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Immigration Status and Substance Use Disorder-related Mortality in Sweden: A National Longitudinal Registry Study

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Objectives: First-generation immigrants, in many countries, are healthier than their native counterparts. This study examined the association between first- and second-generation immigrant status and alcohol- or drugs other than alcohol-related (primarily opioids) mortality for those with risky substance use.

Methods: A Swedish longitudinal, 2003 to 2017, registry study combined Addiction Severity Index (ASI) assessment data with mortality data ($n = 15\,601$). Due to missing data, the analysis sample for this study was 15 012. Multivariate models tested the relationship between immigration status and drugs other than alcohol or alcohol-related mortality, controlling for demographics and the 7 ASI composite scores (CS).

Results: Age, a higher ASI CS for alcohol, a lower ASI CS family and social relationship, a lower ASI CS for drug use and a higher ASI CS for health significantly predicted mortality because of alcohol-related causes. Higher ASI CS for drugs other than alcohol, employment, and health, age, male sex, and immigration status predicted drugs other than alcohol, related mortality. Individuals born in Nordic countries, excluding Sweden, were 1.76 times more likely to die of drugs other than alcohol compared with their Swedish counterparts. Individuals born outside a Nordic country (most common countries: Iran, Somalia, Iraq, Chile) were 61% less likely to die of drugs other than alcohol compared with their Swedish

counterparts. Those with parents born outside Nordic countries were 54% less likely to die of drugs other than alcohol.

Discussion: Research is needed on why people with risky substance use from Nordic countries (not Sweden) residing in Sweden, have higher mortality rates because of drugs other than alcohol (primarily opioids) compared with the other population groups in our study). Findings indicate that ASI CSs are strong predictors of future health problems including mortality due to alcohol and other drug-related causes.

Key Words: alcohol-related mortality, Addiction Severity Index, drugs other than alcohol-related mortality, immigration status, opioid-related mortality

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Deaths due both to alcohol and drugs other than alcohol have increased in Sweden. Drug-related deaths in Sweden, moreover, are higher than reported in most other European countries (European Monitoring Centre for Drugs and Drug Addiction [EMCDDA], 2017). Given Sweden's high death rate because of alcohol and other drugs, there is a need to identify if certain subpopulations are more or less at risk of substance use disorder (SUD)-related mortality. One demographic variable that has been identified in countries other than Sweden as a protective factor is being a first- or second-generation immigrant (see background section below). The study presented here is the next step in our Swedish national registry studies using Addiction Severity Index (ASI) assessment baseline data and health registry data; here, we use mortality data from 2003 to 2017. Given existing research from other countries on first-generation immigration health status, our exploratory hypothesis is that individuals who are first-generation immigrants to Sweden will, independent of country of birth, post-ASI baseline interview, have lower rates of substance use-related mortality compared with those who are Swedish born to Swedish parents.

BACKGROUND

Alcohol-related Mortality

Alcohol consumption is a leading risk factor associated with both intentional and unintentional injury, as well as morbidity and premature death. According to the World

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Health Organization (WHO), alcohol dependence is common in most European countries, affecting a vast number of individuals and contributing to elevated rates of morbidity and mortality (Cherpitel et al., 2009; World Health Organization, 2018). Approximately 3 million premature deaths occur worldwide every year as a result of the harmful use of alcohol (World Health Organization, 2018). In Sweden, 1920 individuals died as a result of alcohol use/dependence in 2016 (1475 men and 445 women; National Board of Health and Welfare (NBHW), 2017). Alcohol, moreover, is often a contributing factor in deaths caused by accidents, violence, and the like. However, it is likely that the number of deaths where alcohol is regarded as a contributing factor in the statistics is underreported. On the basis of existing research and reports, the overall alcohol-related mortality in Sweden is estimated to be between 4500 and 9000 annually (Hemström, 2002; Public Health Agency of Sweden, 2012).

Variables Associated With Alcohol-related Mortality

Alcohol-related mortality rates in Sweden among individuals with a secondary and postsecondary education have decreased, whereas the rates remained unchanged among those with only a primary education (Public Health Agency of Sweden, 2012). A 2016 analysis suggested that alcohol-related mortality was highest among individuals aged 65 to 84 and lowest among those aged 15 to 29 (Public Health Agency of Sweden, 2018). Men, especially older men in compulsory care for SUD, were at greater risk of alcohol-related mortality compared with women (Hall et al., 2015; Delker et al., 2016).

Drugs Other Than Alcohol-related Mortality

Over the last decade, drug-related mortality has increased in many parts of the world (United Nations, 2017) with notable increases in opioid overdoses in North America and in selected European countries (eg, Sweden and Estonia; The European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), 2017). EMCDDA concluded that even if the use of heroin and other opioids remains relatively rare, they continue to be the drugs predominantly associated with more harmful use (EMCDDA, 2017). Specifically, opioids were associated with 81% of all fatal overdoses in Europe and accounted for close to 40% of all drug treatment requests.

The opioid-related mortality rate across the EU, among people between the ages of 15 and 64, is estimated at around 21 deaths per million inhabitants. In Sweden, the rate is 100 deaths per million inhabitants. Only Estonia (103 reported deaths per million) is more elevated (EMCDDA, 2017). However, deaths because of drug use have fallen sharply in Estonia in recent years, whereas the opioid-related mortality rate in Sweden is still increasing (EMCDDA, 2017). The National Board of Health and Welfare (NBHW) recommends the use of registry data in order to conduct longitudinal studies of specific subpopulations with risky SUD and examine SUD-related mortality (NBHW, 2016).

On the basis of the Swedish report *Drug-related deaths: An analysis of the deaths of 2014 and the development of official statistics* from the NBHW (2016) regarding drug-

related mortality in 2014, opioids accounted for 555 of 765 drugs other than alcohol-related deaths in Sweden, indicating that the clear majority of those dying as a result of drugs other than alcohol do so because of use of opioids.

Variables Associated With Drugs Other Than Alcohol Related Mortality

The NBHW report discussed above identified significant sex differences among those dying as a result of drug use, with men being more likely to die of drug use compared with women. A majority of the drugs contributing to premature death among men was likely to come from illegal sources rather than through legal prescription (NBHW, 2016). Women who died from drugs other than alcohol, on the other hand, were more likely to be older, with a median age of 48; more prone to use of legal prescription opioids, such as tramadol and oxycodone; and more likely to suffer from comorbidity, in particular depression, compared with their male counterparts. Women were also, in comparison to men, much more likely to have died as a result of drug-related suicide (NBHW, 2016).

Previous research regarding mortality within the field of substance use suggests that age (EMCDDA, 2003; Degenhardt et al., 2004; Darke et al., 2007; Fugelstad, 2011; Håkansson and Berglund, 2013; CAN, 2014; EMCDDA, 2014, 2017) and use of opioids is a factor associated with an increased risk of drugs other than alcohol-related mortality (Hall et al., 2015; Rudd et al., 2016). In terms of age, research is contradictory regarding who predominantly dies as a result of substance use—younger versus older individuals. In terms of opioid use, the overall number of deaths among people who use opioids is still greater in older age groups; however, in recent years, reports from Sweden and the United States indicate an increased number of deaths among the young (EMCDDA, 2014; Rudd et al., 2016; EMCDDA, 2017; The Public Health Agency of Sweden, 2018). This suggests a possible shift from older to younger individuals in who predominantly dies as a result of opioid use.

With respect to education, studies show that among individuals with an opioid use disorder in drug treatment, educational levels are low and unemployment is common (Onyeka et al., 2012, 2013). Data presented by the national Public Health Agency of Sweden supports these studies, with overall drug-related mortality between 2006 and 2016 highest among young individuals (15–29 years) with a lower level of education (The Public Health Agency of Sweden, 2018).

Substance Use and Immigrant Mortality

Most European and North American analyses of mortality rates among immigrant groups have not examined substance use-related causes. However, there are some studies that have been conducted on this topic. In England and Wales, alcohol-related mortality was elevated among immigrants from Ireland, India, and the Caribbean compared with individuals born in Britain; substance-related mortality rates for these groups, moreover, had risen faster than those of the national population (Harrison et al., 1997). In Spain, foreign-born Spaniards had a lower alcohol-related mortality rate than individuals born in Spain, with automobile accidents the most common cause of alcohol-related mortality for immigrants,

and liver cirrhosis and cardiovascular disorders the most common cause of death for native-born Spaniards (Fierro et al., 2010). In Canada, mortality because of alcohol and drug use was the least common cause of death for immigrant women compared with their counterparts (Omariba, 2015). In French metropolitan areas, foreign-born individuals had a lower all-cause mortality rate than native-born individuals, however, with respect to alcohol-related mortality, there were no significant differences between the 2 groups (Boulogne et al., 2012).

Several studies have looked specifically at substance-related mortality in immigrants from the Former Soviet Union (FSU). Ott et al. (2008) found that men immigrating from countries in the former Soviet Union to Germany had elevated mortality from mental and behavioral conditions related to use of psychoactive substances compared with German-born males. There were no significant differences in crude mortality rates by immigrant status in Israel for immigrants from countries included in the former Soviet Union (Rosca et al., 2012). A subsequent study reported an increased risk for opioid-related mortality among a later wave of Israeli immigrants from former soviet countries (Feingold et al., 2017); however, opioid-related mortality in Israel was substantially lower than in Europe and the United States.

In Sweden and other Nordic countries, immigrant status had no relationship to mortality rates related to cannabis use disorder (Arendt et al., 2013). Beijer et al. (2011) also identified that Finnish immigrants in Sweden ($n = 1757$ men and 526 women) exhibited overall higher drug- and alcohol-related mortality compared with native-born Swedes, whereas immigrants to Sweden from non-Nordic countries had lower rates than Swedes.

Other Causes of Immigrant Mortality

Interest exists in understanding differences between mortality rates of native-born and foreign-born individuals and identifying causes of immigrant mortality. Examinations of these rates in several countries tend to point to immigrants having lower early mortality rates than native-born populations. For example, Boulogne et al. (2012) found that immigrants to France had an overall lower mortality rate than the locally born, and Omariba (2015) and Vang et al. (2017) both revealed that in Canada, immigrants had a mortality advantage and lower risk for avoidable mortality than nonimmigrants. Other studies have focused on differences in immigrant mortality associated with variables, such as sex (Klinthäll and Lindström, 2011; Boulogne et al., 2012; Rosca et al., 2012; Arendt et al., 2013), age (Boulogne et al., 2012; Holmes et al., 2015), educational level (Klinthäll and Lindström, 2011; Arendt et al., 2013; De Grande et al., 2014), violent deaths (eg, homicide, traffic accidents, nontraffic accidents, suicide; Ott et al., 2008; Boulogne et al., 2012), lifestyle deaths (eg, smoking and alcohol-related causes, cancers, cirrhosis; Abraído-Lanza et al., 1999; Ott et al., 2008; Boulogne et al., 2012; Omariba, 2015) socioeconomic conditions (Pudarcic et al., 2003; Ott et al., 2008; Klinthäll and Lindström, 2011; Castañeda et al., 2015), and history of psychiatric and/or SUD treatment (Beijer et al., 2011; Arendt et al., 2013). Differences between immigrants and native-born

populations on these variables appear to be locally dependent—neither generalizable or cross-country patterns are easily discernible in this body of literature, nor does there emerge a stable direction of relationship between these variables and immigrant mortality.

Immigrant mortality has been examined in several recent Swedish studies. After adjustments for socioeconomic status, an association between country of birth and poor health status was seen among immigrants from Southern Europe and Finland, as well as among refugees from developing countries; however, country of birth was not found to be associated with all-cause mortality in this group of immigrants (Pudarcic et al., 2003). Beijer et al. (2011) specifically looked at mortality in homeless men and women in Stockholm, including those who were non-Swedish citizens, and found that among the total homeless population, previous treatment for psychiatric disorder predicted lower likelihood of early mortality, whereas previous treatment for SUDs predicted higher likelihood of early mortality as compared with Swedish citizens. In this sample, homeless people from Finland were observed to have higher mortality, whereas homeless individuals from non-Nordic countries had lower mortality, as compared with Sweden. In a third study of immigrants to Sweden, when controlling for demographic factors, current socioeconomic status, and life conditions before immigration, male and female immigrants from Denmark and Norway, and male immigrants from Finland, had higher mortality risk than native Swedes (Klinthäll and Lindström, 2011). These authors concluded that socioeconomic conditions were more associated with immigrant mortality in these groups than were early life conditions in an immigrant's country of origin.

Generational Differences in Substance Use Disorder Morbidity and Mortality Among Immigrants

The phrase the “immigrant paradox” is a construct related to a phenomenon in which first-generation immigrants exhibit better biopsychosocial outcomes, including lower rates of substance use, than do their native-born peers or second (third and fourth) immigrant generations, despite often living in worse socioeconomic conditions (Bui, 2013; Salas-Wright et al., 2014; Bacio and Ray, 2016). Also, more recent immigrants are generally found to consume less alcohol and to exhibit less excessive drinking than established immigrants and members of native-born populations (Szaflarski et al., 2011; Lee et al., 2013; Sudhinaraset et al., 2016).

Harrison and colleagues originally surmised in their 1997 study that the high rates of alcohol use found among immigrant groups in England and Wales reflected drinking patterns in the immigrants' countries of origin; however, these authors determined that problematic alcohol use among second-generation Irish immigrants was higher than in first-generation immigrants. Increases in alcohol use in second and subsequent generations have continued to be uncovered since Harrison and colleagues' study and among additional immigrant groups in other countries. Recent immigrants to Israel from the former Soviet Union had a much higher risk for opioid deaths than older immigrants (Feingold et al., 2017). A

systematic review of studies of immigrant health in Canada by Vang et al. (2017) found both recent immigrants to Canada to be healthier, as measured by lifestyle indicators that can be affected by substance use, than their Canadian peers, and that established immigrants to have poorer health than Canadians. Comparing first- and second-generation immigrants from Africa, Latin America, Asia, and Europe to native-born Americans, while controlling for sociodemographic factors, Salas-Wright et al. (2014) found SUDs and substance use morbidity to be the lowest among first-generation immigrants and the highest among native-born Americans; second-generation immigrants exhibited rates of SUDs slightly lower than those of native-born Americans.

The largest body of research on generational differences in substance use has focused on Latino immigrants to the United States, although these studies have not examined generational differences in substance use mortality. Peña et al. (2008) found that generational status was predictive of problem alcohol and drug use and suicide attempts in second- and third-generation Latino youth in the United States. Martinez et al. (2011) found the study group of Latino immigrants with the longest US residency to have the greatest risk for alcohol use and to have reported lifetime use of illicit drugs, whereas no member of the most recent immigrant group reported use of illicit drugs.

De La Rosa et al. (2013) investigated whether there were significant differences among a group of recent Latino immigrants to the United States in their patterns of alcohol use 90 days before immigration as compared with 24 months postimmigration. These researchers' findings indicated that the sample drank, binge drank, and engaged in heavy alcohol use more often before immigration than after immigration. Kopak (2013) also examined alcohol use by generational status in a group of Mexican-American immigrants. In this sample, alcohol use did not vary significantly by immigrant status, but alcohol use increased at a steady rate over time in all 3 generations. A small sex difference was found in the second-generation group, with men experiencing a greater increase in the number of drinks consumed compared with women in this generational group.

Healthy Immigrant Effect

The healthy immigrant effect (HIE) hypothesizes that a self-selection process occurs among immigrants such that individuals who immigrate to a new country are: among the healthiest and most functional representatives of their groups; through cultural norms and practice bring a type of immunity or resistance to unhealthy lifestyle behaviors, including substance use; and/or abstain from high-risk or illegal behaviors, such as illicit drug use, out of fear of criminal justice involvement in their new country (Salas-Wright et al., 2014). Hence, first-generation immigrant status is not a health vulnerability factor but a resilience factor. The proving or disproving of the existence of an HIE has been a topic of numerous studies conducted in the United States, Canada, Australia, and Europe. Overall, these have produced mixed evidence of a general healthy immigrant effect, with some studies finding support for an HIE (McDonald and Kennedy, 2004; Keane et al., 2009; Kennedy et al., 2015;

Omariba, 2015) and other studies finding little support for the theory (Abraído-Lanza et al., 1999; Newbold, 2005; Rubalcava et al., 2008). Additional studies identified factors that appear to influence or mitigate the HIE, including race and ethnicity in the United States (Bui, 2013); migration policies of the host country (Constant et al., 2018); and sex, social class, and place of origin among immigrants to Spain (Malmusi et al., 2010), as well as recent Spanish socioeconomic conditions (Gotsens et al., 2015). Salas-Wright et al. (2014) found evidence in support of a healthy immigrant effect for SUDs among immigrants to the United States.

In summary, there is a diverse set of findings about the relationship between immigration status and alcohol- and drug-related mortality. Sweden, one of the countries in Europe with a significant increase in immigration in the last decade, has also one of the highest drugs other than alcohol-related mortality rates. However, little is known at the national level about the alcohol- or drugs other than alcohol-related mortality of immigrants and their Swedish counterpart. Our study responds to this need in research. We followed a population of 15 012 individuals assessed for an SUD and merged their ASI baseline data with mortality data for the time period 2003 to 2017 to predict the relationship between alcohol- or drugs other than alcohol related mortality and the following groups: individuals and their parents all born in Sweden (native Swede); individuals born in Norway, Finland, or Denmark (Nordic first-generation immigrant); individuals born outside of Sweden, Norway, Finland, or Denmark (non-Nordic first-generation immigrant); individuals born in Sweden with at least one parent born in Norway, Finland, or Denmark and no parent born outside the Nordic countries (Nordic second-generation immigrant); and individuals born in Sweden with at least one parent born outside the Nordic countries (non-Nordic second-generation immigrant).

METHODS

Our Swedish national longitudinal study combined Cause of Death Registry data available from the NBHW and Addiction Severity Index (ASI; McLellan et al., 1992) assessment data from 65 municipalities for a period of 14 years (2003–2017) to create a database which included 15 061 individuals. Due to missing data, the analysis sample for this study was 15 012.

Sample

The study presented in this article included a sample of adults (18 years of age and older) with complete demographic data ($n = 15\,012$) who were assessed for risky substance use or an SUD between 2003 and 2017 in 65 Swedish municipalities. This sample was broadly representative of the national Swedish population assessed for an SUD through the use of ASI, although with fewer individuals from rural municipalities.

The ASI assessments were conducted by clinical social workers who works for municipal social care offices overseen by the NBHW. These clinical social workers conduct a majority of SUD ASI assessments in Sweden. They also receive ongoing training on how to conduct ASI assessments, which is provided by the NBHW. Clients may be referred to these municipal social workers by primary care offices, family, police, hospitals, courts, seek care themselves, or

referred through other venues. The individuals in the study all have risky substance use or an SUD.

The individuals in our sample, who all completed an ASI baseline assessment, represent approximately 40% of individuals who completed an ASI baseline interview in Sweden during the study period. Out the 15 012 study individuals about 1 in 10 died within the study period.

The NBHW, the Regional Ethical Review Board at Umeå University, and the University of Denver Institutional Review Board (IRB) reviewed and approved the study protocol. All study data were de-identified and the study met criteria for IRB exemption.

Key Independent Variable

Immigrant Status. A 5-category variable assessed first- and second-generation immigrant status and country of origin: individual and their parents all born in Sweden; individual born in Norway, Finland, or Denmark (first-generation immigrant); individual born outside of Sweden, Norway, Finland, or Denmark (first-generation immigrant); individual born in Sweden with at least one parent born in Norway, Finland, or Denmark and no parent outside of Nordic countries (second-generation immigrant); and individual born in Sweden with at least 1 parent born outside Nordic countries (second-generation immigrant). Category 1 was the reference group.

Control Variables

Age, reported at first ASI baseline, was recoded into a categorical variable where each category except for the last covered 5 years, for example, ages 18 to 24, ending with 52+ because of the low number of people over age 60 in our sample. The **gender** variable was dichotomous male and female and **level of education** at baseline was a continuous variable assessing number of years of education. The **ASI composite scores for severity of alcohol, drug, mental health, health, family and social relationships, employment, and legal problems** were also numeric variables (McGahan et al., 1986; McLellan et al., 1992) with higher scores indicating more problems/needs in the specific area. Each CS is the sum of answers to several questions within an ASI problem area. As recommended by the developer of the ASI CSs, equal weighting is given to all questions within a CS and we then adjust each composite for the answer range of each item and for the total number of items in the composite. The answer to each question is divided by the highest possible response, and by the total number of questions in the composite. This is the standard manner for how to calculate the scores (McLellan et al., 1992). The ASI psychometric properties have been tested extensively over many years in many different countries. These tests have shown good to excellent reliability and validity for the instrument, with some older findings that the reliability of the ASI mental health CS ranges from high to low (Makela, 2004; Samet et al., 2007; Armelius et al., 2009; Nyström et al., 2010; Pankow et al., 2012; Lundgren and Krull, 2018). Our recent study (Padyab et al., 2019) indicated that the ASI CS for mental health was a significant predictor of future inpatient hospitalization for mental health disorder.

Dependent Variables

The two dependent variables were *alcohol-related mortality* and *drugs other than alcohol, related mortality*. Alcohol-related mortality was a Yes/No dichotomous variable derived from the NBHW register database. Determination of alcohol-related deaths was based on *ICD-10* codes and defined as the assignment of a diagnosis related to alcohol consumption—diagnoses, such as alcoholism, toxic effect of alcohol, or mental and behavioral disorders because of use of alcohol, as either an underlying or a contributing cause of death. Information on causes of death was obtained from the national Cause of Death Registry.

Drugs other than alcohol related mortality was also a Yes/No dichotomous variable, derived from the NBHW register database. On the basis of the official Cause of Death Registry at the Swedish NBHW, a death is considered drug-related if a drug-related condition appears anywhere on the death certificate and are based on *ICD-10* codes (Leifman, 2016).

Statistical Analyses

Descriptive statistics were used to describe the sample. Cox proportional hazards regression modeling was applied to calculate crude and adjusted hazard ratios (HR) with 95% confidence intervals (CI) and to assess the relationships between the independent variable, control variables, and the outcome variables. Clients were followed until date of mortality, or the latest date for which they were known to be alive through December 31, 2017, whichever came first. Those who were alive during the course of the study were treated as censored data. Multivariate Cox regression was used to both explore if immigration status remained significantly associated with alcohol- or drugs other than alcohol-related mortality and if immigration status became associated

TABLE 1. Sample Description, n = 15 012

	Percent or Mean (SD)
Age (years)	38.9 (13.7)
Sex	
Female	29
Male	71
Education (years)	11.3 (2.8)
Immigration status	
Individual and their parents born in Sweden	67
Individual born in either Norway, Denmark, or Finland	4.6
Individual born outside of Sweden, Norway, Denmark, and Finland	12.2
Individual born in Sweden and at least one parent born in Norway, Denmark, or Finland (no other country outside Sweden)	7.7
Individual born in Sweden and at least one parent born outside Sweden, Norway, Denmark, and Finland	8.5
ASI composite scores	
Mental health	0.37 (0.27)
Family and social relationships	0.26 (0.23)
Employment	0.77 (0.29)
Alcohol	0.34 (0.29)
Drug use	0.13 (0.14)
Health	0.36 (0.34)
Legal	0.13 (0.22)

ASI, Addiction Severity Index; SD, standard deviation.

TABLE 2. Bivariate Descriptive Statistics in Relation to Cause-specific Mortality

	Still Living, Percent or Mean (SD)	Deceased, Percent or Mean (SD)	Crude Hazard Ratio (95% CI)
Alcohol-related Mortality			
Age group (year)	38.5 (13.6)	51.1 (10.3)	
18–24			1 (Ref)
25–32			2.0 (0.89–4.50)
33–42			4.5 (2.22–9.33)***
43–51			13.3 (6.8–26.2)***
52+			22.8 (11.7–44.5)***
Sex			
Female	97.7	2.3	1 (Ref)
Male	96.8	3.2	1.36 (1.08–1.71)**
Education (years)	11.3 (2.7)	11.2 (2.9)	0.99 (0.96–1.03)
Immigration Status			
Individual and their parents born in Sweden	96.68	3.32	1 (Ref)
Individual born in either Norway, Denmark, or Finland	93.86	6.14	1.72 (1.23–2.41)***
Individual born outside of Sweden, Norway, Denmark, and Finland	98.91	1.09	0.34 (0.21–0.54)***
Individual born in Sweden and at least one parent born in Norway, Denmark, or Finland (no other country outside Sweden)	97.59	2.41	0.72 (0.48–1.07)
Individual born in Sweden and at least one parent born outside Sweden, Norway, Denmark, and Finland	98.9	1.1	0.38 (0.22–0.64)***
ASI composite scores			
Mental health	0.37 (0.3)	0.28 (0.2)	0.35 (0.24–0.53)***
Family and social relationships	0.26 (0.2)	0.19 (0.2)	0.24 (0.15–0.40)***
Employment	0.77 (0.3)	0.78 (0.3)	1.15 (0.80–1.67)
Alcohol	0.33 (0.3)	0.48 (0.3)	4.68 (3.36–6.50)***
Drug use	0.13 (0.1)	0.04 (0.1)	0.002 (0.001–0.01)***
Health	0.35 (0.3)	0.45 (0.3)	2.44 (1.85–3.22)***
Legal	0.13 (0.2)	0.06 (0.1)	0.11 (0.05–0.22)***
Drugs other than alcohol related mortality			
Age group (year)	39.04 (13.6)	33.5 (11.2)	
18–24			1 (ref)
25–32			1.08 (0.82–1.44)
33–42			0.84 (0.63–1.13)
43–51			0.54 (0.38–0.76)***
52+			0.25 (0.16–0.39)***
Sex			
Female	98.5	1.45	1 (Ref)
Male	97.1	2.92	2.01 (1.52–2.65)***
Education (years)	11.2 (2.8)	10.9 (2.5)	0.97 (0.94–1.01)
Immigration status			
Individual and their parents born in Sweden	97.5	2.5	1 (Ref)
Individual born in either Norway, Denmark, or Finland	97.5	2.5	0.82 (0.47–1.40)
Individual born outside of Sweden, Norway, Denmark, and Finland	98.1	1.9	0.79 (0.55–1.13)
Individual born in Sweden and at least one parent born in Norway, Denmark, or Finland (no other country outside Sweden)	96.5	3.5	1.37 (0.96–1.93)
Individual born in Sweden and at least one parent born outside Sweden, Norway, Denmark, and Finland	97.5	2.5	1.11 (0.76–1.62)
ASI composite scores			
Mental health	0.36 (0.27)	0.42 (0.25)	2.83 (1.89–4.23)***
Family and social relationships	0.26 (0.23)	0.26 (0.22)	1.16 (0.71–1.87)
Employment	0.77 (0.29)	0.89 (0.21)	7.57 (4.26–13.47)***
Alcohol	0.34 (0.29)	0.26 (0.28)	0.40 (0.26–0.62)***
Drug use	0.13 (0.14)	0.20 (0.15)	28.9 (14.5–57.6)***
Health	0.35 (0.34)	0.42 (0.34)	1.76 (1.30–2.38)***
Legal	0.13 (0.22)	0.21 (0.26)	3.87 (2.57–5.83)***

****P* < 0.001.

ASI, Addiction Severity Index; CI, confidence interval; SD, standard deviation.

with drugs other than alcohol-related mortality if not significant at the bivariate level. Schoenfeld residual tests were used to check the key assumption (proportional hazards) in all Cox proportional hazard models. We tested for a nonzero slope in regression of the scaled Schoenfeld residuals on functions of time. A nonzero slope is an indication of a violation of the proportional hazard assumption. Our results confirm that Schoenfeld residuals were not correlated with survival time,

suggesting that the proportional hazards assumption is satisfied in the models. Analyses were performed using STATA version 15.1 (StataCorp, College Station, TX).

RESULTS

See Table 1 for a description of the study sample. Seventy-one percent of the sample was men. The mean age of the sample was 38.9 ± 13.7 years, and most (67%) of the

TABLE 3. Multivariate Cox Regression Model: Hazard Ratio (95% Confidence Interval) for the Alcohol-related Mortality in Relation to Immigration Status

Age group (year)	
18–24	1 (Ref)
25–32	2.09 (0.63–6.9)
33–42	5.48 (1.91–15.7)*
43–51	10.9 (3.9–30.2)*
52+	13.1 (4.7–36.4)*
Sex	
Female	1 (Ref)
Male	1.29 (0.9–1.8)
Immigration status	
Individual and their parents born in Sweden	1 (Ref)
Individual born in either Norway, Denmark, or Finland	1.34 (0.89–2.03)
Individual born outside of Sweden, Norway, Denmark, and Finland	0.52 (0.25–1.0)
Individual born in Sweden and at least one parent born in Norway, Denmark, or Finland (no other country outside Sweden)	0.82 (0.47–1.41)
Individual born in Sweden and at least one parent born outside Sweden, Norway, Denmark, and Finland	0.65 (0.30–1.39)
ASI composite scores	
Mental health	0.81 (0.44–1.50)
Family and social relationships	0.25 (0.12–0.52)*
Employment	–
Alcohol	2.54 (1.57–4.09)*
Drug use	0.05 (0.01–0.30)*
Health	1.89 (1.27–2.80)*
Legal	0.62 (0.25–1.55)

* $P < 0.001$.

ASI, Addiction Severity Index.

sample was originally from Sweden, with 12.2% born outside of Sweden, Norway, Denmark, or Finland.

Bivariate Statistical Analysis

Mortality Due to Alcohol and Mortality Due to Drugs Other Than Alcohol

The crude hazard ratios identified that immigration status, age, sex, and all ASI CS other than employment were associated with alcohol-related mortality (see Table 2). Also, crude hazard ratios identified that age, sex, and all ASI CS other than family and social relationship were significantly associated with drugs other than alcohol-related mortality. Immigration status, however, was not associated with drugs other than alcohol-related mortality at the bi-variate level.

Multivariate Regression Analysis

Mortality Due to Alcohol

The results from the Cox regression analysis (Table 3) identified age and ASI CS for alcohol, drugs other than alcohol, family and social relationship, and health remained significant predictors of alcohol-related mortality at the multivariate level. Specifically, the multivariate model (Table 3) indicated that after controlling for demographics and the ASI SCs significant at the bi-variate level, immigration status was no longer significant.

The strongest predictor of alcohol-related mortality was age, with those age 52 and over more than 13 times more

likely to die of alcohol-related causes compared with the age group 18–24. The second strongest predictor was the ASI CS for alcohol. Specifically, the higher this score the higher likelihood of alcohol-related mortality. Finally, ASI CS for family problems and ASI CS for drugs were negatively and significantly associated with alcohol-related mortality and ASI CS for health problems was positively and significantly associated with alcohol-related mortality.

Mortality Due to Drugs Other Than Alcohol

The finding described in Table 4 below indicates that immigration status became a significant predictor of mortality related to drug use other than alcohol at the multivariate level. Six variables were significantly associated with drugs other than alcohol-related mortality, ASI CS for drugs other than alcohol, employment, health, male sex, age, and immigration status.

Specifically, individuals born outside the Nordic countries were 61% less likely to die of drugs other than alcohol-related causes compared with individuals born in Sweden to parents born in Sweden. Those who had at least 1 parent from outside the Nordic countries were 54% less likely to die of drugs other than alcohol-related causes compared with individuals born in Sweden to parents born in Sweden. Those born in Norway, Denmark, or Finland, conversely, had 1.76 times higher likelihood of mortality related to drugs other than alcohol compared with their Swedish counterparts.

TABLE 4. Multivariate Cox Regression Model: Hazard Ratio (95% Confidence Interval) for Drugs Other Than Alcohol-related Mortality in Relation to Immigration Status

Age group (year)	
18–24	1 (Ref)
25–32	0.93 (0.64–1.34)
33–42	0.93 (0.63–1.36)
43–51	0.56 (0.35–0.88)**
52+	0.35 (0.18–0.65)***
Sex	
Female	1 (Ref)
Male	1.89 (1.32–2.69)***
Immigration status	
Individual and their parents born in Sweden	1 (Ref)
Individual born in either Norway, Denmark, or Finland	1.76 (0.98–3.16)*
Individual born outside of Sweden, Norway, Denmark, and Finland	0.39 (0.23–0.69)***
Individual born in Sweden and at least one parent born in Norway, Denmark, or Finland (no other country outside Sweden)	0.94 (0.58–1.49)
Individual born in Sweden and at least one parent born outside Sweden, Norway, Denmark, and Finland	0.46 (0.26–0.83)**
ASI composite scores	
Mental health	1.54 (0.87–2.71)
Family and social relationships	–
Employment	4.44 (2.21–8.95)***
Alcohol	0.64 (0.38–1.08)
Drug use	6.22 (2.18–17.7)***
Health	1.59 (1.05–2.42)*
Legal	0.94 (0.52–1.68)

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$.

ASI, Addiction Severity Index.

A number of the control variables remained significantly associated with drugs other than alcohol-related mortality. Specifically, being a male was positively associated and age was negatively associated with mortality because of drugs other than alcohol-related causes. The ASI CS for drugs other than alcohol was the strongest predictor of mortality related to drugs other than alcohol. Other CSs that remained significant at the multivariate level were the ASI employment and physical health scores.

SUMMARY AND DISCUSSION

At the bi-variate level, immigration status significantly predicted alcohol-related mortality but not drugs other than alcohol-related mortality. However, when demographics and the 7 ASI CSs were controlled for in the Cox regression models, the relationship between immigration status and mortality related to alcohol use did not remain significant whereas the relationship between immigration status and mortality because of drugs other than alcohol became significant. At the multivariate level, individuals born in Nordic countries outside Sweden were almost twice as likely, 1.76 times, to die of drugs other than alcohol-related causes compared with their Swedish counterparts. Also, being born outside of a Nordic country or having parents who were born outside of a Nordic country seemed to be protective factors, significantly associated with lower likelihood of dying from drugs other than alcohol. Hence, the “Healthy Immigrant Effect” theory only seemed to hold true for drug use other than alcohol use, and for immigrants from non-Nordic countries, whether they were first- or second-generation immigrants, and did not hold true for first-generation immigrants from Finland, Denmark, and Norway.

The primary factor associated with death of alcohol-related causes was age and ASI CS for alcohol. Given that, for example, those who were age 52 and older had a more than 13 times higher likelihood of dying compared with the youngest age group (18–24), it is not surprising that a number of other factor, such as sex and immigration status, lost their significance at the multivariate level. This finding aligns with findings from other studies that have used registry data to examine the mortality of individuals who entered mandatory treatment because of their severity of SUD (Hall et al., 2015). Hence, policy and program efforts aimed at reducing alcohol-versus drugs other than alcohol-related mortality rates in Sweden need to target different age groups.

It is notable that ASI CS for alcohol, drugs other than alcohol, health, and family and social relationships remained strongly significant at the multivariate level, indicating that ASI CSs have good predictability for future health of adults with risky substance use or SUD.

An unexpected finding was that individuals with higher ASI CSs for family problems and needs had lower rates of alcohol-related mortality. One possibility for this finding may be that individuals dying of alcohol-related causes were socially isolated, and therefore reported fewer family problems compared with their counterparts. Also, the ASI CS for drugs other than alcohol was negatively related to dying of alcohol-related causes. This may be because of that until the

late 20th century, very few individuals used drugs other than alcohol, and alcoholism was quite high in Sweden.

Finally, having a higher ASI CS on health (ie, reporting more problems and needs with respect to health) was a significant predictor of both alcohol- and drugs other than alcohol-related mortality.

DISCUSSION

First, it is clear from study findings that separate subgroups of the Swedish population have elevated risks of alcohol- and of drugs other than alcohol-related mortality. One factor that predicted mortality because of both alcohol-related causes and drugs other than alcohol-related causes was having a higher ASI CS for health, that is, reporting more physical health problems. Third, the ASI CS baseline for health seems to consistently predict later health problems, including hospitalization and disability. This is true in our current study as well as in our other registry studies (Padyab et al., 2018; Lundgren et al., forthcoming). This is of value to know so that those who conduct the ASI baseline interviews make certain to connect individuals with high ASI health CS to medical services.

Second, it is difficult to assess why individuals from Finland, Norway, and Denmark who reside in Sweden have higher drugs other than alcohol-related mortality rates even when controlling for the 7 ASI CSs and demographics compared with both Swedish individuals born to Swedish parents and those who are first- and second-generation immigrants from non-Nordic countries. Possibly, individuals in this subgroup may already have drug-related problems before immigration. Also, they may be immigrating to Sweden for very different reasons than individuals who come from non-Nordic countries, many who are first- or second-generation refugees. Some may, for example, seek treatment, or some may seek a greater sense of invisibility as people who use drugs other than alcohol. Finally, there may be normative differences in drug use other than alcohol between the Nordic countries.

Fourth, it is concerning that a consistent pattern in Sweden is that young (18–24) men seem to be at a highest risk of drugs other than alcohol (primarily opioid-related) mortality. Significant prevention efforts need to be developed, and these prevention programs need to be provided throughout the Swedish school system, pediatric clinics, employment training programs, and other places where youth and young adults in Sweden can be reached.

Study Limitations

First, readers should be careful about making comparisons of immigrant substance-related mortality between or across countries based upon the findings of our study and studies reviewed, as many contextual, political, and intervening factors are unique to each country and may be reflected in these findings.

Second, registry data always come with a range of limitations, such as variation in assessment capacity and missing data. This study is fortunate in that those who conduct ASI interviews in Sweden receive high quality and ongoing training in interview data collection to ensure accurate data and, of note, there was very little missing data in the data set

used for analyses. Second, it is important to note that in using these large databases, we are not predicting the significance of the total model. The aim here was to examine the relative importance of a demographic factor, here immigration status, and identify if this factor was or remained a significant predictor when controlling for other factors known to effect alcohol- or drugs other than alcohol-related mortality.

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