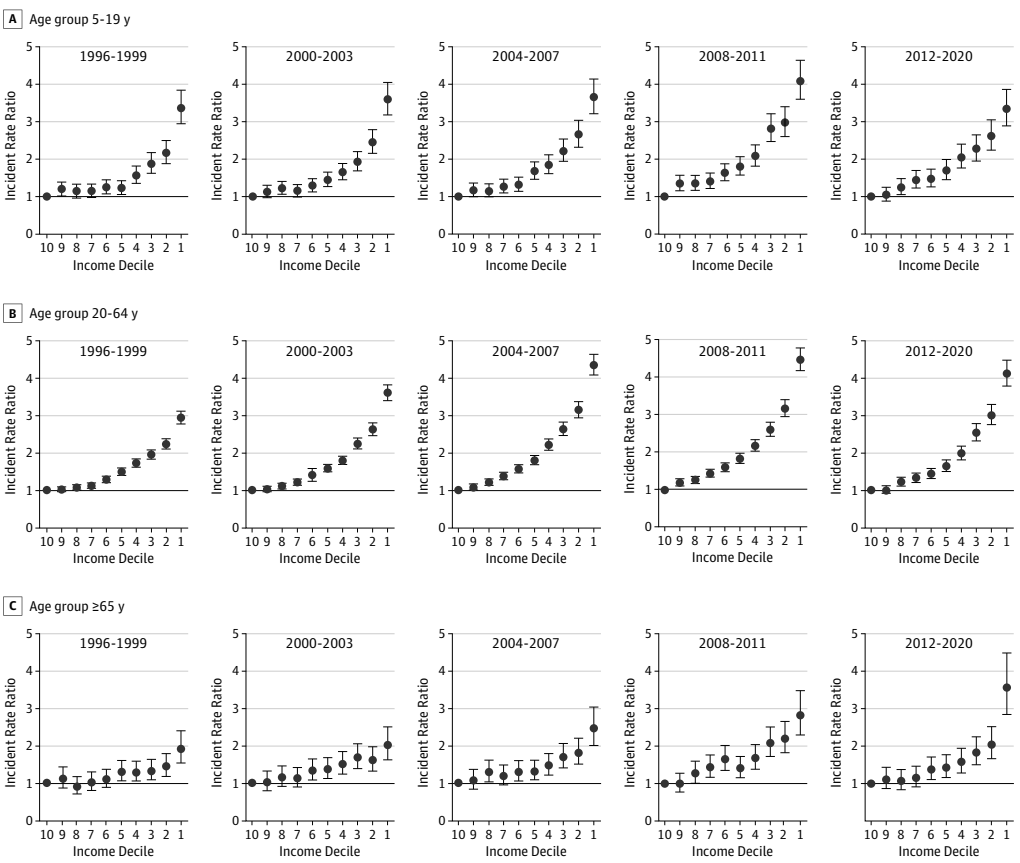
Variable	Segment 1		Segment 2		Segment 3		Segment 4		Total Follow-up, MAAPC (95% CI)
	Segment Start	AAPC (95% CI)	Segment Start	AAPC (95% CI)	Segment Start	AAPC (95% CI)	Segment Start	AAPC (95% CI)	
Overall Trends									
Total	1996	2.26 (0.71 to 3.83)	2000	0.01 (−0.61 to 0.64)	2008	−3.96 (−4.78 to −3.15)	NA	NA	−0.84 (−1.03 to −0.38)
Men	1996	−0.52 (−1.00 to −0.04)	2008	−4.93 (−6.33 to −3.52)	NA	NA	NA	NA	−2.01 (−2.54 to −1.49)
Women	1996	4.69 (2.18 to 7.25)	2000	0.95 (−0.00 to 1.91)	2008	−3.25 (−4.46 to −2.02)	NA	NA	0.34 (−0.38 to 1.06)
Income-Specific Trends									
Men									
Nondwelling population	1996	1.12 (−0.25 to 2.50)	2005	7.20 (−6.17 to 22.48)	2008	−7.41 (−9.58 to −5.19)	NA	NA	−0.85 (−2.99 to 1.34)
1 (lowest decile)	1996	1.31 (0.62 to 2.01)	2008	−7.98 (−18.03 to 3.29)	2011	−0.47 (−6.61 to 6.08)	NA	NA	−0.60 (−2.57 to 1.41)
2	1996	1.29 (0.43 to 2.16)	2008	−5.54 (−8.12 to −2.89)	NA	NA	NA	NA	−1.04 (−2.02 to −0.05)
3	1996	0.72 (0.05 to 1.39)	2008	−6.09 (−8.12 to −4.01)	NA	NA	NA	NA	−1.60 (−2.37 to −0.83)
4	1996	−0.23 (−1.50 to 1.05)	2007	−5.18 (−7.79 to −2.49)	NA	NA	NA	NA	−2.19 (−3.38 to −0.98)
5	1996	−1.02 (−2.05 to 0.01)	2008	−4.82 (−7.82 to −1.72)	NA	NA	NA	NA	−2.30 (−3.43 to −1.16)
6	1996	−2.13 (−2.88 to −1.37)	2011	−8.40 (−16.94 to 1.02)	NA	NA	NA	NA	−3.20 (−4.74 to −1.64)
7	1996	−2.26 (−2.93 to −1.60)	NA	NA	NA	NA	NA	NA	−2.26 (−2.93 to −1.60)
8	1996	−1.06 (−2.71 to 0.61)	2002	−7.16 (−15.66 to 2.20)	2005	2.26 (−8.68 to 14.50)	2008	−5.26 (−6.93 to −3.55)	−2.98 (−5.10 to −0.81)
9	1996	−3.91 (−4.44 to −3.38)	NA	NA	NA	NA	NA	NA	−3.91 (−4.44 to −3.38)
10 (highest decile)	1996	−3.71 (−4.59 to −2.82)	NA	NA	NA	NA	NA	NA	−3.71 (−4.59 to −2.82)
Women									
Nondwelling population	1996	13.39 (0.89 to 27.44)	1999	−7.94 (−24.85 to 12.76)	2002	8.66 (2.07 to 15.68)	2007	−2.73 (−5.08 to −0.33)	1.97 (−1.76 to 5.83)
1 (lowest decile)	1996	5.61 (2.36 to 8.96)	2002	1.44 (−2.27 to 5.30)	2008	−4.04 (−6.88 to −1.12)	NA	NA	0.93 (−0.77 to 2.65)
2	1996	3.02 (2.18 to 3.87)	2007	−3.43 (−4.97 to −1.88)	NA	NA	NA	NA	0.46 (−0.27 to 1.20)
3	1996	2.68 (1.43 to 3.96)	2005	−2.19 (−3.36 to −1.02)	NA	NA	NA	NA	0.22 (−0.57 to 1.01)
4	1996	1.31 (0.40 to 2.23)	2008	−3.37 (−5.83 to −0.84)	NA	NA	NA	NA	−0.27 (−1.23 to 0.69)
5	1996	1.58 (0.29 to 2.88)	2007	−3.97 (−6.34 to −1.53)	NA	NA	NA	NA	−0.62 (−1.74 to 0.52)
6	1996	3.77 (1.74 to 5.85)	2002	−0.46 (−1.41 to 0.49)	2012	−8.99 (−18.33 to 1.42)	NA	NA	−0.07 (−1.37 to 1.25)
7	1996	2.49 (0.38 to 4.65)	2005	−2.12 (−4.00 to −0.21)	NA	NA	NA	NA	0.16 (−1.13 to 1.47)
8	1996	7.27 (−1.86 to 17.24)	2000	−1.19 (−2.40 to 0.03)	NA	NA	NA	NA	0.63 (−1.37 to 2.67)
9	1996	0.06 (−0.81 to 0.93)	2010	−5.35 (−10.38 to −0.03)	NA	NA	NA	NA	−1.17 (−2.42 to 0.09)
10 (highest decile)	1996	−0.91 (−1.80 to −0.01)	NA	NA	NA	NA	NA	NA	−0.91 (−1.80 to −0.01)

Abbreviations: AAPC, average annual percentage change; MAAPC, mean AAPC; NA, not applicable.

[a] Standardized to the 2013 European Standard Population by 5-year age groups.

of the first hospital admissions for mental disorders in adults aged 20 to 64 years: the lower the income decile, the higher the IRR compared with the highest decile. In adults, the IRR of the lowest income decile in different periods varied from 2.94 (95% CI, 2.78-3.11) to 4.46 (95% CI, 4.17-4.76) (**Figure 3**B). The negative income gradient was observed in the 4 most common *ICD-10* main groups, and the gradient was steepest in schizophrenia and related psychotic disorders, followed by substance use disorders (*ICD-10* diagnoses F20-F29 and F10-F19, respectively). The gradients were less steep in mood disorders and neurotic disorders (*ICD-10* diagnoses F30-F39 and F40-F48, respectively). Estimated IRRs of the lowest income

Figure 3. Incidence Rate Ratios for the First Psychiatric Hospital Admissions by Income



Data markers denote the incidence rate ratio estimates compared with the highest income decile; error bars, 95% CIs. The model is adjusted for age group, sex, urbanicity, and decrease in income decile among those aged 5 to 19 years and for age group, sex, urbanicity, decrease in income decile, educational level, and living alone in those aged 20 to 64 years and 65 years or older. Income is equivalized in disposable income deciles, with 1 indicating the lowest income decile and 10, the highest (reference group).

decile were 5.89 (95% CI, 5.77-6.02) for schizophrenia and psychotic disorders, 5.21 (95% CI, 5.08-5.33) for substance use disorders, 2.81 (95% CI, 2.68-2.94) for mood disorders, and 2.89 (95% CI, 2.76-3.02) for neurotic disorders (eFigures 11-12 and eTable 7 in the Supplement). In children and adolescents, a constant gradient in the IRRs was observed in the 5 lowest deciles (Figure 3A). In nondwelling children and adolescents, the IRRs compared with the highest-income decile varied from 6.76 (95% CI 5.75-7.94) to 8.83 (95% CI 7.56-10.32) (eFigure 13 in the Supplement). In persons 65 years and older, no clear gradient was observed, but the IRRs were highest in the lowest income decile, varying from 1.93 (95% CI, 1.55-2.41) to 3.56 (95% CI, 2.83-4.47) (Figure 3C). Corresponding analyses were reproduced with income decile statuses 1, 3, and 5 years before the first admissions. The observed income gradients decreased but did not disappear. In adults, the highest IRRs in the lowest income decile were 3.68 (95% CI, 3.45-3.92) 1 year before first admissions, 2.97 (95% CI, 2.79-3.15) 3 years before first admissions, and 2.71 (95% CI, 2.56-2.87) 5 years before first admissions (eFigures 14-16 in the Supplement).

Discussion

In this comprehensive, nationwide cohort study of register data, we found a clear negative income gradient in the incidence rates of first hospital admissions for mental disorders in the adult population, even after adjusting for potential confounders, including the level of education, urbanicity, living alone, and decrease in income within the previous 3 years. Low household income was associated with higher incidence during the whole study period among different age groups and be-

tween men and women, although in those 20 years or younger and 65 years or older, differences between the highest deciles diminished. Trends in incidence varied between income groups. The trends decreased throughout the whole study period only in the high-income groups. To our knowledge, this is the first national-level study showing that a robust income gradient is also present in the incidence rates of first hospitalizations due to mental disorders.

The income gradient in the adult population was evident at all levels of household income in overall and *ICD-10* diagnostic main category-specific incidence rates. This finding is in line with the psychosocial theory of health inequalities, which states that adversity and stress associated with lower income increase the risk of a variety of illnesses,[46,47] although the mechanisms linking income and mental health vary between disorders.[22] Mental disorders have been associated with low future income,[48] but changes in income after the first admissions were not evaluated in the present study. The disorder resulting in the first hospital treatment may also have influenced the person's ability to earn or maintain their level of income already before the first admission.[49] However, the income gradient was smaller, although still clearly observed, when income 1, 3, or 5 years before the first admissions was used for grouping the income deciles.

Opposite trends in the beginning of the study period suggested an increase in disparity between the highest and lowest income groups, which is another main finding of this study. Individuals with higher income might be in more stable and secure positions that make them more willing to undergo or more capable of receiving more intense outpatient care and avoiding first hospitalizations. This possibility is in convergence with the diffusion of innovations and cultural capital explanations of health inequalities, which state that adoption of new behaviors and the earlier uptake of new interventions, in this case outpatient care, occur earlier in higher socioeconomic positions.[50] This also supports the view that some of the mechanisms linking income and health may be located within the health care system itself.[25]

The current approach facilitates comparisons in equality of the trends between income groups but offers limited means to interpret the population's mental health in general. However, the overall rate of first admissions decreased during the study period in men and first increased and then decreased after 2008 in women. This finding is convergent with the decreasing total number of individuals in hospital care in Finland during the same time.[32] Some evidence suggests that the true rate of mental health problems has increased in adolescents,[51,52] and increasing disparity in mental health has previously been observed in the United States, United Kingdom, and Finland.[53-55] The present results showed the increasing disparity between income groups also in first hospital-treated mental disorders; this seems to be the case especially in girls and women aged 15 to 19 years.

We focused on all first inpatient treatments rather than on diagnosis-specific rates so that possible sex-, income-, or race/ethnicity-related differences or variation in the temporal stability of the recorded diagnoses did not confound the analysis of the income gradient.[56-59] Diagnosis-specific analysis, on the other hand, offers insight into temporal variations in the overall trends. In addition to changes in population mental health, these variations may reflect changes in the health care system and diagnostic practices. For example, during the deinstitutionalization process, inpatient treatment shifted to other facilities in Finland, which may at least partly explain the reduction in the rate of substance use–related first admission in men.[60] In women, an increase in depression severity is a possible explanation for the increased rate of first hospitalizations.[55] Decreasing trends in first admission rates of individual disorders, such as schizophrenia, have been associated with increased outpatient care and variations in diagnostic practices.[61-63]

Diagnosis-specific income gradient was steepest in schizophrenia and related psychotic disorders. Interestingly, social selection may be a more important mechanism in this diagnostic group.[23] Differences in gradients between disorders need to be interpreted with caution, however, because help-seeking patterns and the proportion of outpatient care may have varied among income groups, disorders, and time. In substance use disorders, social consequences, rather than severity of dependence, may be associated with treatment entry and may partly explain the gradient.[64] Mood disorders presented as the most common diagnostic group, with relatively smaller IRRs between the highest and lowest income deciles. This finding may reflect the relatively endogenous and evenly devastating nature of depression severe enough to require hospital treatment.

In terms of increased life expectancy, the deinstitutionalization of mental health care in Finland was successful for people with previous hospitalizations from 1981 to 2003, except for those with alcohol and substance abuse.[65] Major legislative changes in 1991 transferred the responsibility to provide mental health services to the municipalities. This change coincided with an economic recession period that lasted until 1993 and led to significant regional differences in the capacity of psychiatric outpatient care. The general increase in the first-time hospitalizations in that era may reflect occasional failures in outpatient management. Nearer the global economic crisis in 2008, service organizing was partly recentralized as larger hospital districts started to take over the managing of psychiatric services. These systemic changes may moderate the general trends in hospitalizations but do not explain the income-related trends. The finding that individuals with low income are overrepresented in first hospitalizations, regardless of their diagnoses or the dominant service provider institutions at the time, should be taken into account even in countries with relatively low income inequality and universal welfare policies, such as Finland.[66]

Individual household members of different ages contribute differently to their household income. Children and adolescents in Finland have few possibilities of contributing to their families' income, but family income is associated with many aspects of health.[67-69] Nondwelling children and adolescents had high incidences of hospitalizations throughout the study period, and being institutionalized under foster care is probably the most common reason for nondwelling. By Nordic standards, foster care is relatively common in Finland,[70] and chil-

dren and adolescents in foster care have a substantial frequency of psychiatric hospitalizations and mental health problems.[71]

In persons 65 years and older, differences diminished between the highest income deciles, but those in the lowest income decile had the highest IRRs compared with the highest income decile. This finding is in line with some previous research,[72] but in these age groups, persons' economic circumstances are also affected by pension systems, household composition, and wealth and savings. Comorbid medical conditions are associated with mental disorders and low income and hence may partly explain the observed association. Whether the reasons for having low or reduced income are associated with the income gradient in mental health is an interesting question for further study.

Limitations

This study had some important limitations. First, no comprehensive data on outpatient treatments before the first inpatient treatments or population mental health in general were available for the study period. Change in income 3 years before the first admission was controlled instead. Second, not all monetary income and no wealth are captured with the national statistics of equivalized disposable income. Third, owing to the period covered by the registers, we used a 20-year clearance period to define a first hospital admission, which is a relatively short period of time in the group 65 years and older. Finally, the nature of causality and causal inference in epidemiology and health inequality are matters of debate. On its own, the present observational, register-based cohort study can describe the income gradient existing in the incidence of first psychiatric inpatient treatments.

Conclusions

This study observed a robust but temporally varying negative income gradient in first hospital-treated mental disorders. It appears that reduction in the use of inpatient care has not taken place equally between persons at different income levels. Many individuals admitted to psychiatric inpatient care for the first time are from low-income households. Hence, meeting the needs of these individuals in vulnerable positions in society appears to be an ongoing challenge for mental health services.

ARTICLE INFORMATION

Accepted for Publication: September 26, 2019.

Published Online: December 18, 2019. doi:10.1001/jamapsychiatry.2019.3647

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Obtained funding: Suokas.
Administrative, technical, or material support: Hakulinen, Lumme, Kampman, Pirkola.
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Conflict of Interest Disclosures: Dr Suokas reported receiving grants from the Jalmari and Rauha Ahokas Foundation and Finnish Psychiatric Association during the conduct of the study and personal fees from H Lundbeck AS outside the submitted work. Dr Kampman reported receiving personal fees from H Lundbeck AS/Otsuka Pharmaceutical Co, Ltd, and The Finnish Patient Insurance Centre outside the submitted work. Dr Pirkola reported receiving personal fees from H Lundbeck AS/Otsuka Pharmaceutical Co, Ltd. No other disclosures were reported.

Funding/Support: This study was supported by the Jalmari and Rauha Ahokas Foundation (Dr Suokas), the Finnish Psychiatric Association (Dr Suokas), grant 310591 from the Academy of Finland (Dr Hakulinen), the Palkansaajasäätiö Foundation (Dr Hakulinen), and the Tampere University Hospital Education Foundation (Drs Kaltiala and Pirkola).

Role of the Funder/Sponsor: The sponsors had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

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PUBLICATION II

Geographical variation in treated psychotic and other mental disorders in Finland by region and urbanicity

Suokas, K., Kurkela, O., Nevalainen, J., Suvisaari, J., Hakulinen, C., Kampman, O.,

Pirkola, S

Soc Psychiatry Psychiatr Epidemiol (2023)

https://doi.org/10.1007/s00127-023-02516-x

Social Psychiatry and Psychiatric Epidemiology
https://doi.org/10.1007/s00127-023-02516-x

RESEARCH

Geographical variation in treated psychotic and other mental disorders in Finland by region and urbanicity

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Received: 13 April 2023 / Accepted: 6 June 2023

Abstract

Purpose In Finland, prevalence of schizophrenia is higher in the eastern and northern regions and co-occurs with the distribution of schizophrenia polygenic risk scores. Both genetic and environmental factors have been hypothesized to contribute to this variation. We aimed to examine the prevalence of psychotic and other mental disorders by region and degree of urbanicity, and the impacts of socio-economic adjustments on these associations.

Methods Nationwide population registers from 2011 to 2017 and healthcare registers from 1975 to 2017. We used 19 administrative and three aggregate regions based on the distribution of schizophrenia polygenic risk scores, and a seven-level urban–rural classification. Prevalence ratios (PRs) were calculated by Poisson regression models and adjusted for gender, age, and calendar year (basic adjustments), and Finnish origin, residential history, urbanicity, household income, economic activity, and physical comorbidity (additional adjustments) on an individual level. Average marginal effects were used to visualize interaction effects between region and urbanicity.

Results A total of 5,898,180 individuals were observed. All mental disorders were slightly more prevalent (PR 1.03 [95% CI, 1.02–1.03]), and psychotic disorders (1.11 [1.10–1.12]) and schizophrenia (1.19 [1.17–1.21]) considerably more prevalent in eastern and northern than in western coastal regions. After the additional adjustments, however, the PRs were 0.95 (0.95–0.96), 1.00 (0.99–1.01), and 1.03 (1.02–1.04), respectively. Urban residence was associated with increased prevalence of psychotic disorders across all regions (adjusted PR 1.21 [1.20–1.22]).

Conclusion After adjusting for socioeconomic and sociodemographic factors, the within-country distribution of mental disorders no longer followed the traditional east–west gradient. Urban–rural differences, on the other hand, persisted after the adjustments.

Keywords Mental disorders · Schizophrenia · Prevalence · Geographical · Urbanicity · Social determinants

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Published online: 13 June 2023

Introduction

The prevalence of psychotic and other mental disorders varies globally and locally [1–4], with urban–rural differences being a particularly important factor in Northern Europe [5–9]. The underlying mechanisms for these variations are not well understood and are thought to be influenced by a combination of neighbourhood and individual-level social-environmental factors, including pollution, lack of green space, social stress or selective migration, among other things [5]. Some combined analyses have shown gene-environment synergism in the risk profiles [10–14].

In Finland, there is a well-documented pattern of higher prevalence of schizophrenia and other psychotic disorders in the east and of mood and anxiety disorders in the south [15–20]. In schizophrenia, regional differences have been more significant than urban–rural variations, and this geographical east–west pattern in schizophrenia prevalence coincides with schizophrenia polygenic risk scores, leading to the hypothesis that population genetics may play a role (Supplementary Fig. S1a) [16, 17, 21, 22]. However, social determinants of mental health, such as the proportion of low-income earners (Supplementary Fig. S1b), level of education, unemployment, migration, or household structure also vary across the country with less favourable compositions often seen in the eastern parts of the country. Urban areas, on the other hand, are more common in southern and western regions (Supplementary Fig. S1c). It is not known to what extent regional and urban–rural variations interact, and to what extent the geographical variations are confounded by socioeconomic factors.

We aimed to evaluate regional and urban–rural variation in psychotic and all mental disorders, their interaction, and the impact of socioeconomic adjustments on these geographical differences. To facilitate comparisons of geographical differences in prevalence of schizophrenia with different adjustments and schizophrenia polygenic risk scores that have previously been reported, we grouped the administrative regions of Finland into three aggregate regions and aimed to present detailed maps of the geographical prevalence distributions (Fig. 1). We hypothesized that much of the variability in prevalence of mental disorders would be explained by demographic and socioeconomic factors.

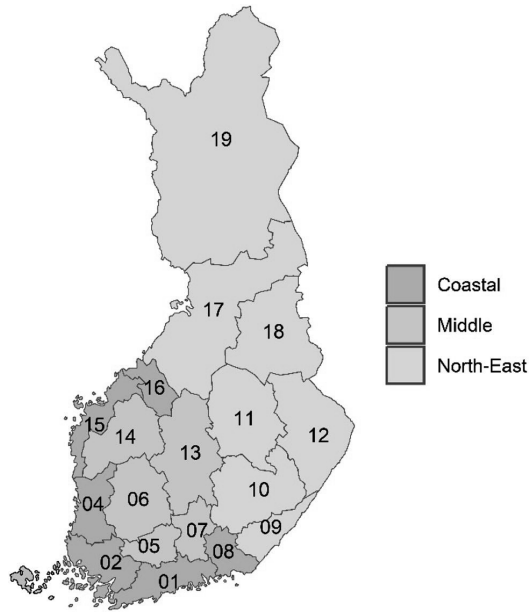


Fig. 1 Administrative regions in Finland and aggregate regions based on the polygenic risk-score distribution in this study. Regions: 01 Uusimaa, 02 Varsinais-Suomi, 04 Satakunta, 05 Kanta-Häme, 06 Pirkanmaa, 07 Päijät-Häme, 08 Kymenlaakso, 09 South Karelia, 10 Etelä-Savo, 11 Pohjois-Savo, 12 North Karelia, 13 Central Finland, 14 South Ostrobothnia, 15 Ostrobothnia, 16 Central Ostrobothnia, 17 North Ostrobothnia, 18 Kainuu, 19 Lapland

Methods

We conducted a population-based register study including all individuals living in Finland from 2011 to 2017. Using individual-level population and health care registers, we calculated the prevalence of people with a history of mental health-related contact with primary care or psychiatric secondary inpatient or outpatient care on the last day of each of the study years. In addition, all individuals living in Finland between 1996 and 2017 were followed up in the registers to identify the incidence of the first psychiatric inpatient admissions. These time limits were based on the coverage of the national health care registers.

The Research Ethics Committee of the Finnish Institute for Health and Welfare approved the study protocol (decision #10/2016§751). Data were linked with permission from Statistics Finland (TK-53–1696-16) and the Finnish Institute of Health and Welfare. Informed consent is not required for register-based studies in Finland.

Assessment of mental disorders

Information on mental healthcare was obtained from the Finnish Care Register for Health Care. Psychiatric inpatient care can be reliably recognized since 1975, secondary outpatient care has been included since 2006 and primary care

has been included since 2011 (for details, see Supplementary Methods).

The International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) has been used in Finland since 1996. We described specific disorders with the ten-level ICD-10 sub-chapter categories and in the following categories: all psychotic disorders (ICD-10: F20-29, F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, F32.3, F33.3, F1x.5, F1x.7), mania and bipolar disorders with psychotic symptoms (F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6), psychotic depression (F32.3, F33.3), and substance-induced psychotic disorders (F1x.5, F1x.7). The diagnoses of schizophrenia and other primary psychotic disorders were classified in a particular order, with schizophrenia being the first (F20), followed by schizoaffective disorder (F25), delusional disorders (F22 and F24), brief psychotic disorders (F23), schizotypal disorder (F21), other nonorganic psychotic disorders (F28), and unspecified nonorganic psychosis (F29). If a person had more than one diagnosis from the schizophrenia spectrum, they were classified under the first group of disorders in the order presented above.

In primary care, the ICPC-2 International Classification of Primary Care, instead of ICD-10, is used in some facilities, and ICPC-2 mental health-related diagnoses were converted to corresponding ICD-10 sub-chapter categories when possible (for details, see Supplementary Methods).

Discharge diagnoses and diagnoses from outpatient visits were also collected. A description of the method used for handling partly overlapping register data entries is publicly available [23].

Regions and urban–rural classification

Finland consists of 19 administrative regions, each with a central town, possible other towns and surrounding areas with varying degrees of urbanicity. Based on the distribution of the schizophrenia polygenic risk score [21, 22], we grouped the administrative regions into three aggregate regions: coastal, inland, and eastern and northern (Fig. 1). The region of residence on the last day of each study year was used for the main analysis. We used the seven-level urban–rural classification for the year 2010 issued by the Finnish Environment Institute based on a nationwide grid of 250×250 m cells, to measure urbanicity for each individual's place of residence [24]. In order to show geographical variation by region and urbanicity, we created maps with region-urbanicity subregions (Supplementary Fig. S1c).

Cofactors

We collected the following categorical individual-level demographic and socioeconomic data on the last day of each study year from the population registers: age (five-year intervals), gender (man or woman), origin (Finnish background or not, determined based on the country of birth data of the person's parents [25]), currently inhabiting the region of birth (yes or no), economic activity (employed; unemployed; students; pensioners and others outside the labour force), and equivalized household net income deciles. Net income was obtained after subtracting taxes and was adjusted for the size of the household dwelling unit using the Organisation for Economic Cooperation and Development–modified equivalence scale.

Physical comorbidity was assessed using the Charlson comorbidity index (CCI), a widely used comorbidity index with a weighted score of 17 comorbid conditions [26]. For each study year and for every individual in the study, the CCI score was calculated using available ICD-10 diagnoses of any actual treatment contact in healthcare registers from the beginning of the previous calendar year. Age was not included in the CCI scores but was adjusted in the main model. CCI scores were categorized by previously used cut-points: none, 1–3, and ≥ 4 [27].

Statistical analysis

The prevalence of a history of mental disorders was calculated for the last day of each calendar year of the study by summing the number of people with a history of mental health treatments in each region divided by the number of inhabitants in the region. Data were aggregated by strata defined by all possible combinations of cofactors. Prevalence ratios were examined using a Poisson regression model with a robust sandwich variance estimator. The strata in the aggregated data were taken as the unit of analysis and the log of population size of the strata was used as an offset term.

Regional prevalence ratios were adjusted for gender, age, and calendar year (basic adjustment). Additional adjustments for origin, residential history, urbanicity, household income, economic activity, and CCI were also made. Bayesian information criteria were used for the model selection.

For a fine-scale view of the variability of prevalence by region and urbanicity, the average marginal effects for each region-urbanicity subregion were predicted using a Poisson regression model that included a region-urbanicity interaction term. The predicted prevalence in each region-urbanicity subregion was calculated while holding the other predictors constant as observed [28].

The sensitivity to definitions of the outcome and explanatory variables was investigated by alternative definitions and comparison of results across the following additional analyses: The prevalence of all treated mental disorders and inpatient treatments only were compared; the incidence and prevalence of regional inpatient treatments were compared; and the current living region and the region of birth were

compared. For data management and analyses, we used R, version 3.6.3 (R Project for Statistical Computing), and Stata, version 17.1 (StataCorp LLC).

Results

During the years 2011 to 2017, a total of 5,898,180 individuals contributed to the study population. Altogether, 1,197,690 individuals of the total of 5,512,745 at the end of 2017 had a history of some medical contact in primary or secondary care mental health services. This resulted in a crude prevalence rate of 21.73% (24.07% in women and 19.32% in men). Prevalences stratified by the covariates are reported in the Supplementary Table.

Regional variation in prevalence of mental disorders

The crude prevalence of all psychotic disorders, schizophrenia, and most of the other psychotic disorders was higher in the eastern and northern than in the coastal regions (Table 1). However, unspecified psychosis, bipolar disorder and substance-induced psychotic disorders, as well as mood disorders and neurotic disorders, were more common in the coastal region, resulting in only a minimal difference in the prevalence of all mental disorders (Table 1).

After basic adjustments, prevalence ratios (PRs) of 1.11 (95% CI 1.10–1.12) for all psychotic disorders, 1.20 (1.19–1.21) for schizophrenia spectrum, 0.85 (0.84–0.86) for bipolar disorder, and 1.03 (1.02–1.03) for all mental disorders in the eastern and northern compared to the coastal regions were observed (Fig. 2a).

Coastal, Inland, and East-north regions are described in Fig. 1. In the basic adjustment, prevalence ratios are adjusted for age, gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, gender, calendar time, urbanicity, origin, residence history, household income, economic activity, and Charlson comorbidity index. Error bars indicate 95% Cis. Subgroups of all included psychotic disorders are highlighted in bold. Bipolar disorder

Table 1 Prevalence of mental disorders by place of residence in 2017: number of cases, prevalence rates, and crude prevalence ratios (PR)[a]

	Number of diagnosed individuals (prevalence %)				PR (95% CI)
	Whole country 5 512 745 (100%)[b]	Coastal 2 808 181 (50.9%)[b]	Inland 1 352 887 (24.5%)[b]	Eastern and northern 1 351 677 (24.5%)[b]	Eastern and northern vs. coastal
Any mental disorder (F00-99)	1 197 690 (21.73)	599 739 (21.36)	302 794 (22.38)	295 157 (21.84)	1.02 (1.01–1.02)
All psychotic disorders[c]	112 318 (2.04)	55 722 (1.98)	26 456 (1.96)	30 140 (2.23)	1.10 (1.09–1.12)
Schizophrenia spectrum (F20-29)[d]	93 182 (1.69)	44 537 (1.59)	22 448 (1.66)	26 197 (1.94)	1.21 (1.20–1.22)
Schizophrenia (F20)	34 269 (0.62)	16 567 (0.59)	7 821 (0.58)	9 881 (0.73)	1.19 (1.17–1.21)
Schizoaffective disorders (F25)	6 720 (0.12)	3 141 (0.11)	1 645 (0.12)	1 934 (0.14)	1.26 (1.23–1.29)
Delusional disorders (F22, F24)	11 092 (0.20)	5 156 (0.18)	2 972 (0.22)	2 964 (0.22)	1.15 (1.13–1.17)
Brief psychotic disorders (F23)	8 830 (0.16)	4 459 (0.16)	2 303 (0.17)	2 068 (0.15)	1.00 (0.98–1.02)
Schizotypal disorder (F21)	2 458 (0.04)	1 070 (0.04)	583 (0.04)	805 (0.06)	1.59 (1.53–1.65)
Other (F28)	1 009 (0.02)	441 (0.02)	269 (0.02)	299 (0.02)	1.33 (1.25–1.41)
Unspecified (F29)	17 238 (0.31)	8 953 (0.32)	4 062 (0.30)	4 223 (0.31)	0.97 (0.95–0.99)
Bipolar disorder[e]	44 890 (0.81)	24 438 (0.87)	10 512 (0.78)	9 940 (0.74)	0.82 (0.81–0.83)
Psychotic depression[f]	22 167 (0.40)	10 929 (0.39)	4 869 (0.36)	6 369 (0.47)	1.19 (1.17–1.21)
Substance-induced psychotic disorders[g]	9 672 (0.18)	5 295 (0.19)	2 101 (0.16)	2 276 (0.17)	0.88 (0.86–0.90)
Substance use disorders (F10-19)	161 307 (2.93)	81 372 (2.90)	38 485 (2.84)	41 450 (3.07)	1.04 (1.03–1.05)
Mood disorders (F30-39)	416 542 (7.56)	214 956 (7.65)	105 926 (7.83)	95 660 (7.08)	0.92 (0.91–0.92)
Neurotic disorders (F40-48)	460 247 (8.35)	239 839 (8.54)	115 580 (8.54)	104 828 (7.76)	0.87 (0.87–0.88)

[a]Prevalence of a history of treated disorders on 31 Dec 2017. The aggregate regions are described in Fig. 1

[b]Total population in the region (percentage of whole country population)

[c]All psychotic disorders included the following disorders: schizophrenia spectrum disorders (F20-29), mania and bipolar disorder with psychotic symptoms (F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6), psychotic depression (F32.3, F33.3), and substance-induced psychotic disorders (F1x.5 through F1x.7)

[d]Schizophrenia spectrum diagnoses were categorized in the order presented in the table

[e]Bipolar disorder included mania and bipolar disorder with psychotic symptoms (F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6)

[f]Psychotic depression included diagnoses F32.3 and F33.3

[g]Substance-induced psychotic disorders included three categories of substance-induced psychotic disorders (F1x.5 through F1x.7)

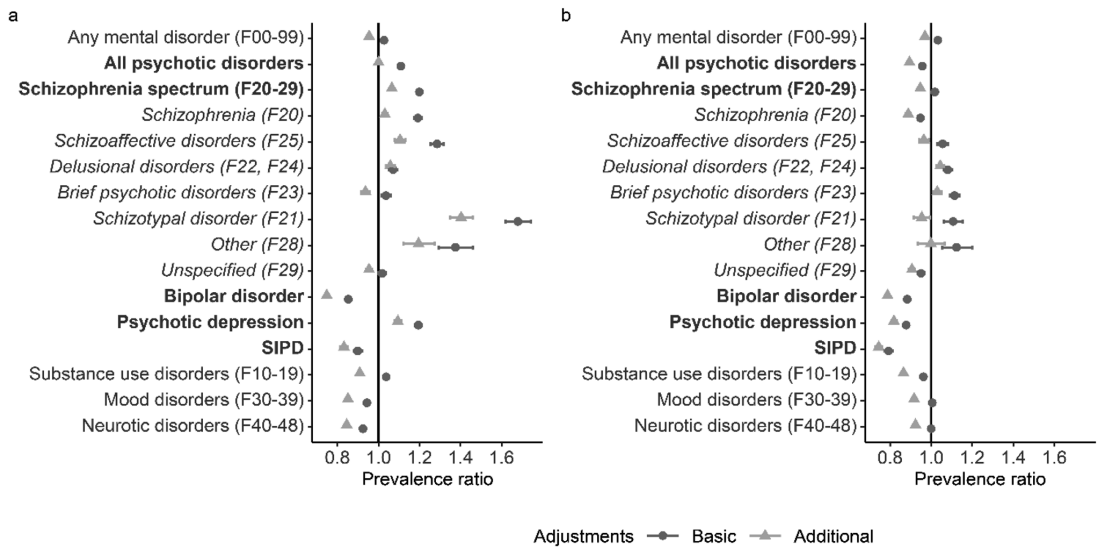


Fig. 2 Prevalence ratios of mental disorders by place of residence. Higher prevalence ratios indicate higher risk in **a** eastern and northern and **b** inland regions compared to coastal regions

included ICD-10 codes F30.1, F30.2, F30.8, F30.9, F31.1, F31.2, F31.5, F31.6, psychotic depression codes F32.3 and F33.3, and substance-induced psychotic disorders (SIPD) codes F1x.5 to F1x.7. Schizophrenia spectrum diagnoses (in italic) were categorized in the order presented in the figure.

When additional adjustments for socioeconomic factors and comorbidities were included in the models, the eastern and northern prominence in psychotic disorders disappeared, with a PR of 1.00 (0.99–1.01). PRs of 1.06 (1.06–1.07) for schizophrenia spectrum, 1.03 (1.02–1.04) for schizophrenia, and 0.75 (0.74–0.76) for bipolar disorder were observed (Fig. 2a). The PR for all mental disorders was 0.95 (0.95–0.96) (Fig. 2a). Adding income to the models caused a major change in the PR estimates, and the effect of each of the additional covariates is shown in the online Supplementary Fig. S2. There were some variations between neighbouring regions within the aggregate regions and between diagnoses (Supplementary Fig. S3).

Urban–rural variation in prevalence of mental disorder

Residence in inner urban areas or in the local centres in rural areas was clearly associated with increased prevalence of all mental disorders and major psychotic disorders in both levels of adjustment (Fig. 3). The additional adjustments changed the prevalence ratios in some levels of urbanicity, although the link between urbanicity and psychotic disorders remained clear. In inner urban areas, PRs of 1.10 (1.10–1.10) for all mental disorders and 1.21 (95% CI, 1.20–1.22) for psychoses, compared to the whole national mean with additional adjustments, were observed.

Prevalence of mental disorders by region and urbanicity

The analysis of prevalence of mental disorders by region of residence and urbanicity with basic adjustments showed an eastern and northern prominence in the prevalence of all mental disorders and psychotic disorders in all levels of urbanicity. After the additional adjustments, prominence of the inner urban area in the coastal regions became evident across any mental disorders, all psychotic disorders, and schizophrenia. Furthermore, after the additional adjustments, bipolar disorder come up in the coastal regions in all levels of urbanicity (Supplementary Fig. S4). The average marginal effects of prevalence for each region-urbanicity subregion are visualized in the maps (Figs. 4 and 5).

Additional analyses

The following additional analyses were conducted: First, if inpatient care was analyzed alone, clear eastern and northern prominence would have been observed (Supplementary Fig. S5). Second, irrespective of whether region of birth or region of residence was utilized as the explanatory variable, the prevalence ratios with basic adjustments revealed the prominence of eastern and northern regions in any mental

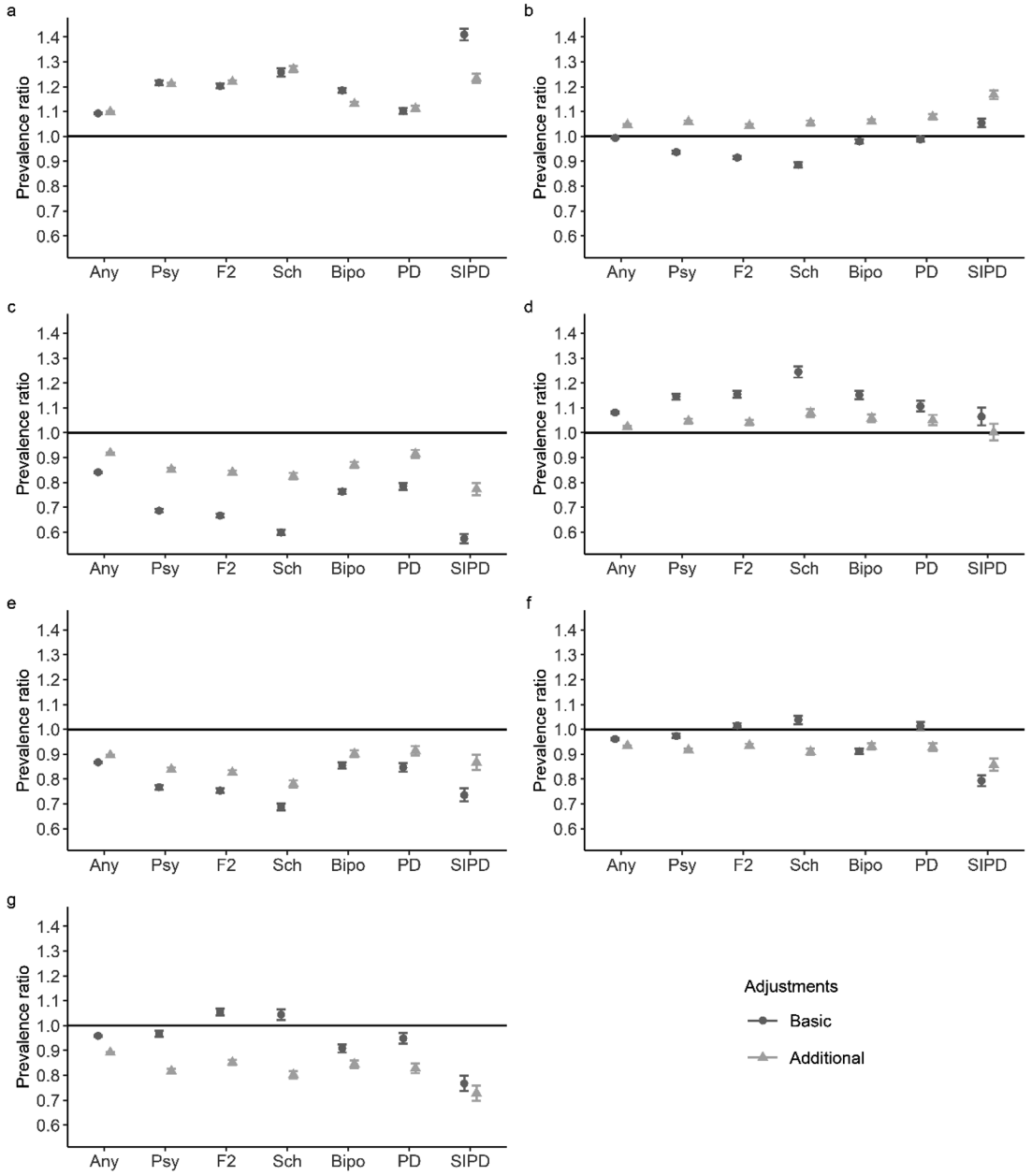


Fig. 3 Prevalence ratios of selected mental disorders by urbanicity of the place of residence, compared to the national mean. **a** Inner urban area (32.5%) **b** Outer urban area (26.4%) **c** Peri-urban area (11.0%) **d** Local centres in rural areas (5.8%) **e** € Rural areas close to urban (7.1%) **f** Rural heartland areas (10.8%) **g** Sparsely populated rural areas (5.1%). The proportion of population living in each level of urbanicity is given in parentheses. Any refers to any mental disorder, Psy to all psychotic disorders, F2 to schizophrenia spectrum, Sch to schizophrenia, Bipo to bipolar disorder, PD to psychotic depression, and SIPD refers to substance-induced psychotic disorders. In the basic adjustment, prevalence ratios are adjusted for age, gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, gender, calendar time, region, origin, residence history, household income, economic activity, and Charlson comorbidity index. Error bars indicate 95% CIs

disorders, all psychotic disorders, and schizophrenia (Supplementary Fig. S6). Third, using data on incidence of the first inpatient episodes instead of prevalence would cause changes in the proportions of different diagnostic categories. In inpatient treated cases of all mental disorders and all psychotic disorders, the eastern and northern prominence persisted. In the case of the schizophrenia spectrum, however, the observed difference in geographical prominence disappeared. (Supplementary Fig. S7). Fourth, the eastern and northern prominence in any mental disorder and all psychotic disorders disappeared after the additional adjustments in both men and women (Supplementary Fig. S8).

Discussion

In this nationwide register-based study of over 5 million Finnish persons, we found that the prevalence of all mental disorders and psychotic disorders treated in both primary or secondary care was higher in the eastern and northern regions compared to coastal regions. After adjusting for socioeconomic factors, however, this geographical difference was no longer evident. By contrast, the urban–rural differences, as measured using a detailed seven-level classification of current residency, persisted after the adjustments and were consistent with previous findings from other Nordic countries. Urban effect was evident across the country and diagnostic categories, although regional differences in some diagnostic subgroups, such as schizophrenia and bipolar disorders, were observed. Taken together, our results demonstrate the significant impact of social determinants on the mental health of the population and have important national implications.

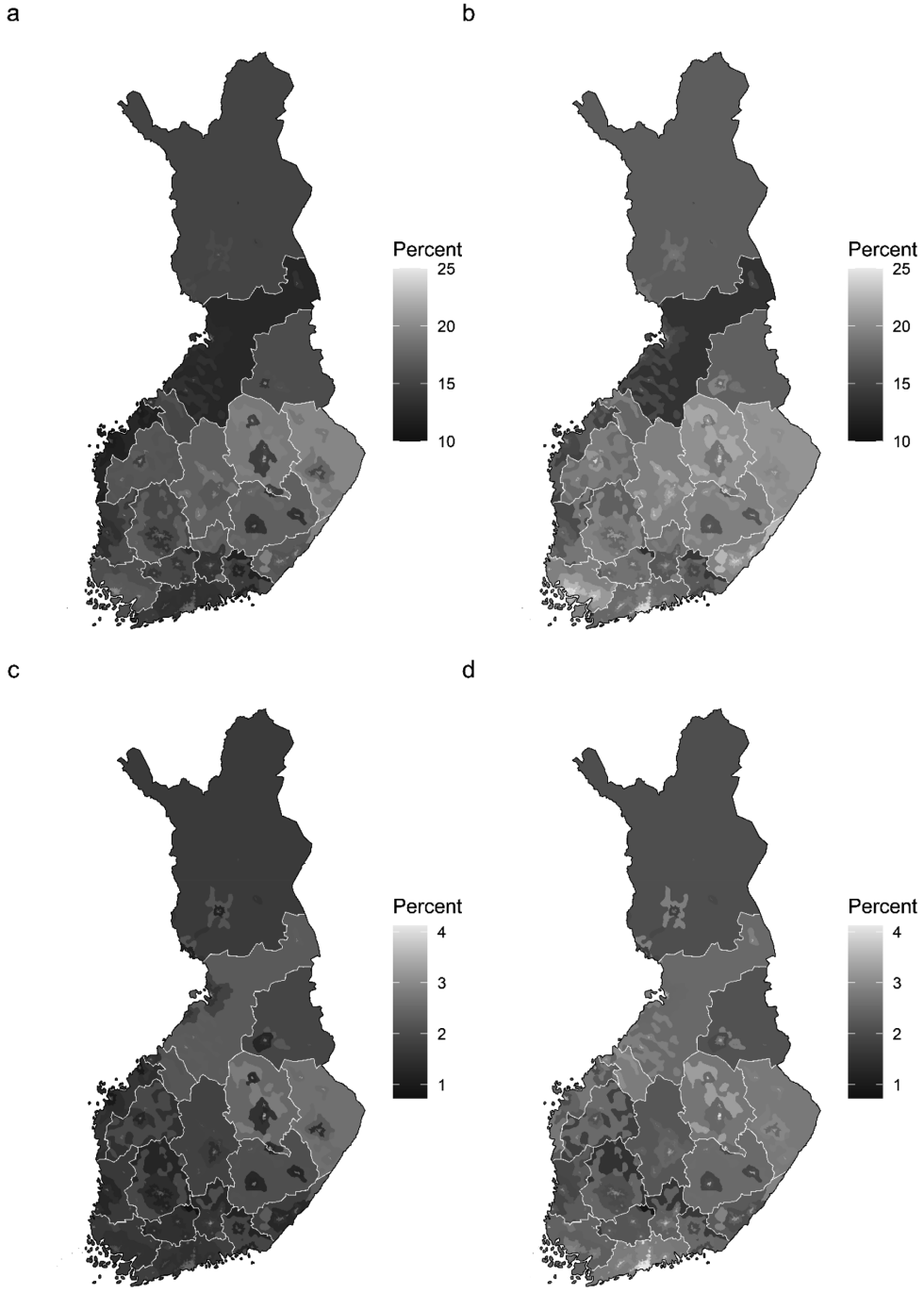
To the best of our knowledge, this is the first comprehensive study demonstrating the associations between the within-country distribution of socioeconomic and demographic factors and the prevalence of mental disorders treated with either primary or secondary care. Epidemiological studies in Finland have investigated regional and urban–rural variations in mental disorders since the 1930s but have usually included only inpatient register data [15–20, 29]. Including outpatient and primary care data can be seen as a main strength of the current study, as including this data substantially changed the prevalence ratios in eastern and norther parts of the country, and there are some variations in the overall inpatient care across the regions [30]. The east–west differences have been consistently observed, but one recent study found significant regional variation in mental disorder disability pensions that did not follow the traditional east–west health differences [31]. Thus, within-country geographical differences in mental health are sensitive to a variety of social determinants and draw a more complex picture than reported in previous studies.

Previous findings on the association between urbanicity and mental disorders in Finland have been mixed, with the earliest studies showing an association between living in cities and schizophrenia [29], but more recent studies suggestive of urban effects but yielding inconsistent results [15–17]. Current results align with previous studies in Northern Europe, demonstrating an association between variety of psychotic disorders and urbanicity [5, 7, 32]. Finland no longer appears to be an exception in this respect. Structural changes in demography, employment and services have affected particularly eastern rural parts of the country in recent decades and probably affect the temporal differences in the link between urbanicity and psychotic disorders in Finland [17, 33].

Household income was a particularly strong cofactor in the models. This is not surprising, as income inequality and individual level low income and mental disorders have been strongly linked with complex bi-directional pathways [34–38]. In the current study, we did not explore the causal pathways behind the mental disorders and income distribution. Nevertheless, income was a relevant cofactor, as it is unlikely that the within-country distribution of income was determined by the regional prevalence of mental disorders.

Contrary to regional differences, urban–rural variation did not disappear after socioeconomic adjustments. Urban environments in a sparsely populated country such as Finland may vary greatly within the country in terms of potential urban risk attributes such as nature spaces, migration, social stress, or demographical and socioeconomic composition. Our analysis of the urbanicity-region interaction with socioeconomic adjustments showed that urbanicity is a relevant factor for mental health in all regions of the country, regardless of the size of the regional urban centre, from Kajaani with a population of 36,000 to Helsinki with a population of 665,000. We evaluated regional differences and urbanicity based on current residency, while controlling for living in the birth region. This approach enabled accounting for within-country migration. However, we did not have data on individual histories of urban residency or changes in geographical distribution of urbanicity. Selective migration can affect regional composition and socioeconomic contexts, and also affects the associations between urbanicity and psychotic disorders [5, 10, 39, 40]. In Finland, however, it has been suggested that individuals with mental disorders are not particularly likely to move to the most urban centers [41], and accessibility of Finnish primary health care is mostly at good level, although in a recent study, travel time in rural areas negatively associated with primary care mental health service use [42, 43].

The relatively high prevalence of bipolar disorder with psychotic features in southern urban areas and the comparatively high prevalence of schizophrenia spectrum diagnoses in eastern and northern areas emphasize the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◂**Fig. 4** Average marginal effects of region of residence and urbanicity on the prevalence of any mental disorder and all psychotic disorders. **a** any mental disorder, basic adjustments, **b** any mental disorder, additional adjustments, **c** all psychotic disorders, basic adjustments, and **d** all psychotic disorders, additional adjustments. Predicted prevalence in each region-urbanicity subregion was calculated while holding the other predictors constant as observed. In the basic adjustment, prevalence ratios were adjusted for age, gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, gender, calendar time, origin, residence history, household income, economic activity, and Charlson comorbidity index

importance of considering different register-based diagnoses side by side. Although the Finnish registers show good consistence [44], a tendency towards a narrow definition of schizophrenia in clinical practice in Finland has been recognized [45]. Whether there are differences in diagnostic practices in primary or secondary care mental health services across the country has not been evaluated recently. In Finland, there is a relatively high number of specialists in psychiatry and general practitioners are trained in psychiatry as well [46]. With the observed differences in certain diagnostic categories in mind, future assessment of the real-world diagnostic consistency and reliability might be useful in terms of both scientific and clinical accuracy.

The study of population genetics in Finland has attracted a great deal of interest, and there is a well-documented north–south and east–west genetic differentiation within the population [22, 47, 48]. Although the use of polygenic risk scores for explaining geographic differences in phenotypes is not currently recommended due to methodological limitations, the striking similarity between schizophrenia prevalence and polygenic scores has been suggested as an example of the potential of polygenic risk scores to explain geographic health differences [21]. Our results showed that after adjusting for socioeconomic factors, the prevalence of all psychotic disorders did not display statistically significant east–west differences, and did not align with the geographical gradient of schizophrenia polygenic scores. A diagnosis of schizophrenia was slightly more prevalent in eastern parts of the country, but did not follow a gradient that was comparable to that of schizophrenia polygenic scores. Mental disorders are highly polygenic and pleiotrophic, and most of their genetic common variant architecture has not been identified [49]. Schizophrenia polygenic risk scores are associated with a variety of traits, adding complexity to the concept [50–54]. In the present study, however, genetics were not evaluated. Thus, accounting for neighbourhood contextual factors and socioeconomic composition and individual level social determinants, together with genetic information, may be beneficial in future studies of geographical differences in mental health in Finland.

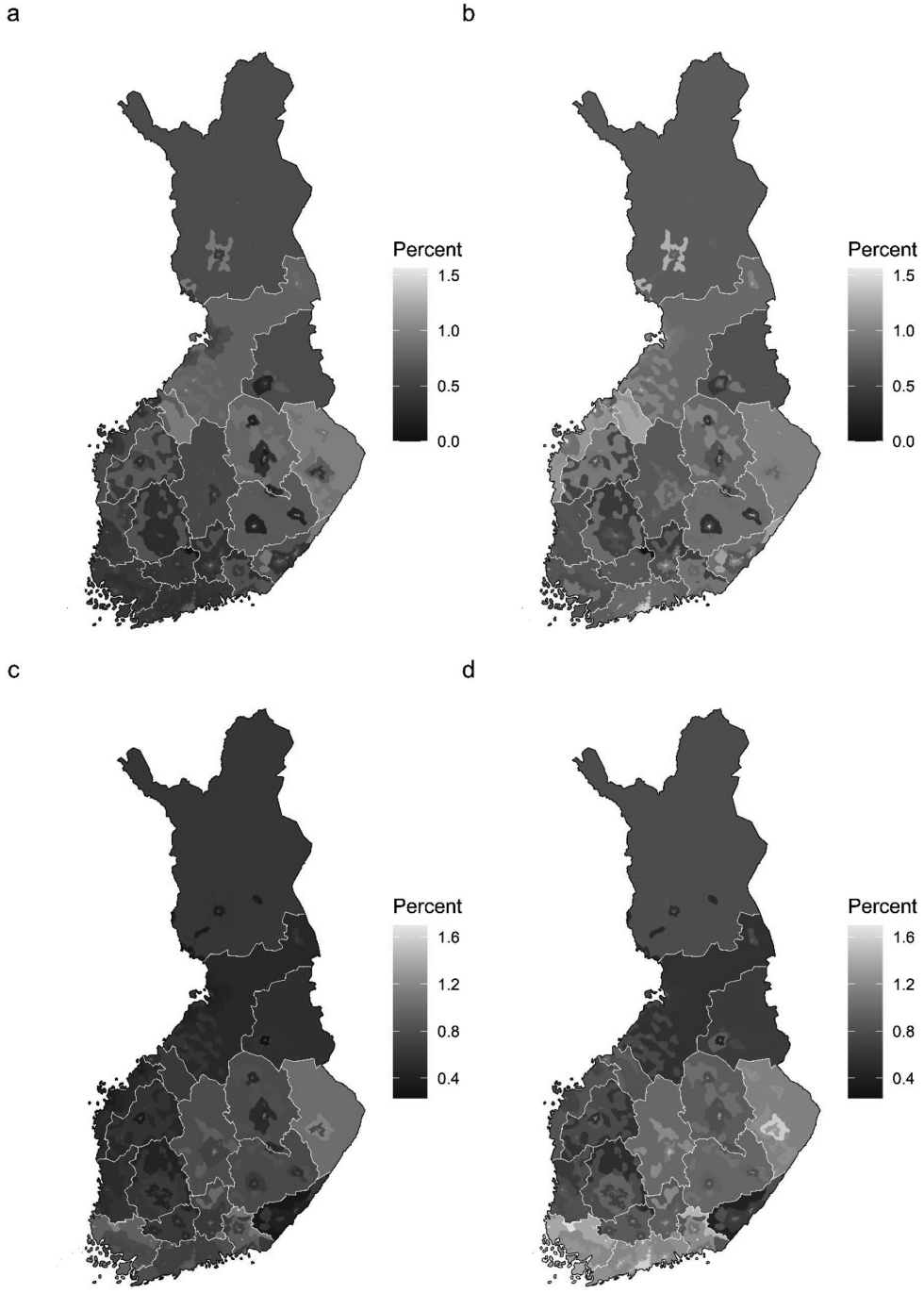
Strengths and limitations

The main strength of our study is the use of interlinked Finnish national registers, which provide comprehensive data on both primary and secondary care treatments for mental disorders across the country. The inclusion of primary care treatment data is important, as primary care mental health treatment is common in Finland, and our previous study showed that including primary care may alter findings [55]. There is no universal definition of urbanicity, and to the best of our knowledge the current seven-level classification with 250 × 250 m pixels has not been used before in this context and is more detailed than previous classifications.

This study has certain limitations. First, primary care data is available only since 2011, and to our knowledge, there are no studies on the accuracy of primary care psychiatric diagnoses in the Finnish registers. Hence, incident cases cannot be recognized. The prevalence of treated mental health treatments was the outcome of interest, and we did not focus on the complex bi-directional causal chains of income and mental health on an individual level, but rather on the overall composition of the population. Second, the current urban–rural classification is available only since 2010, and therefore historical changes in urban effects cannot be evaluated and the individual level residence history by urbanicity cannot by traced. Third, no individual level genetic data was used and thus the comparison between our study and that of Kurki et al. is indirect [22]. Fourth, private and employer-paid mental health outpatient care are significant components of the Finnish health care system, and probably more common in urban settings, but were not covered in the registers for the study period. Finally, the present observational results do not allow a causal interpretation.

Conclusion

Urbanicity and socioeconomic position are important determinants of geographical variations in population mental health. In this study, the previously well documented east–west gradient in psychotic disorders that coincides with the geographical distribution of schizophrenia polygenic risk scores, was no longer observed after detailed adjustments. Our current findings align with previous studies in Northern Europe, demonstrating a solid association between psychotic disorders and urbanicity also in Finland, which has previously been uncertain. At the national level, acknowledging these geographical patterns and their correlations with societal factors may enhance understanding of population health. While the utilization of primary care registers represents a noteworthy strength for Finnish register-based epidemiology, their diagnostic accuracy regarding mental disorders remains to be evaluated.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◂**Fig. 5** Average marginal effects of region of residence and urbanicity on the prevalence of schizophrenia and bipolar disorder. **a** schizophrenia, basic adjustments, **b** schizophrenia, additional adjustments, **c** bipolar disorder, basic adjustments, and **d** bipolar disorder, additional adjustments. Predicted prevalence in each region-urbanicity subregion was calculated while holding the other predictors constant as observed. In the basic adjustment, prevalence ratios were adjusted for age, gender, and calendar time. In the additional adjustment, prevalence ratios were adjusted for age, gender, calendar time, origin, residence history, household income, economic activity, and Charlson comorbidity index

Further study is needed to provide better understanding of the geographical patterns of mental health.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00127-023-02516-x.

Acknowledgements This study was funded by the Jalmari and Rauha Ahokas Foundation, European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 101040247 to CH), and the Finnish Psychiatric Association. The funding sources had no role in study design, data collection, analysis, interpretation, writing, or submission.

Authors contribution All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by KS, OK, and JN. The first draft of the manuscript was written by KS and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding Open access funding provided by Tampere University including Tampere University Hospital, Tampere University of Applied Sciences (TUNI). This study was funded by the Jalmari and Rauha Ahokas Foundation, European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 101040247 to CH), and the Finnish Psychiatric Association. The funding sources had no role in study design, data collection, analysis, interpretation, writing, or submission.

Data and code availability The data that support the findings of this study are available from the National Institute of Health and Welfare (http://www.thl.fi) and Statistics Finland (www.stat.fi). Restrictions apply to the availability of these data, which were used under license for this study. Inquiries about secure access to data should be directed to data permit authority Findata (https://findata.fi/en/). A description of the method used for handling partly overlapping register data entries is publicly available [23].

Declarations

Conflict of interest We declare no competing interests.

Ethical approval The Research Ethics Committee of the Finnish Institute for Health and Welfare approved the study protocol (decision #10/2016§751). Data were linked with permission from Statistics Finland (TK-53–1696-16) and the Finnish Institute of Health and Welfare.

Informed Consent Informed consent is not required for register-based studies in Finland.

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PUBLICATION III

Mortality
in persons with recent primary or secondary care contacts for mental disorders in Finland

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World Psychiatry, 21: 470-471
https://doi.org/10.1002/wps.21027

Mortality in persons with recent primary or secondary care contacts for mental disorders in Finland

Excess mortality among persons with mental disorders has been consistently documented[1,2], but the mortality risk over a full spectrum of mental disorders treated both in primary and secondary care remains to be explored at a nationwide level.

Integration of mental health care in primary care services is considered a priority in low-, middle-, and high-income countries[3], and depression and anxiety are among the top ten most common reasons for visits in primary care[4]. The global shortage of mortality data concerning mental disorders in primary care may lead to an overestimation of the population-wide burden of the full spectrum of treated mental disorders[5,6].

Excess mortality is related to a variety of risk factors at the individual, health system and social levels[7]. Mental disorders are associated with socioeconomic factors and an increased vulnerability to several physical conditions, with complex bi-directional pathways[8]. Physical comorbidities contribute to the majority of life-years lost in people with mental disorders, and low socioeconomic position (SEP) associates with mental disorders and physical conditions, as well as with mortality in the general population[9].

This national register-based open cohort study aimed to: a) assess the excess mortality in persons with mental disorders seen in both primary and secondary care, and compare these estimates with secondary care data only; b) determine the extent to which adjusting for physical comorbidities and individual-level socioeconomic factors affects the estimates.

We used individual-level register data concerning all citizens with Finnish background aged at least 20 years and living in Finland at some point between January 1, 2011 and December 31, 2017. We identified all deaths (using the Finnish Causes of Death Register), the dynamic population at risk of death (through Population Registers), and all mental health contacts (using Care Register for Health Care, in which primary care has been included since 2011) during that period. The ethical review board of the Finnish Institute for Health and Welfare approved the study protocol. Data were linked with the permission of Statistics Finland (TK-53-1696-16) and the Finnish Institute of Health and Welfare. Informed consent is not required for register-based studies in Finland.

A history of mental health related contacts was defined as having any contact with secondary care psychiatric inpatient or outpatient services, or with primary care, with a diagnosis of any mental disorder (i.e., ICD-10 chapter V, or International Classification of Primary Care-2 chapter P) within the previous year.

We collected data on the following individual-level variables: sex, urbanicity of residence area, region of residence, living alone status, level of educational attainment, economic activity, and equivalized household net income deciles. Income measurement with a three-year lag was used to account for potential reverse causation. Physical comorbidity was assessed using the Charlson Comorbidity Index (CCI), categorized by previously used cut-points: none, 1-3, and ≥4.

Three sets of data were collected and analyzed separately, concerning: a) individuals seen in primary and secondary care combined, compared with those without such contacts; b) individuals seen in primary and secondary care separately, compared with those without such contacts; c) individuals seen in secondary care only, compared to all individuals without such contacts (including individuals with possible primary care treatments), which is the traditional approach.

Mortality rate ratios (MRRs) were estimated using a Poisson regression model. Men and women were analyzed separately. To investigate the association between physical comorbidities and mortality, a stratified analysis for the CCI categories was performed. In addition, the ICD-10 diagnostic blocks were analyzed separately. We performed sensitivity analyses using three- and five-year histories of mental health related contacts. R and Stata were used for the analyses.

During the period between 2011 and 2017, we observed 4,417,635 individuals (51.3% women), contributing 28,049,912 person-years. Along that period, 860,287 (19.5%) of all observed individuals had mental health related contacts, more commonly in primary care. Mood disorders was the most commonly used ICD-10 diagnostic block. Altogether, 357,119 persons died (50.3% women), of whom 44,364 (12.4%) had had some contact with psychiatric secondary or primary care within the previous year.

Age and calendar year adjusted MRRs of 2.83 (95% CI: 2.79-2.87) and 1.79 (95% CI: 1.76-1.82) were observed for men and women with a one-year history of primary or secondary care mental health contacts, compared to those without. After SEP adjustments, MRRs of 2.17 (95% CI: 2.13-2.20) and 1.71 (95% CI: 1.68-1.74) were observed. After further adjustments for physical comorbidities, the estimates decreased to 1.63 (95% CI: 1.60-1.65) and 1.20 (95% CI: 1.18-1.22), respectively. These SEP and comorbidity adjusted MRR estimates were 27% and 42% lower, respectively, compared to the MRRs of 2.24 (95% CI: 2.19-2.30) and 2.07 (95% CI: 2.01-2.12) obtained with the traditional approach considering secondary care only.

In diagnosis-specific analysis, the highest SEP and comorbidity adjusted MRRs were observed in disorders related to substance use. Excess mortality varied by age and turned to decrease in both men and women starting from the age of 35 years (see supplementary information).

Individuals with recent primary care mental health contacts had more commonly diagnosed physical comorbidities than individuals treated in psychiatric secondary care (24.5% vs. 18.1% of person-time). The presence of physical comorbidities modified the association between mortality and a one-year history of mental health contact: excess mortality related to mental disorders was the highest in people without comorbidities, and the lowest in people with multiple comorbidities. Sensitivity analysis with three- or five-year histories of treated mental disorders,

instead of one year, showed only a little difference (see supplementary information).

These findings confirm the previously reported evidence of an excess mortality in people with mental disorders, but also suggest that the previously published MRR estimates would have been considerably lower if primary care had been included in those analyses. As mental disorders are commonly treated in primary care, the current results are likely to have generalizability, especially in high-income countries. They provide a more optimistic view of the burden of mental disorders and highlight the diversity of these disorders in the population.

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This study was supported by grants from the Jalmari and Rauha Ahokas Foundation, the Finnish Psychiatric Association, and the Signe och Ane Gyllenberg Foundation. The authors thank A. Solismaa for helpful comments on this letter. Supplementary information on the study is available at https://kmmsks.github.io/mpsc.

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DOI:10.1002/wps.21027