Prevalence and risk factors for HIV, hepatitis B, and hepatitis C in people with severe mental illness: a total population study of Sweden

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Summary

Background Severe mental illness is associated with increased morbidity and mortality. The elevated risk of blood-borne viruses (BBVs) in people with severe mental illness is of concern, but the full extent of this problem is unclear. We aimed to determine the prevalence of and risk factors for BBVs in people with severe mental illness.

Methods In this nationwide, population-based, cross-sectional study, we estimated the point prevalence of HIV, hepatitis B (HBV), and hepatitis C (HCV) in people with severe mental illness, including the total adult (≥18 years) Swedish population. We defined severe mental illness as a clinical diagnosis of schizophrenia, schizoaffective disorder, bipolar disorder, or other psychotic illness according to the Swedish version of the International Statistical Classification of Diseases version 8, 9, or 10. We used multivariable logistic regression to determine the odds of BBVs in individuals with severe mental illness, relative to the general population, and to identify independent risk factors (age, sex, immigration status, socioeconomic status, education, and substance misuse) for BBV infection. We also did a sensitivity analysis excluding BBV diagnoses made before the introduction of the Register for Infection Disease Control (1997).

Findings Of 6 815 931 adults in Sweden, 97 797 (1·43%) individuals had a diagnosis of severe mental illness. Prevalence of BBVs was elevated in people with severe mental illness, of which 230 (0·24%) had HIV, 518 (0·53%) had HBV, and 4476 (4·58%) had HCV. After accounting for sociodemographic characteristics, the odds of HIV were 2·57 (95% CI 2·25–2·94, p<0·0001) times higher in people with severe mental illness than in the general population, whereas the odds of HBV were 2·29 (2·09–2·51, p<0·0001) times higher and the odds of HCV were 6·18 (5·98–6·39, p<0·0001) times higher. Substance misuse contributed most to the increased risk of BBV: after adjustment, odds ratios were 1·61 (1·40–1·85, p<0·0001) for HIV, 1·28 (1·16–1·41, p<0·0001) for HBV, and 1·72 (1·67–1·78, p<0·0001) for HCV.

Interpretation Our results highlight the need to address the issue of higher prevalence of BBVs in people with severe mental illness and identify interventions preventing infection. Targeting of comorbid substance misuse would have particular effect on reduction of BBV prevalence in this population.

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Introduction

Severe mental illness is commonly defined as a mental disorder that is persistent and disabling in nature, such as schizophrenia, schizoaffective disorder, bipolar disorder, and other psychoses.[1] Increased mortality rates of 2–3 times the general population are well documented among people with severe mental illness, and translate into a reduction in life expectancy of up to 20 years.[2] Approximately 60% of this excess in mortality has been attributed to poor physical health.[2] Although much attention has been focused on addressing cardiovascular, respiratory, and cancer health inequalities, infectious diseases have been largely neglected in mental health research and policy.[3] This situation is problematic as meta-analytic evidence suggests blood-borne virus (BBV) prevalence is elevated amongst individuals with severe mental illness.[3] In North America, the pooled prevalence of BBVs in populations with severe mental illness is estimated to be as high as 6% for HIV, 2·2% for hepatitis B virus (HBV), and 17·4% for hepatitis C virus (HCV).[3] Therefore, HIV and HCV are ten times, and HBV around five times, more common in people with severe mental illness than in the general population.[4] Although lower, similar patterns are evident in people with severe mental illness in European countries (Germany, Belgium, Spain, Greece, Italy), with combined prevalence estimates of 1·9% for HIV, 2·7% for HBV, and 4·9% for HCV.[3] However, the true scale of the problem is unclear, because previous studies have used small, unrepresentative convenience samples recruited from treatment settings.[3] As far as

Research in context

Evidence before this study

We searched PubMed, PsychINFO, and Embase for studies examining the association between severe mental illness and blood-borne viruses (BBVs) published in English from Jan 1, 1980, to Aug 1, 2016. We used the search terms "severe mental illness", "serious mental illness", "schizophrenia", "schizoaffective disorder", "bipolar disorder", "psychosis", "blood-borne viruses", "human immunodeficiency virus", "HIV", "Hepatitis B", "HBV", "Hepatitis C", and "HCV". Additionally, we did a hand search of electronic journals. We identified a recent meta-analysis, which reviewed the literature on the prevalence of HIV, hepatitis B (HBV), and hepatitis C (HCV) in people with severe mental illness until Jan 1, 2015. We identified no additional studies. Evidence suggests infection with BBVs in people with severe mental illness is higher than in the general population in places where the prevalence of BBVs is low, and on par with the general population in places where prevalence of BBVs is high. In North America, the pooled prevalence of BBVs in people with severe mental illness is as high as 6·0% (range 0·24–22·9) for HIV, 2·2% (0·78–4) for HBV, and 17·4% (2·7–38) for HCV. In the limited number of European studies, the pooled prevalence rates were 1·9% (range 0·5–5·1) for HIV, 2·7% (2–4·8) for HBV, and 4·9% (0·7–10·7) for HCV. However, the available studies are of moderate to low quality, with small sample sizes, and are likely to overestimate the prevalence owing to use of unrepresentative convenience samples from treatment settings. Furthermore, there is a paucity of research in northern European countries.

Added value of this study

To the best of our knowledge, this study is the first to investigate the prevalence of and risk factors for HIV, HBV, and HCV infection in people with severe mental illness (schizophrenia, bipolar disorder, schizoaffective disorder, and non-organic psychosis) using a nationwide, population-based sample, and the first study to investigate the relationship between BBV and severe mental illness prevalence in northern Europe. The study is based on the entire adult Swedish population, comprised of 6 815 931 people. This sample size allowed us to generate more precise and representative estimates compared with previous studies and augmented the sparse research available on the topic. Compared with previous European studies of patients with severe mental illness, prevalence of HIV and HBV was lower, but HCV was similar. All BBVs were increased in individuals with severe mental illness compared with the general population. Furthermore, we assessed the risk factors associated with this increase in prevalence of HIV, HBV, and HCV in people with severe mental illness. We found substance misuse history conveys the greatest risk in all BBV (approximately four times the risk of HIV and HBV, and 25 times the risk of HCV).

Implications of all the available evidence

Individuals with severe mental illness are at greater risk of infection with BBVs, which probably contributes to the excess of morbidity and mortality observed in this population. This problem has not been widely addressed. Effective drug treatment is available for both severe mental illness and BBV, but additional support might be required in this population to ensure treatment adherence and manage comorbidities. Management of sexual health and substance misuse in people with severe mental illness is needed to tackle the increased risk of infection. Facilitation of access to sexual health clinics for people with severe mental illness and targeted BBV screenings in mental health services might provide potential pathways to address this issue. However, given the substantial risk substance misuse poses for infection with BBVs in the severe mental illness population, helping people manage their substance misuse and implementing harm reduction strategies should be the major focus of any intervention. Future research should focus on identifying the most effective interventions to address the excess of HIV, HBV, and HCV infection in people with severe mental illness.

we are aware, no population-based studies have been done of BBV prevalence in severe mental illness, and no studies have examined prevalence in northern European countries.[3] Additionally, literature on risk factors for BBV in individuals with severe mental illness is limited, but high prevalence of substance misuse has been identified as a particular concern in this group.[5]

To address this gap, we did a total population study of Sweden to establish the prevalence of HIV, HBV, and HCV in people with severe mental illness. Furthermore, we identified risk of infection relative to the general population, and specific sociodemographic and clinical risk factors for BBV infection in people with severe mental illness.

For **Statistics Sweden** see http://www.scb.se/en

For the **Swedish National Board of Health and Welfare** see http://www.socialstyrelsen.se/english

Methods

Study design and population

We did a nationwide, population-based, cross-sectional study using longitudinal data from Swedish national registers held by Statistics Sweden and the Swedish National Board of Health and Welfare. Registers were linked using the unique personal identification number assigned to each Swedish citizen at birth or to immigrants on arrival in Sweden who have been granted at least 12 months' residency; it is not dependent on having a Swedish address. The only people missing from the registers would have been recent immigrants with unconfirmed status. Personal identification numbers are recorded in all contacts with health-care, social, and administrative services (both private and

state). We compared the prevalence of BBV in those with severe mental illness and in the general population. We included all individuals aged 18 years or older who were alive on Dec 31, 2010. The study was approved by the research ethics committee at the Karolinska Institute, Stockholm, reference numbers 2010/1185-31/5 and 2013/1118-32.

Diagnoses

Severe mental illness was defined as a clinical diagnosis of schizophrenia, schizoaffective disorder, bipolar disorder, or other psychotic illnesses (excluding any substance-induced psychosis, but including diagnoses such as delusional disorder and unspecified psychosis) according to the Swedish version of the International Statistical Classification of Diseases (ICD) version 8, 9 or 10 (appendix).[6] Diagnoses could derive from either inpatient or outpatient records included in the National Patient Register. Inpatient records began in 1964 and outpatient records in 2001, with full population coverage (ie, everyone with a personal identification number) by 1973 and 2006, respectively. In cases of multiple previous diagnoses, the most recent was chosen, because we judged this diagnosis was likely to be most accurate, by accounting for the full clinical history. The quality of Swedish registers has previously been validated for severe mental illness.[7]

BBV status was defined as having a diagnosis of HIV, HBV, or HCV according to ICD-8, ICD-9, or ICD-10 (appendix).[6] BBV status was identified via linkage to the National Patient Register and the Register for Infection Disease Control (complete from 1997). Sweden has mandatory reporting of all HIV,[8] HBV,[9] and HCV cases[10] to the Swedish Institute for Infectious Disease Control and therefore all individuals diagnosed with BBV in Sweden were included in the study.

Potential risk factors

Age, sex, ethnicity, socioeconomic status, education, and substance misuse have been identified as potential explanations for the association between BBV and severe mental illness in previous literature.[11] We retrieved information regarding the age and sex of participants via the Total Population Register. Owing to insufficient available data on ethnicity, we used immigration status as a proxy, identifying immigration status via the Total Population Register. In line with previous Swedish register studies,[12] we classified individuals as Swedish born or having immigrated into Sweden. We defined socioeconomic status as the disposable income for each individual in 2010, generated from the total family income, including any salary, benefits, and pensions. We categorised socioeconomic status by creating quintiles of the disposable income of the total Swedish population (<958, 958–1335, 1336–1812, 1813–2505, and >2505 in hundreds of Swedish kronor). We categorised education into three levels: fewer than 10 years, 10–12 years, and more than 12 years or having attended university. We retrieved socioeconomic status and education information from the Longitudinal Integration Database for Health Insurance and Labour Market Studies (see Statistics Sweden). We defined a history of substance misuse as having a clinical diagnosis of substance misuse in the inpatient or outpatient National Patient Register, or receiving a prescription for any opiate replacement therapy, which was identified via the Prescribed Drug Register (which began in 2005; see the Swedish National Board of Health and Welfare). We considered substance misuse as potentially being on the causal pathway between severe mental illness and BBV.

Statistical analysis

We calculated the point prevalence of HIV, HBV, and HCV in the general population and in those with a severe mental illness diagnosis on Dec 31, 2010, with additional subdivision by severe mental illness diagnosis. To examine the increased risk of having BBV with a severe mental illness diagnosis, relative to the general population, we used logistic regression specifying severe mental illness status as the predictor and BBV status as the outcome. Multivariable logistic regression models were fitted to assess the effect of covariates on these univariable associations. Firstly, we controlled for age and sex, and then we additionally controlled for immigration status, socioeconomic status, and education. Finally, we controlled for history of substance misuse in addition to all previous covariates. We did a sensitivity analysis excluding BBV diagnoses made before the introduction of the Register for Infection Disease Control (1997).

See Online for appendix

To identify potential risk factors for individual BBVs, multivariable logistic regression models were fitted for the total population with severe mental illness subtype as an interaction term. We specified BBVs as the outcome with age, sex, immigration status, socioeconomic status, education, and substance misuse as predictors. We assessed effect modification using likelihood ratio tests. We used Stata (version 14) for all data management and analyses.

Role of the funding source

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Results

The total adult Swedish population was 6 815 931, of which 97 797 (1·43%) individuals had a diagnosis of severe mental illness: 21 232 (0·31%) were diagnosed

	Total population (N=6 815 931)	Severe mental illness (n=97 797)	Severe mental illness and HIV (n=230)	Severe mental illness and HBV (n=518)	Severe mental illness and HCV (n=4476)
Age (years)	46 (32–60)	52 (41–63)	48 (42–55)	44 (35–50)	48 (40–55)
Female	3 377 433 (49·55%)	50 800 (51·94%)	89 (38·70%)	188 (36·29%)	1532 (34·23%)
Male	3 438 498 (50·45%)	46 997 (48·06%)	141 (61·30%)	330 (63·71%)	2944 (65·77%)
Swedish born	5 631 926 (82·63%)	80 192 (82·00%)	153 (66·52%)	289 (55·79%)	3751 (83·80%)
History of substance misuse	269 029 (3·95%)	26688341 (26·93%)	142 (61·74%)	341 (65·83%)	4038 (90·21%)
Quintiles of socioeconomic status					
1 (lowest)	1 287 197 (18·89%)	20 768 (21·24%)	68 (29·57%)	201 (38·80%)	1346 (30·07%)
2	1 340 562 (19·67%)	38 434 (39·30%)	83 (36·09%)	217 (41·89%)	2131 (47·61%)
3	1 381 293 (20·27%)	20 621 (21·09%)	55 (23·91%)	78 (15·06%)	738 (16·49%)
4	1 400 902 (20·55%)	10 587 (10·83%)	16 (6·96%)	13 (2·51%)	175 (3·91%)
5 (highest)	1 405 976 (20·63%)	7387 (7·55%)	8 (3·48%)	9 (1·74%)	86 (1·92%)
Education*					
<10 years	1 309 214/6 684 115 (19·59%)	28 799/96 096 (29·97%)	87/221 (39·37%)	262/499 (52·51%)	2092/4390 (47·65%)
10–12 years	3 113 825/6 684 115 (46·59%)	44 086/96 096 (45·88%)	96/221 (43·44%)	192/499 (38·48%)	2008/4390 (45·74%)
>12 years or university	2 261 076/6 684 115 (33·83%)	23 211/96 096 (24·15%)	38/221 (17·19%)	45/499 (9·02%)	290/4390 (6·61%)

Data are n (%) or median (IQR). HBV=hepatitis B virus. HCV=hepatitis C virus. *Education data was missing for 131 816 (1·94%) individuals.

Table 1: **Clinical and demographic characteristics**

	Single infection			Dual co-infection			Triple co-infection
	HIV	HBV	HCV	HIV and HBV	HIV and HCV	HBV and HCV	HIV, HBV, and HCV
General population (N=6 815 931)	5909 (0·09%)	14 783 (0·22%)	41 600 (0·61%)	272 (<0·01%)	762 (0·01%)	2545 (0·04%)	56 (<0·01%)
Any severe mental illness (n=97 797)	230 (0·24%)	518 (0·53%)	4476 (4·58%)	13 (0·01%)	106 (0·11%)	271 (0·28%)	7 (0·01%)
Schizophrenia (n=21 232)	44 (0·21%)	112 (0·53%)	1194 (5·62%)	..	25 (0·12%)	55 (0·26%)	..
Schizoaffective disorder (n=6180)	12 (0·19%)	35 (0·57%)	199 (3·22%)	..	6 (0·10%)	16 (0·26%)	..
Bipolar disorder (n=34 576)	45 (0·13%)	91 (0·26%)	958 (2·77%)	..	11 (0·03%)	48 (0·14%)	..
Other psychosis (n=35 809)	129 (0·36%)	280 (0·78%)	2125 (5·93%)	11 (0·03%)	64 (0·18%)	152 (0·42%)	5 (0·01%)

Data are n (%). HBV=hepatitis B virus. HCV=hepatitis C virus. ..=fewer than five individuals (reporting of which is not permitted by Swedish data sharing rules).

Table 2: **Prevalence of single, dual, and triple infections with blood-borne viruses**

with schizophrenia, 6180 (0·09%) with schizoaffective disorder, 34 576 (0·51%) with bipolar disorder, and 35 809 (0·53%) with other psychosis (table 1). Education history was missing for 131 816 (1·94%) individuals, but no other variables had missing data.

Of the general population, 0·09% had an HIV diagnosis. The prevalence of HIV in those with severe mental illness was 0·24%, but differed by diagnostic subgroup (table 2). The odds of HIV infection in those with severe mental illness was nearly three times higher than in the general population (table 3). An increase in odds was present for all severe mental illness diagnoses. This pattern remained after adjustment for age, sex, immigration status, socioeconomic status, and education, as well as after additional adjustment for substance misuse (table 3). Results were of a similar magnitude when pre-1997 diagnosis of HIV was excluded (odds ratio [OR] 1·54, 95% CI 1·32–1·80, p<0·0001).

In the general population, being male was a risk factor for HIV, similarly in those with bipolar disorder and other psychosis diagnoses (table 4). However, in individuals with a schizophrenia diagnosis, being male reduced the odds. Having a history of substance misuse increased the odds of HIV infection in those with and without severe mental illness. Being Swedish born was more protective in the general population than in those with severe mental illness (table 4).

In the general population, 0·21% of individuals were infected with HBV, with a higher prevalence among

	Unadjusted	Model 1	Model 2	Model 3
HIV				
Any severe mental illness	2·79 (2·44–3·18); p<0·0001	2·86 (2·51–3·26); p<0·0001	2·57 (2·25–2·94); p<0·0001	1·61 (1·40–1·85); p<0·0001
Schizophrenia	2·45 (1·82–3·04); p<0·0001	2·37 (1·76–3·20); p<0·0001	2·11 (1·57–2·85); p<0·0001	1·38 (1·03–1·87); p=0·033
Schizoaffective disorder	2·30 (1·30–4·05); p=0·0040	2·47 (1·40–4·36); p=0·0017	2·20 (1·25–3·89); p=0·0064	1·43 (0·81–2·53); p=0·22
Bipolar disorder	1·54 (1·15–2·07); p=0·0039	1·65 (1·23–2·21); p=0·00086	1·81 (1·34–2·43); p<0·0001	1·09 (0·81–1·47); p=0·57
Other psychosis	4·27 (3·59–5·09); p<0·0001	4·34 (3·64–5·16); p<0·0001	3·43 (2·86–4·11); p<0·0001	2·12 (1·76–2·55); p=0·00013
HBV				
Any severe mental illness	2·50 (2·29–2·73); p<0·0001	2·81 (2·57–3·06); p<0·0001	2·29 (2·09–2·51); p<0·0001	1·28 (1·16–1·41); p<0·0001
Schizophrenia	2·49 (2·07–3·00); p<0·0001	2·83 (2·35–3·41); p<0·0001	1·99 (1·64–2·42); p<0·0001	1·17 (0·96–1·42); p=0·13
Schizoaffective disorder	2·67 (1·92–3·73); p<0·0001	3·10 (2·23–4·34); p<0·0001	2·42 (1·73–3·39); p<0·0001	1·43 (1·02–2·01); p=0·038
Bipolar disorder	1·24 (1·01–1·52); p=0·041	1·40 (1·14–1·72); p=0·0014	1·66 (1·34–2·04); p<0·0001	0·88 (0·72–1·09); p=0·24
Other psychosis	3·70 (3·29–4·17); p<0·0001	4·06 (3·61–4·58); p<0·0001	2·79 (2·47–3·15); p<0·0001	1·56 (1·37–1·76); p<0·0001
HCV				
Any severe mental illness	8·63 (8·36–8·91); p<0·0001	8·62 (8·35–8·90); p<0·0001	6·18 (5·98–6·39); p<0·0001	1·72 (1·67–1·78); p<0·0001
Schizophrenia	10·72 (10·11–11·37); p<0·0001	9·84 (9·28–10·45); p<0·0001	5·81 (5·46–6·17); p<0·0001	2·02 (1·89–2·15); p<0·0001
Schizoaffective disorder	5·99 (5·20–6·99); p<0·0001	6·33 (5·49–7·30); p<0·0001	4·50 (3·90–5·19); p<0·0001	1·29 (1·11–1·49); p=0·0011
Bipolar disorder	5·13 (4·81–5·47); p<0·0001	5·38 (5·04–5·75); p<0·0001	4·54 (4·25–4·85); p<0·0001	1·08 (1·01–1·16); p=0·022
Other psychosis	11·35 (10·85–11·88); p<0·0001	11·28 (10·78–11·80); p<0·0001	8·11 (7·74–8·49); p<0·0001	2·19 (2·07–2·29); p<0·0001

Data are OR (95% CI); p value. Model 1 is adjusted for age and sex. Model 2 is adjusted for age, sex, immigration status, education, and socioeconomic status. Model 3 is adjusted for age, sex, immigration status, education, socioeconomic status, and substance misuse. HBV=hepatitis B virus. HCV=hepatitis C virus.

Table 3: **Odds of infection with blood-borne viruses in people with severe mental illness compared with the general population**

individuals with severe mental illness (table 2). The unadjusted odds of HBV infection were more than two times higher for individuals with severe mental illness than in the general population (table 3). After adjustment for age, sex, immigration status, socioeconomic status, and education, the odds of HBV infection in individuals with severe mental illness remained elevated. This increase in odds was present for all severe mental illness diagnoses (table 3). The odds of HBV infection also remained elevated after additional adjustment for substance misuse. The OR increased when pre-1997 diagnoses were excluded (OR 1·43, 95% CI 1·32–1·56, p<0·0001).

In both the severe mental illness population and individuals without severe mental illness, being male, non-Swedish born, having a history of substance misuse, and being of lower socioeconomic status increased the risk of having HBV (table 4). Odds of HBV infection fell with increasing age in individuals without severe mental illness, and in those with schizophrenia, bipolar, or other psychosis. As with HIV, being Swedish born was more protective for those without severe mental illness than for those with severe mental illness diagnoses.

HCV was the most common BBV, with a prevalence of 0·61% in the general population (table 2). Furthermore, HCV showed the greatest increase in prevalence in those with severe mental illness diagnoses. Prevalence was also higher than in the general population for each individual severe mental illness diagnosis (table 2). The odds of HCV infection were more than eight times higher in individuals with severe mental illness than in those without, with all diagnoses showing a significant increase in odds (table 3). This pattern persisted after adjustment for age, sex, immigration, socioeconomic status, and education, and adjustment for substance misuse in addition to all previous confounders (table 3). Results were of a similar magnitude when we excluded HBV diagnoses before 1997 (OR 1·64, 95% CI 1·58–1·71, p<0·0001).

Being male increased the odds of HCV diagnosis in individuals without severe mental illness, or with schizophrenia, bipolar disorder, or other psychosis groups (table 4). Being older was associated with increased odds of HCV in the general population, but reduced odds of infection in those with schizophrenia, bipolar disorder, and other psychosis. Increased socioeconomic status and years in education reduced HCV risk universally. A substance misuse history dramatically elevated the odds of HCV (table 4).

Dual co-infections were rare in the general population (table 2). The prevalence of co-infection was higher in the severe mental illness population than in the general population. Triple co-infection was very rare in all populations (table 2).

Discussion

In this study of BBV and severe mental illness covering the entire adult population of Sweden, we found the prevalence of infection with HIV, HBV, and HCV in individuals with severe mental illness was considerably

	Without severe mental illness	Schizophrenia	Schizoaffective disorder	Bipolar disorder	Other psychoses	p value*
Risk factor for HIV						
Male sex†	1·68 (1·59–1·78)	0·54 (0·30–0·97)	0·97 (0·31–3·08)	1·83 (1·00–3·31)	1·60 (1·08–2·36)	0·0078
Age (years)‡	1·00 (0·998–1·002)	0·986 (0·963–1·010)	0·958 (0·915–1·003)	0·994 (0·975–1·014)	0·998 (0·986–1·011)	0·27
Swedish born§	0·18 (0·17–0·19)	0·47 (0·25–0·90)	0·71 (0·19–2·63)	0·39 (0·20–0·77)	0·48 (0·33–0·69)	<0·0001
History of substance misuse¶	3·96 (3·65–4·29)	4·11 (2·25–7·52)	6·02 (1·81–20·04)	3·25 (1·79–5·91)	4·25 (2·93–6·15)	0·90
Quintiles of socioeconomic status‖						0·13
2	0·94 (0·87–1·02)	0·67 (0·33–1·35)	0·44 (0·13–1·52)	0·66 (0·27–1·57	0·85 (0·55–1·33)	
3	0·86 (0·79–0·94)	1·10 (0·47–2·59)	0·21 (0·02–1·82)	1·22 (0·53–2·78)	1·27 (0·79–2·03)	
4	0·76 (0·70–0·83)	1·03 (0·23–4·57)	0·76 (0·70–0·83)	1·35 (0·53–3·42)	0·52 (0·22–1·24)	
5 (highest)	0·93 (0·85–1·02)	0·93 (0·85–1·02)	2·12 (0·24–18·39)	0·69 (0·19–2·50)	0·62 (0·22–1·72)	
Education**						0·65
10–12 years	0·90 (0·84–0·96)	1·07 (0·57–2·00)	1·50 (0·37–6·02)	0·90 (0·42–1·92)	0·83 (0·56–1·22)	
>12 years or university	0·91 (0·85–0·98)	0·73 (0·24–2·14)	1·90 (0·38–9·46)	1·53 (0·71–3·30)	0·63 (0·35–1·11)	
Risk factor for HBV						
Male sex†	1·29 (1·24–1·34)	0·97 (0·63–1·49)	1·52 (0·77–3·00)	1·44 (0·95–2·19)	1·22 (0·94–1·58)	0·68
Age (years)‡	0·984 (0·983–0·985)	0·978 (0·963–0·992)	0·982 (0·956–1·009)	0·979 (0·966–0·993)	0·971 (0·962–0·979)	0·039
Swedish born§	0·07 (0·07–0·08)	0·23 (0·16–0·34)	0·14 (0·07–0·28)	0·30 (0·19–0·48)	0·37 (0·29–0·47)	<0·0001
History of substance misuse¶	4·82 (4·59–5·06)	5·30 (3·53–7·95)	4·52 (2·27–8·97)	5·98 (3·76–9·52)	5·21 (4·02–6·75)	0·84
Quintiles of socioeconomic status‖						0·011
2	0·92 (0·88–0·96)	0·68 (0·44–1·06)	1·34 (0·58–3·06)	1·24 (0·75–2·04)	0·78 (0·59–1·02)	
3	0·75 (0·71–0·79)	0·99 (0·56–1·77)	1·00 (0·34–2·94)	0·68 (0·35–1·31)	0·61 (0·42–0·88)	
4	0·63 (0·59–0·67)	0·63 (0·59–0·67)	0·63 (0·59–0·67)	0·29 (0·09–0·97)	0·35 (0·18–0·70)	
5 (highest)	0·53 (0·50–0·57)	1·31 (0·30–5·57)	0·53 (0·50–0·57)	0·80 (0·30–2·09)	0·16 (0·04–0·66)	
Education**						0·60
10–12 years	0·68 (0·65–0·70)	0·83 (0·55–1·24)	0·56 (0·27–1·16)	0·52 (0·33–0·81)	0·63 (0·49–0·82)	
>12 years or university	0·52 (0·50–0·54)	0·55 (0·26–1·56)	0·31 (0·09–1·06)	0·34 (0·18–0·64)	0·37 (0·24–0·58)	
Risk factor for HCV						
Male sex†	1·50 (1·46–1·53)	1·31 (1·13–1·52)	1·03 (0·76–1·38)	1·18 (1·03–1·34)	1·40 (1·27–1·55)	0·0002
Age (years)‡	1·009 (1·008–1·009)	0·995 (0·990–1·000)	1·003 (0·991–1·015)	0·995 (0·991–0·999)	0·996 (0·993–0·999)	<0·0001
Swedish born§	0·86 (0·84–0·89)	1·23 (1·03–1·46)	1·09 (0·74–1·60)	0·88 (0·72–1·08)	1·35 (1·19–1·53)	<0·0001
History of substance misuse¶	32·04 (31·34–32·76)	30·84 (25·39–37·46)	20·67 (13·61–31·38)	16·68 (13·78–20·20)	32·13 (27·30–37·81)	<0·0001
Quintiles of socioeconomic status‖						0·12
2	0·83 (0·80–0·85)	0·76 (0·65–0·89)	0·79 (0·55–1·13)	0·84 (0·71–1·00)	0·75 (0·67–0·84)	
3	0·57 (0·55–0·59)	0·60 (0·49–0·75)	0·61 (0·38–0·97)	0·59 (0·49–0·72)	0·53 (0·46–0·61)	
4	0·45 (0·43–0·46)	0·20 (0·11–0·37)	0·20 (0·06–0·65)	0·34 (0·25–0·45)	0·38 (0·31–0·48)	
5 (highest)	0·35 (0·34–0·37)	0·28 (0·12–0·65)	0·46 (0·11–1·97)	0·35 (0·25–0·49)	0·27 (0·19–0·37)	
Education**						0·0006
10–12 years	0·82 (0·80–0·84)	0·70 (0·61–0·80)	0·92 (0·67–1·26)	0·71 (0·61–0·82)	0·87 (0·78–0·96)	
>12 years or university	0·48 (0·47–0·50)	0·29 (0·21–0·41)	0·41 (0·23–0·74)	0·38 (0·30–0·47)	0·39 (0·32–0·47)	

Data are OR (95% CI) or p values. Each analysis is controlled for all other risk factors in the table. HBV=hepatitis B virus. HCV=hepatitis C virus. *Test for effect modification. †Reference group: female sex. ‡Per 1-year increase in age. §Reference group: non-Swedish born. ¶Reference group: no history of substance misuse. ‖Reference group: lowest quintile of SES (1). **Reference group: <10 years of education.

Table 4: **Associations between key characteristics and infection with blood-borne viruses**

higher than in the general population. This increase was not fully explained by differences in age, sex, immigration status, socioeconomic status, educational level, or substance misuse history. However, a history of substance misuse had the biggest effect on BBV risk. Apart from substance misuse, risk factors for BBV appear to act differentially across severe mental illness subtypes. In individuals without severe mental illness, being an immigrant into Sweden, being of lower socioeconomic status, and having reduced time in education all increase BBV risk, but we could not show this result consistently in severe mental illness subtypes.In particular, women with schizophrenia have increased risk of HIV compared with men (ie, OR for men of 0·54) whereas this is reversed in the general population

To our knowledge, this population-based study is the first to investigate the prevalence and risk factors for

BBVs in people with severe mental illness, and provides the first estimate of prevalence of BBVs in individuals with severe mental illness in Sweden, which has comprehensive health service coverage. The large, full-population sample allowed for precise and representative estimates. Furthermore, because HIV, HBV, and HCV are statutorily notifiable infections in Sweden and data quality has previously been validated for both BBVs and severe mental illness,[7–10] we believe our findings represent as accurate and complete case recording as is possible in a routine setting, without mandatory testing. Some points should be considered in terms of the generalisability of these findings. The relatively high prevalence of HCV in the general population of Sweden has been reported in previous literature, and is thought to be related to high rates of recreational drug use during the 1960s and 1970s in Swedish-born individuals.[10,13] Our study potentially overestimates HCV prevalence, because not all cases become chronic (viraemic rate ranges from 74% to 91%).[13] However, our general population prevalence is consistent with a 2012 estimate of 0·56% for Sweden.[13] The general population prevalence of BBVs in Sweden is similar to other northern European countries such as Denmark and the UK.[13–16]

Compared with previous literature, our prevalence estimates for both HIV and HBV in the severe mental illness population are lower than those of other European studies.[3] Our estimate for HCV lies within the wide range found previously in Europe (0·7–10·7%).[3] In most of these studies, BBV testing was done as part of routine care during inpatient treatment, whereas in our study individuals would only be tested when an opportunity to do so arose (ie, contact with a health professional). Individuals might not seek help for either severe mental illness or BBV diagnoses and so would not be in the registers, leading to a potential underestimation of prevalence. This situation might be particularly true for HCV, for which symptoms are mild and might go undiagnosed.[17] We were unable to determine whether the opportunity to receive a BBV diagnosis is the same for individuals with severe mental illness and those without. However, given that individuals with severe mental illness receive less appropriate assessment and treatment for physical health problems than do the general population,[18] this difference might also be reflected in assessment and treatment for BBVs. As such, our study potentially differentially underestimates the prevalence of BBVs in severe mental illness compared with the general population. Previous studies in the general population,[19] and a limited number of studies of patients with severe mental illness,[4,20] have identified male sex, substance misuse, lower socioeconomic status, reduced education, and non-white ethnicity as risk factors for BBVs. As far as we are aware, our study is the first to show different effects of risk factors by BBV and severe mental illness subgroups.

Our study has other potential limitations. The study design adopted does not allow us to make inferences about the temporality of the relationship between BBVs and severe mental illness. However, the primary aim was to estimate point prevalence and, as such, a cross-sectional methodology was most appropriate. Also, given that most severe mental illness has an onset in early adulthood,[21] most BBV infection was likely to be contemporaneous or later. Diagnosis of severe mental illness and BBV occurred at different times and was made based on different versions of the ICD. Therefore, potential misclassification exists within subgroups of severe mental illness, which we attempted to limit by using the most recent diagnosis code recorded in medical records. However, misclassification into the severe mental illness group versus the group without severe mental illness is unlikely. We were unable to ascertain whether particular symptoms or phases of illness conveyed particular risk (for example, manic states have been associated with increased risk of HIV acquisition[22]). Our measure of substance misuse (diagnosis or opiate replacement prescribing) might be imperfect and additional risk behaviours might explain increased BBV prevalence in severe mental illness relative to the general population. For example, we were unable to account for incarceration, homelessness, and risky sexual behaviours.[19,20] Also, our binary immigration status variable might not capture the range of potential baseline risk associated with particular countries. As such, we recognise the potential for residual and unmeasured confounding in our study. Conversely, one could argue that many of the risk behaviours mediate, rather than confound, the relationship between severe mental illness and BBVs, and their inclusion in a regression model would result in overadjustment. All variables had complete data, apart from education, which had 1·94% missing values. Missing data below 5–10% should have little effect on statistical inference, so we did a complete-case analysis.[23] We found no evidence that missing data was related to either BBV or severe mental illness diagnosis, therefore this approach should be unbiased. Finally, despite the large sample size, our study might have been underpowered to examine some risk factors for less common severe mental illness diagnoses (eg, the effect of education on HIV risk in schizoaffective disorder).

This study has important implications for policy and practice. BBVs contribute to mortality in the general population, with HBV and HCV found to increase all-cause mortality by 2·3 times, and 5·8 times, respectively.[24] Comorbidity of BBV infection and severe mental illness provides a worse prognosis for both conditions.[25] As such, the increased prevalence of BBVs probably accounts for some of the excess mortality experienced by individuals with severe mental illness. Beyond this, BBV diagnosis is likely to contribute to

increased stigma[26] and disability, and have negative effects on quality of life and illness course in those with severe mental illness.[25] However, national guidelines for treatment of physical health problems in individuals with severe mental illness pay little attention to infectious disease risk and sexual health,[27] and consultations of sexual-history taking commonly fail to account for mental health problems.[28] To effectively address the syndemic of severe mental illness, BBV, and substance misuse, integrated approaches to care that facilitate greater collaboration between mental health, sexual health, and substance misuse services are necessary. Potentially, testing for BBVs should become routinely available during contact with mental health and substance misuse services. Effective pharmacotherapy exists for both severe mental illness and BBVs, and treatments can be used together successfully with low risk of drug interactions.[25] The clinical challenge is encouragement of treatment adherence and coordination of clinical services that are necessary to address the diverse psychiatric and medical problems that coexist in this population. Furthermore, prevention strategies should be adopted to reduce the risk of BBV infection among people with severe mental illness. Existing evidence is insufficient to appraise the effectiveness of sexual health risk reduction strategies, sexual health promotion, or interventions intended to change behavioural outcomes associated with BBV infection in severe mental illness.[29] However, given the substantial risk substance misuse poses for the acquisition of BBVs, helping individuals with severe mental illness reduce harms associated with their substance use might be the most beneficial avenue to reduce infection rates. Additionally, such an intervention could affect other domains such as criminality, suicide, all-cause mortality, and general health and wellbeing.[30] Evidence suggests that harm reduction strategies are effective at reducing BBV infection risk, with the strongest evidence for needle and syringe programmes and opioid substitution treatment.[31] As such, greater commissioning and more widespread coverage of harm reduction strategies is necessary.

Contributors

CB-S, LJ, DPJO, and JFH were involved in study conception and design. LJ extracted the data. CB-S and JFH completed the data analysis. CB-S, LJ, GL, CD, DPJO, and JFH interpreted the data and provided important intellectual input. CB-S and JFH wrote the first draft. CB-S, LJ, GL, CD, DPJO, and JFH read and commented on the manuscript.

Declaration of interests

We declare no competing interests.

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