Empirical Economics (2024) 66:1287–1310
https://doi.org/10.1007/s00181-023-02483-x

The causal impact of mental health on tobacco and alcohol consumption: an instrumental variables approach

Francis Mitrou[1,2] · **Ha Trong Nguyen**[1,2] · **Huong Thu Le**[1,2] · **Stephen R. Zubrick**[1,2]

Received: 7 October 2022 / Accepted: 3 August 2023 / Published online: 18 August 2023

Abstract

The reciprocal relationship between psychiatric and substance use disorders is well-known, yet it remains largely unknown whether mental health morbidity causally leads to addictive behaviours. This paper utilises a fixed effects instrumental variables model, which is identified by time-varying sources of plausibly exogenous variations in mental health, and a nationally representative panel dataset from Australia to present robust evidence on the causal impact of mental distress on cigarette smoking and alcohol drinking behaviours. We find that mental distress significantly increases the prevalence and intensity of either cigarette or alcohol consumption. Further analysis reveals that mental distress also substantially increases household monetary expenditures on either tobacco or alcohol. The impact is greater for lower educated individuals or children of smokers, and is slightly higher for males. Our findings highlight the importance of mental health screening and treatment programs, especially among lower educated individuals or children of smokers, to assist in the prevention of addictive activities.

Keywords Mental health · Depression · Smoking · Drinking · Alcohol addiction · Instrumental variables

JEL Classification C26 · I10 · I12 · I14

[1] We follow previous studies (Frijters et al. 2014; Nguyen & Connelly 2018; Yang and Zikos 2022) which use the same dataset and similar "mental health" measures to adopt the term "mental health" in this paper. Moreover, we employ the terms "mental health disorders", "mental distress", "mental illness" or "mental health issues" interchangeably in this paper, mainly because there is no commonly agreed practice on which term to use (Fluharty et al. 2017). Furthermore, cigarette smoking and alcohol drinking have been identified as "addictive behaviours" (Grant et al. 2010).

✉ Ha Trong Nguyen
ha.nguyen@telethonkids.org.au

[1] Telethon Kids Institute, Perth, Australia

[2] Centre for Child Health Research, The University of Western Australia, Perth, Australia

1 Introduction

Mental health disorders and addictive behaviours[1] are two public health issues that are estimated to impose significant socio-economic costs to the global economy (OECD 2014; Chisholm et al. 2016; Prochaska et al. 2017; WHO 2017). Individuals with mental health disorders disproportionally engage in more addictive behaviours such as smoking, drinking, gambling, or using illicit drugs (Lawrence et al. 2009; Moylan et al. 2012; Lalanne et al. 2016). Addictive behaviours are difficult to manage and even more so for people with mental health problems (Nunes and Levin 2004; Kalman et al. 2005). To optimize public health interventions and medical treatments it is important to understand whether mental health disorders cause addictive behaviours.

The bi-directional relationship between mental health disorders and addictive behaviours is contended, with inconclusive evidence from different studies using data from various countries and methods (Fluharty et al. 2017). Furthermore, it remains challenging to determine the causal impact of mental health disorders on addictive behaviours due to issues of individual unobservable factors, reverse causality and measurement errors. In particular, omitted variables, such as genetic factors, may influence both mental health and addictive behaviours (Volkow and Li 2005). Reverse causality may be an issue as individuals with mental health problems are more likely to smoke or drink (Khantzian 1987) but consumption of addictive substances may worsen health, including mental health (Volkow et al. 2014). Measurement error would be another problem because researchers typically rely on information reported by respondents when using survey data, and this can be subject to participant recall bias and interpretation error in relation to collection instruments. These self-reported addictive behaviours may be influenced by participant mental health status, causing a bias in the estimate of the contribution of mental health to addictive behaviours. Studies in the current literature have not been successful in addressing all three issues at the same time (see Sect. 2 for a literature review), resulting in uncertainty around the interpretation of casual estimates of mental health on addictive behaviours.

In this paper, we employ a fixed effects instrumental variables (FE-IV) model, which is identified by time-varying sources of plausibly exogenous variations in mental health, to estimate the causal impact of mental health on addictive behaviours. We apply this FE-IV model to 18 waves of high-quality Australian longitudinal data to simultaneously tackle the above three research challenges.

Specifically, we employ the death of a close friend as an instrument in mental health equations. This instrument influences many individuals in our data, varies significantly over time for the same individuals and displays a strong causal relationship with subsequent mental health. Moreover, results from a series of robustness tests indicate that this instrument is empirically strong. This study thus improves on most previous research by employing an individual FE-IV model approach to address the endogeneity of mental health and provides more robust evidence on the causal impact of mental health on consumption of alcohol and tobacco.

Our study produces three main results. First, we show that mental distress leads to a measurable increase in the consumption of either cigarettes or alcohol. Second, in line with the mental distress-induced impact on cigarette or alcohol consumption, our results indicate that mental distress also considerably raises household monetary

expenditures on tobacco and/or alcohol. Third, the mental distress-attributable impact on smoking and drinking is greater for persons with lower levels of education or those whose parents were smokers, and somewhat higher for males.

This paper proceeds as follows: Sect. 2 briefly reviews the related literature, while Sect. 3 discusses the data. Section 4 details our empirical framework, and Sect. 5 presents the empirical results. Section 6 reports results for various sub-groups and Sect. 7 concludes the paper.

2 Literature review

This paper explores the impact of mental health on addictive behaviours, relating itself to a very rich literature on the connection between mental health and addictive behaviours.[2] This literature has documented a strong positive association between mental distress and substance use disorders (Lawrence et al. 2009; Moylan et al. 2012; Lalanne et al. 2016). Longitudinal studies in this literature have also explored the bi-directional comorbidity between mental health disorders and addictive behaviours.[3] Evidence so far suggests positive associations in both directions: some studies found substance use disorders were associated with subsequent anxiety disorders (Johnson et al. 2000; Klungsøyr et al. 2006; Marsden et al. 2019) while other studies reported mental distress was associated with later substance use (Zubrick et al. 2012; Katz et al. 2013; Kim-Mozeleski et al. 2020). Some studies go further to establish a bi-directional relationship between mental health and substance use disorders (Kendler et al. 1993; Breslau et al. 1998; Needham 2007; Leung et al. 2012; Ranjit et al. 2019).

Although panel studies can establish the reciprocal association between substance use disorders and mental health problems, their findings can be confounded by unobservable characteristics, such as genetic factors or personal traits, that are associated with both substance use and mental disorders (Wooldridge 2010). To address the issue of unobservable individual heterogeneity, some studies have employed an individual fixed effects (FE) model (Boden et al. 2010; Fergusson et al. 2011; Horwood et al. 2012). The FE results appear to confirm the bi-directional link between mental health disorders and substance use. While the individual FE model can help address the unobservable individual heterogeneity issue, it cannot deal with the reverse causality and measurement error issues, preventing these longitudinal studies from drawing

[2] This paper is also related to the economic literature on addictive behaviours. See, for example, Sloan and Wang (2008) for a review on economic theory and evidence on smoking behaviours and Lillard (2020) on the economics of nicotine consumption.

[3] Potentially due to availability of cigarette smoking information in datasets used and the apparent socio-economic costs of smoking, studies in this literature usually focus on the relationship between cigarette smoking and mental health. See, for instance, Fluharty et al. (2017) for a recent review on this relationship. A related line of research focuses on the change in mental health after smoking cessation. The dominant evidence from this line of studies suggests that smoking cessation is associated with reduced depression, anxiety, and stress (Taylor et al. 2014b). Establishing the causal link between mental disorders and addictive behaviours conclusively would require evidence from randomised trials, which is hard to achieve in modern times due to the understandable ethical constraints that surround designs involving human subjects. Following this direction, studies have employed experiments on animals. For instance, Iñiguez et al. (2009) experimented with varying nicotine exposure to rats to find that nicotine exposure during adolescence causes a depression-like status in adulthood.

a definitive conclusion about the causality of any link between substance use and depression.

To provide causal evidence on the impact of substance use, which is dominantly measured by cigarette smoking, on depression, some studies have employed an instrumental variables (IV) method. In particular, Mojtabai and Crum (2013) used state-level cigarette taxes and public perceptions toward smoking as instruments for smoking behaviours to show that smoking regularly increases the risk for developing mood and anxiety disorders. Furthermore, an increasing number of studies have employed a Mendelian randomization method, using a genotype known to affect tobacco consumption as an instrument for cigarette smoking, to examine the causal impact of smoking in anxiety and depression. Evidence from these studies commonly suggests that smoking does not lead to mental health issues (Lewis et al. 2011; Bjørngaard et al. 2013; Taylor et al. 2014a; Skov-Ettrup et al. 2016).

Overall, our review of the literature indicates that while several efforts have been made to examine a causal bi-directional link between mental health disorders and substance use, the current literature has not successfully established the causal impact of mental health on addictive behaviours given limitations of the methods used. We extend on these studies to combine both individual FE and IV methods in a unified framework to provide a more rigorous investigation into the causal effects of mental health on the consumption of alcohol and tobacco.

3 Data and sample

3.1 Data

Our data source is from waves 2 to 19 (year 2002 to 2019) of the Household Income and Labour Dynamics in Australia (HILDA) survey.[4] HILDA is a nationally representative annual panel survey from Australia (Summerfield et al. 2019). It began in 2001 with a sample of 7,682 households and 13,969 individuals. In each wave, interviews are conducted with all household members who are 15 years of age or older at the survey time. Interviews are administered in-person and by telephone, with supplemental questionnaires collected via mail. The data contain comprehensive information at the individual and household level, including information on mental health and addictive behaviours of surveyed individuals (see Appendix Table A1 for details on variable description and summary statistics).

3.2 Mental health measures

Our main measure of mental health is derived from the Mental Health Inventory (MHI-5), a subscale of the 36-Item Short Form Health Survey (SF-36) (Ware et al. 1994). This subscale is constructed from responses to five questions asking the respondents about how often during the past four weeks that they have (1) "been a nervous person", (2)

[4] We do not use wave 1 of HILDA because information to construct our instrument is only available from wave 2 onwards.

"felt so down in the dumps nothing could cheer you up", (3) "felt calm and peaceful", (4) "felt down", and (5) "been a happy person". The respondent could select one of six responses that range from "all of the time" (1) to "none of the time" (6). We construct a mental health index by summing scored responses to these five questions, with reverse coded responses for the first four questions. We then standardize this index to have a mean of zero and a standard deviation of one. By construction, a greater value of this index indicates a higher level of psychological distress, which is associated with poorer mental health. To differentiate with the original MHI-5 index, we name our mental health indicator as "standardized reversed MHI-5" index.

This index is strongly correlated (with the magnitude of 0.81 and the correlation is statistically significant at the 1% level–see Appendix Table A2)) with the commonly used Kessler Psychological Distress Scale (K10) score, which has been collected biennially since wave 7 of HILDA.[5] This index is also highly associated with a clinically diagnosed depression or anxiety indicator which was collected in waves 9, 13 and 17 of HILDA: the correlation is 0.41 and statistically significant at the 1% level (see Appendix Table A2). This measure has been employed extensively in Australia (Frijters et al. 2014; Nguyen and Connelly 2018; LaMontagne et al. 2020; Yang and Zikos 2022) and internationally (Ware et al. 2000). We employ this standardized reversed MHI-5 subscale in the main analysis for two reasons: (1) it is available in all waves of HILDA, enabling us to have a sufficiently large sample to implement some subgroup analyses and (2) as demonstrated above, this subscale has been proven to be a psychometrically sound measure of mental health (Berwick et al. 1991; Ware et al. 2000). In Sect. 5.3 we will test the sensitivity of the results by employing other mental health measures available in the data such as K10 and some variations of mental health measures constructed from SF-36 (ABS 1997).

3.3 Addictive behaviour measures

We consider two types of addictive behaviours: tobacco smoking and consumption of alcohol. For smoking behaviours, we use three self-reported measures. The first measure is a dummy variable called "smoker" indicating whether the individual smoked cigarettes or used any other tobacco products at the time of the survey. The second measure denoted by "daily smoker" is an indicator describing whether the individual smoked daily at the time. We further employ the "weekly number of cigarettes" the individual usually smoked each week as the third measure of smoking.

We also employ three self-reported measures to capture drinking behaviours. We first use a dummy variable (referred as "drinker" thereafter) to indicate whether the

[5] Specifically, K10 is constructed using responses to a set of 10 questions with the preamble "The following questions are about your feelings in the past 4 weeks. In the last four weeks, about how often did you feel: (1) depressed, (2) everything was an effort, (3) so nervous that nothing could calm you down, (4) so restless that you could not sit still, (5) hopeless, (6) nervous, (7) restless or fidgety, (8) so sad that nothing could cheer you up, (9) tired out for no good reasons, and (10) worthless?". Responses to each question are recorded in a five-point scale, ranging from "all of the time" (1) to "none of the time" (5). As has been done with the MHI-5 subscale, we construct our K10 index by summing scored responses to the 10 questions and standardize it to have a zero mean and a standard deviation of one. Similar to the MHI-5 index, a higher value of our K10 index also indicates a poorer mental health status.

individual drank alcohol at the survey time. Moreover, we employ an indicator called "daily drinker" which describes whether an individual drank alcohol every day to capture their drinking frequency. Given evidence on potential health benefits associated with low-moderate alcohol consumption (Mukamal et al. 2003; Knott et al. 2015), it is uncertain whether "drinker" or "daily drinker" variable captures potentially harmful drinking. To further gauge drinking intensity, we use the Australian standard gender-based benchmark for potentially harmful drinking (NHMRC 2009) to construct a variable denoted by "excessive drinker" to describe whether the individual usually drank 5 or more (for females) or 7 or more (for males) standard drinks per day.[6] Thus, by construction (NHMRC 2009), this excessive drinking variable captures high risk drinking behaviour reported by individuals in this study.

3.4 Sample

We restrict the sample to individuals who are observed on at least two occasions during the study period because we mainly use a FE model. We further exclude observations with missing information on any variable that we control for in empirical model. These restrictions result in a final sample, which varies by addictive outcomes, of about 23,6500 individual-year observations from roughly 24,700 unique individuals observed over 18 years.

3.5 Descriptive analyses

Summary statistics for main outcomes and other characteristics by mental health status are presented in Table 1. Table 1 indicates that individuals with poorer mental health (i.e., individuals with standardized reversed MHI-5 > median) were appreciably different from those with better mental health. Individuals with poorer mental health were more likely to be female, younger, were less likely to be in a marital relationship, were more likely to be Aboriginal or to have come to Australia from a Non-English Speaking Background (NESB) country or were more likely to have lower education. Table 1 also reveals that individuals with poorer mental health were more likely to engage in smoking or harmful drinking, as measured by excessive drinking. By contrast, individuals with poorer mental health were less likely to engage in more moderate drinking patterns, as represented by drinking or daily drinking. However, it is important to note that these relationships between mental health and addictive behaviours could be

[6] We do not use the current NHMRC alcohol consumption benchmark which was introduced in December 2020 because this new guideline was not available to individuals surveyed during our study period (i.e., 2001 – 2019). Nevertheless, using this new and more restrictive benchmark which suggests "no more than 10 standard drinks a week and no more than 4 standard drinks on any one day" for healthy men and women (NHMRC 2020) does not change our findings. We do not use the number of standard drinks per day as an outcome because responses to a question asking about this are recorded in bands (e.g., "1 to 2 standard drinks" or "3 to 4 standard drinks") and top-coded (i.e., "13 or more standard drinks"). Our data also show that the six measures of addictive behaviours used in this paper are positively and highly statistically correlated (at the 1% level) with one another. Furthermore, each of these addictive measures is positively and statistically significantly (at the 1% level) associated with an indicator describing whether the individual had ever used any illicit drug (see Appendix Table A2). We do not employ illicit drug use as an additional measure for addictive behaviours because the question about drug use is only asked in wave 17 of HILDA.

Table 1 Sample means of outcomes and key covariates by mental health condition

	Poorer mental health	Better mental health	Poorer mental health–better mental health
	(1)	(2)	(3)
Male	0.46	0.51	−0.05***
Age (years)	49.54	51.84	−2.3***
Married/De facto	0.65	0.73	−0.08***
Separated/divorced/widowed	0.18	0.15	0.03***
Aboriginal	0.02	0.01	0.01***
Non-English-Speaking migrant	0.17	0.12	0.04***
English-speaking migrant	0.10	0.11	−0.01***
Year 12	0.14	0.13	0.01***
Vocational and training qualification	0.36	0.40	−0.04***
Bachelor or higher degree	0.18	0.19	−0.01***
Number of household members	2.68	2.68	0.00
SF36 mental component summary	0.60	−0.66	1.27***
SF36 9-item mental health index	0.75	−0.73	1.48***
K10	0.49	−0.60	1.09***
Smoker	0.20	0.14	0.06***
Daily smoker	0.17	0.12	0.05***
Weekly number of cigarettes	16.96	11.72	5.24***
Drinker	0.79	0.84	−0.05***
Daily drinker	0.07	0.09	−0.01***
Excessive drinker	0.09	0.07	0.02***
Number of observations	117,537	117,841	

Figures are sample means. Estimated sample from the regression of "smoker" as an outcome. Tests are performed on the significance of the difference between the sample mean for individuals with "poorer mental health" (identified as those with standardized reversed MHI-5 > median of this mental health variable among individuals included in the final sample) and those with "better mental health" (standardized reversed MHI-5 < = median). The symbol *denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level

driven by unobserved characteristics, reverse causality, and measurement errors. We will address these three issues using FE-IV regressions in the following sections.

4 Empirical framework

We use the following model to estimate the impact of mental health MH_{it} on addictive outcome Y_{it} of individual i at time t:

$$Y_{it} = \alpha + \beta MH_{it} + X_{it}\gamma + \delta_i + \mu_{it} \quad (1)$$

In Eq. (1), X_{it} is a vector of individual characteristics and μ_{it} is an error term. α, β and γ are parameters to be estimated and β is our interested parameter. We include in X_{it} a parsimonious list of characteristics of the individuals or their households, including gender, age (and its square), marital status, Aboriginal status, migration status, education, and household size. We also control for temporal differences in addictive behaviours by including dummies for years and quarters of survey time in all regressions. We additionally control for differences in local socio-economic environments which may influence the individual behaviours by including a relative socio-economic disadvantage index, regional unemployment rates, a metropolitan dummy and state/territory dummies.

Equation (1) which controls for time-invariant individual unobservable characteristics (δ_i) helps address the issue of unobservable individual heterogeneity (such as genetic endowments or discount rate) which is correlated with both mental health and addictive behaviours. However, it cannot deal with reverse causality and measurement error issues which originate from the likelihood that unobserved time-variant, individual-specific factors (μ_{it}) co-vary with both the mental health and addictive behavioural outcomes. We further tackle the possible endogeneity issue of mental health in Eq. (1) by employing an instrumental variables approach. In particular, we introduce an auxiliary equation for mental health:

$$MH_{it} = \pi + X_{it}\tau + Z_{it}\sigma + \delta_i + \omega_{it} \tag{2}$$

in which Z_{it} is a $1 * \mathrm{D}$ vector of instruments ($D \geq 1$), ω_{it} is an error term, and τ and σ are vectors of parameters to be estimated. Instrumental variable(s) in Z_{it} must satisfy three conditions (Wooldridge 2010): (i) they must be adequately correlated with MH_{it}; (ii) they must be uncorrelated with Y_{it} except through MH_{it}; and (iii) they cannot be associated with individual time-varying unobservable factors in the addictive behaviour equation.

We propose to use the death of a close friend as an instrument for the mental health variable in Eq. (2). This instrument has been successfully employed in previous studies to investigate the causal effects of mental health on labour supply (Frijters et al. 2014), educational attainment (Johnston et al. 2014), physical health (Yang & Zikos 2022) or children's developmental outcomes (Le & Nguyen 2017, 2018). We thus adopt death of a close friend as the instrument to examine the impact of mental health on addictive behaviours in this paper. As discussed in previous studies (Frijters et al. 2014; Johnston et al. 2014), the death of a close friend is likely to satisfy the above mentioned three requirements to be a good instrument.[7] Specifically, the death of a close friend has been found to worsen mental health (Frijters et al. 2014; Johnston et al. 2014). This instrument is also theoretically sound: the plausibly exogenous[8] death of a close friend

[7] In HILDA, individuals are asked "Did any of these happen to you in the past 12 months?". We use the statement about "Death of a close friend" to construct the instrument. We purposely do not use the death of family members or close relatives as an instrument because these deaths may signal genetic risks, lead to windfall income (in form of inheritance from deceased relatives) or directly influence the addictive behaviours of other household members or relatives.

[8] Our empirical framework is akin to that in a recent study by Friedman (2020). In particular, Friedman (2020) finds that life stressful events such as death of a non-family member statistically significantly

directly affects the individual's mental health, but only indirectly affects their addictive behaviours through the mental health channel. As has been done in previous studies, we will empirically test the strength of this instrument against the criterium (iii) by controlling for numerous time-variant variables, including physical health, which are likely correlated with our instrument in Sect. 5.3.

We apply an IV model to panel data in an FE-IV model to control for both time-invariant and time-variant unobserved factors. To estimate Eq. (1), we employ an Ordinary Least Squares (OLS) method. We model all outcomes as linear.[9] Furthermore, we use a Two-Staged Least-Squares (2SLS) method to estimate the system of Eqs. (1) and (2). In all regressions, robust standard errors are clustered at the individual level to account for serial correlation.

5 Empirical results

5.1 Main results

Estimates of mental health as measured by standardized reversed MHI-5 on various addictive outcomes are reported in Table 2. In Table 2 we report estimates and relevant statistics from four alternative specifications: (i) "Pooled OLS" results estimated from a model similar to Eq. (1) without controlling for individual heterogeneity, (ii) "FE" results estimated from Eq. (1), (iii) "Pooled-IV" results estimated from Eqs. (1) and (2) without controlling for individual heterogeneity, and (iv) "FE-IV" results estimated from Eqs. (1) and (2). We report pooled results to compare with those presented in most of the prior literature which does not account for individual FEs.

Pooled OLS results (reported in columns 1, 5 and 9 of Table 2) show strong associations (with the estimates are all statistically significant at least at the 5% level) between mental distress and all six addictive outcomes considered. Furthermore, while mental distress is negatively associated with the probability of drinking, it is positively associated with other five addictive behavioural outcomes. These results suggest that individuals with poorer mental health are less likely to drink. By contrast though, they are more likely to smoke, smoke more frequently (as measured by smoking daily or smoking more cigarettes per week) or engage in potentially dangerous drinking (as represented by drinking daily or drinking excessively). Our pooled OLS results are thus in line with those reported in the previous cross-sectional studies which consistently show that individuals experiencing mental distress disproportionally engage in smoking or harmful drinking (Lawrence et al. 2009; Moylan et al. 2012).

FE estimates (reported in columns 2, 6 and 10 in Table 2) show that controlling for the individual FE changes the results considerably. For instance, accounting for

Footnote 8 continued
increases subsequent initiation and intensity of smoking among adolescents in the US. The empirical model applied by Friedman (2020) to explore the impact of these life stressful events on subsequent smoking behaviours is similar to a reduced form of our empirical model in which a similar life stressful event is employed as an instrument for mental health in the first stage regression (Angrist & Pischke 2008).

[9] We also employed a Probit model for all binary outcome variables. Appendix Table A3 indicate that pooled Probit results are largely similar to the pooled OLS results (reported in Table 2) in terms of the magnitude and statistical significance level, suggesting that our results are not driven by the linearity assumption.

Table 2 Impact of mental health on addictive behaviours—results from various models

Panel A: Smoking outcomes	Pooled OLS	FE	Pooled IV	FE-IV	Pooled OLS	FE	Pooled IV	FE-IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Smoker				Daily smoker			
Stand. rev. MHI-5	3.80***	0.70***	41.84***	19.96***	3.27***	0.47***	32.59***	11.56***
	[0.20]	[0.10]	[4.84]	[4.30]	[0.18]	[0.09]	[4.14]	[3.62]
Observations	235,378	235,378	235,378	235,378	235,378	235,378	235,378	235,378
Individuals	24,678	24,678	24,678	24,678	24,678	24,678	24,678	24,678
Mean of dep. variable	18.99	18.99	18.99	18.99	15.45	15.45	15.45	15.45
F-statistic of IV			117.34	76.37			117.34	76.37
Hausman test (p value)			0.00	0.00			0.00	0.00
Panel B: Drinking outcomes	Drinker				Daily drinker			
Stand. rev. MHI-5	- 1.29***	0.02	16.42***	16.08***	0.24**	0.34***	0.10	0.13
	[0.19]	[0.11]	[3.88]	[4.49]	[0.11]	[0.06]	[2.50]	[3.33]
Observations	235,389	235,389	235,389	235,389	235,389	235,389	235,389	235,389
Individuals	24,697	24,697	24,697	24,697	24,697	24,697	24,697	24,697
Mean of dep. variable	81.61	81.61	81.61	81.61	6.92	6.92	6.92	6.92
F-statistic of IV			115.86	75.53			115.86	75.53
Hausman test (p value)			0.00	0.00			0.96	0.95

Table 2 (continued)

Pooled OLS	FE	Pooled IV	FE-IV
(9)	(10)	(11)	(12)
Weekly number of cigarettes			
3.58***	0.56***	32.27***	10.97**
[0.24]	[0.12]	[4.78]	[4.74]
234,604	234,604	234,604	234,604
24,628	24,628	24,628	24,628
14.69	14.69	14.69	14.69
		113.45	74.31
		0.00	0.02
Excessive drinker			
1.31***	0.94***	22.42***	17.66***
[0.12]	[0.10]	[3.10]	[4.28]
235,049	235,049	235,049	235,049
24,665	24,665	24,665	24,665
11.42	11.42	11.42	11.42
		113.63	77.81
		0.00	0.00

"Pooled OLS" results are from the regression (1) without controlling for individual FEs while FE results are from the regression (1). Pooled-IV results are from models (1) and (2) without controlling for individual FEs while FE-IV results from models (1) and (2). "F-statistic of IV" denotes the F statistic for the strength of the excluded instrument in the first stage regression. "Hausman test (p value)" denotes p value from a Hausman test for endogeneity of the mental health variable in Eq. (1). Other explanatory variables include gender, age (and its square), migration status, Aboriginal status, marital status, education, household size, local socio-economic background variables, state/territory dummies, year dummies, and survey quarter dummies. Robust standard errors clustered at the individual level in parentheses. For all binary outcome variables, results (coefficient estimates, standard errors and sample means) are multiplied by 100 for aesthetic purposes. The symbol *denotes significance at the 10% level, **at the 5% level, and ***at the 1% level

individual heterogeneity reduces the magnitude of the mental distress estimates for all three smoking outcomes and the excessive drinking indicator, with the reduction ranging from 28% (as in the estimate on excessive drinking) to 86% (daily smoking). Controlling for the individual confounders also turns the estimate of mental distress on drinking from negative and highly statistically significant to positive and statistically insignificant.

The above comparisons between pooled OLS and FE estimates suggest that failing to account for individual unobserved characteristics may result in over-reporting the positive association between mental distress and addictive behaviours. One of the unobserved characteristics would be discount rates as individuals with a higher discount rate, who value current consumption more than future consumption, typically tolerate higher risk lifestyles and invest less in their current health (Grossman 1972). Another unobserved characteristic could be some generic factors that are correlated with both mental health and addictive behaviours (Wang et al. 2012; Pasman et al. 2018; Lillard 2020). Therefore, the simple regression which does not control for such unobserved characteristics over-estimates the positive effect of mental distress on addictive behaviours. The same pattern is also observed in other studies employing an individual FE model to document the bi-directional relationship between mental health and substance use disorders (Needham 2007; Leung et al. 2012; Ranjit et al. 2019). As discussed above, while the FE estimator helps control for time-invariant individual characteristics, it cannot deal with issues associated with reverse causality and measurement errors. We next turn to results obtained from the FE-IV estimator, which simultaneously addresses all three issues.

FE-IV estimates are represented in columns 4, 8 and 12 of Table 2.[10] The lowest first-stage F statistic is 74, rejecting the null hypothesis of a weak instrument (Stock & Yogo 2005).[11] Table 2 also shows that, as compared to a FE-IV model, employing a FE model alone greatly under-estimates the impact of mental distress on all three smoking outcomes and the excessive drinking outcome. In particular, the estimate of mental distress is about 18 (as in the case of excessive drinking) to 28 (as in the case of smoking) times greater in the FE-IV estimator than in the FE estimator while being statistically significant at least at the 5% level in both estimators. In terms of magnitude, the FE-IV estimates indicate that a one-standard-deviation increase in mental distress increases the probability of (i) smoking by 28 percentage points (pp)

[10] For comparison purposes, we also report pooled IV regression results in columns 3, 7 and 11 of Table 2. In line with the FE-IV results, the pooled IV results show positive and statistically significant estimates of mental illness on all addictive outcomes except the daily drinking indicator. In our IV approach, pooled IV regressions may provide inaccurate estimates because they don't control for time invariant unobservable factors which may be associated with the instruments and addictive outcomes at the same time.

[11] First-stage regression results from pooled IV and FE-IV estimator are reported in column 1 and 2, respectively, of Appendix Table A4. The results are largely in line with those documented in other studies (Frijters et al. 2014; Johnston et al. 2014). For instance, the death of a close friend statistically significantly deteriorates mental health. Moreover, age has an inverse U-shape relationship with mental illness and marital breakdown worsens mental health. Appendix Table A5 reports estimation results of remaining variables from second-stage regressions. The results are largely as expected. For example, smoking (either prevalence or intensity) decreases with age. In addition, while drinking and daily drinking increases, at a decreasing rate, with age, excessive drinking decreases, at an increasing rate, with age. While education has no clear relationship with smoking and drinking behaviours, increased household size consistently decreases these two addictive behaviours.

(corresponding to 105% of the sample mean), (ii) smoking daily by 12 pp (75% of the sample mean), and (iii) drinking excessively by 18 pp (155% of the sample mean). Similarly, a one-standard-deviation increase in mental distress is found to raise the number of cigarettes smoked per week by 11 (equivalent to 75% of the sample mean).

Table 2 additionally represents that the FE-IV estimator turns the estimate of drinking from statistically insignificant to statistically significant (at the 1% level). The FE-IV result thus indicates that mental distress leads to drinking and the estimated impact is relatively large in magnitude: a one-standard-deviation increase in mental distress raises the drinking probability by 16 pp (or 20% of the sample mean). Table 2 also shows the considerable changes in the estimates of mental distress on the above addictive measures are in line with results from a Hausman test which suggest mental distress is endogenous when modelling these outcomes. Therefore, the results indicate that failing to adjust for the endogeneity of mental distress would considerably under-estimate the positive impact of mental distress on these addiction measures.

The FE-IV estimate of mental distress on the daily drinking indicator is not statistically significant at any conventional level. This non-significant estimate is consistent with the result from a Hausman test which indicates that we can model the mental health and daily drinking outcome independently. Thus, the results from two Hausman-styled tests[12] support the use of a FE estimator to model the impact of mental distress on the probability of drinking daily. As discussed above, the FE results show that mental distress statistically significantly (at the 1% level) increases the chance of drinking daily, albeit at a rather small magnitude: an increase of one standard deviation of mental distress raises the daily drinking probability by 0.34 pp (or 5% of the sample mean).

5.2 Discussion

In summary, we interpret these results to show that mental distress considerably increases the prevalence and intensity of either cigarette or alcohol consumption. Our finding is in line with the self-medication hypothesis, first introduced by Khantzian (1987), in which individuals engage in these addictive activities to cope with stress. In particular, agonists of nicotinic cholinergic receptors, including nicotine itself, contained in cigarettes can temporarily relieve symptoms of depression and anxiety (Kumari and Postma 2005). Much like the effect of nicotine reward pathways, alcohol consumption can help regulate mood symptoms by supporting the release of endorphins, the naturally occurring feel-good opioids which affect regions of the brain associated with reward processing (Bruijnzeel & Gold 2005). Alcohol is also a central nervous system depressant, and its long-term use can cause problems with cognition and memory in heavy users (Mukherjee 2013).[13]

However, it has also been hypothesized that smoking or drinking to self-medicate depression is associated with the development of cigarette or alcohol dependence (Sloan and Wang 2008; Dome et al. 2010; Crum et al. 2013), which in turn entails

[12] Specifically, the Hausman-styled test that supports the use of a FE model (over an OLS pooled model) and the one that rejects the endogeneity of mental illness in the FE-IV model.

[13] Moreover, our finding lends empirical support to a prediction from a rational addiction theory in economics proposed by Becker and Murphy (1988) that anxiety and tensions can cause an addition.

substantial health and socio-economic consequences. Thus, our finding when viewed with these hypotheses suggest that depressed individuals may rely on cigarette or alcohol consumption to provide some temporary relief of depression, despite significant costs of such addictions. To this end, our findings support existing evidence that individuals living with mental distress may make life choices that might otherwise be considered irrational and not in their best private interests (Kung et al. 2018; Bayer et al. 2019; Nguyen et al. 2021).

5.3 Robustness checks

To assess the robustness of our results, we check whether our main findings are sensitive to: (i) the choice of mental health variables and (ii) the inclusion of additional time-variant variables. The results (detailed analysis is reported in Appendix B) show that our findings are robust to these tests.

5.4 Characterizing the composition of compliers

As with other IV studies, the IV estimates in this study capture a Local Average Treatment Effect (LATE) of mental distress on additive behaviours (Imbens and Angrist 1994). Specifically, the LATE is applicable to individuals who experienced a worsening mental health state because of the death of a close friend ("compliers"). To profile the characteristics of compliers, we use an approach outlined in Angrist and Pischke (2008). Particularly, we calculate the ratio of the instrument coefficient estimated from Eq. (2) for sub-groups of individuals relative to the instrument coefficient estimated for the whole population. This relative likelihood provides indicative evidence suggesting which parts of the population are most likely to be affected by the instrument (i.e., the death of a close friend). To address a heretofore unsolved aggregation issue associated with a continuous treatment (Abadie 2003), we dichotomize our treatment variable by using the suggested cut-off of 68 points or lower for the original MHI-5 index to define if the individual has any depressive symptoms (Yamazaki et al. 2005). We focus on specific sub-groups, identified by gender, age, marital status, education level, previous smoking status and previous mental health state.[14]

Table 3 shows the relative likelihood that an individual with a particular characteristic belongs to the compliers in our data. As compared to the overall population, the compliers are more likely to be female, younger, single, or to have lower qualifications. Moreover, consistent with prior evidence of cigarette dependence (Sloan and Wang 2008; Dome et al. 2010; Crum et al. 2013), we find that individuals with a previous smoking history over-represent among the compliers. Similarly, and in line with prior findings (Zubrick et al. 2012; Friedman 2020), individuals with previous mental distress are more responsive to the treatment. The over-representation of individuals with a previous smoking history or previous mental distress among the compliers when viewed with an oft observed pattern of a higher prevalence and intensity of cigarette

[14] For brevity purposes, we present results estimated from the regression of "smoker" as an outcome. Results for other outcomes are broadly similar and will be available upon request.

Table 3 Characterizing the composition of compliers

Characteristic identified by	Calculated likelihood ratio
Gender	
Female	1.14
Male	0.82
Age	
Young	1.85
Old	0.54
Marital status	
Single	1.50
Married	0.63
Education	
No post-school degree	1.02
Bachelor degree or higher	0.85
Previous smoking status	
Non-smoker	0.87
Smoker	1.32
Previous mental health status	
Had no mental illness	0.78
Had mental illness	1.21

Statistics are calculated using an estimated sample from the regression of "smoker" as an outcome. "Young" sub-group includes individuals aged equal or below the median of the whole sample while "Old" sub-group consists of remaining individuals. "Previous" smoking (mental illness) status is identified using one-year lag of smoking (mental illness) status. "Mental illness" is identified using the suggested MHI-5 cut-off of 68

consumption among these individuals explains some relatively high estimates of mental distress obtained from the IV approach. To this end, our IV estimates may provide an upper bound of the Average Treatment Effect for the overall population (Angrist and Pischke 2008). The notable differences in these observable characteristics between the compliers and the comparison population suggest that our estimates may not be generalized to the general population. Nevertheless, they are particularly informative for some sub-populations, including those with previous mental distress or history of addiction, who are typically of policy interest (AIHW 2017).

5.5 Results on additional outcomes and household expenditure

We next investigate the effects of mental health on other related outcomes. In particular, to capture the potential compounding impact of mental distress on smoking and drinking behaviours (Tauchmann et al. 2013; Ren et al. 2020), we construct a binary variable describing whether the individual either smoked cigarettes or drank alcohol at the survey time and use it as an additional outcome variable. We also construct a

dummy variable which indicates if the individual either smoked daily or drank daily and use it as another dependent variable in the FE-IV model. Results from these experiments, reported in Columns 1 to 4 of Table 4, suggest that mental distress statistically significantly increases the prevalence and intensity of cigarette or alcohol consumption. Specifically, an increase of one standard deviation in mental distress raises the probability of either smoking or drinking by 13 pp (Column 2). The impact of mental distress on the intensity of addictive behaviours is slightly less pronounced since the same increase in mental distress is found to raise the probability of either smoking daily or drinking daily by 11 pp (Column 4).

We further experiment with using household annual monetary expenditures on tobacco, alcohol or both items.[15] As mental distress may affect the household expenditure on items other than tobacco and alcohol, we measure expenditure on tobacco, alcohol or both items in a relative terms, as represented by the share of each of these items in the total household expenditure on all reported items. Of note, having a mental distress also impacts other areas of household expenditure.[16] Results from this experiment, reported in Columns 5 to 10 of Table 4, reveal two findings of interest. First, consistent with our earlier findings of an impact of mental distress on rising prevalence and intensity of smoking and drinking, the results in this section also indicate that mental distress statistically significantly increases shares of household expenditure on tobacco or/and alcohol. Second, the estimates are sizable, suggesting that mental distress also causes direct and substantial financial costs to the households of individuals with mental health issues. Particularly, the preferred FE-IV estimate suggests that a one-standard-deviation increase in mental distress raises the share of alcohol expenditure in total household expenditure by 1.65% (or 35% of the sample mean, Column 8). Similarly, the same increase in mental distress raises the proportion of tobacco expenditure in total household expenditure by 0.06% (or 2.1% of the sample mean, according to the preferred FE estimate which is statistically significant at the 1% level, as seen from Column 5). To our knowledge, these significant financial costs to households of addictive behaviours of those with mental distress have not previously been documented in the extant literature.[17]

[15] Information on household expenditure is available from Wave 5 onwards and reported by all surveyed members who self-identified that they had responsibility for paying household bills. In cases multiple members of the same household provided response (about a quarter of all surveyed households did so), household expenditure amount is averaged across all individuals providing response. Furthermore, because the preamble of expenditure questions asks: "In a typical week, does this household spend money on", expenditure is calculated at the household level and measured on an annual basis (by multiplying weekly expenditure by 52 (weeks)). Despite some concerns over the quality of expenditure data reported in HILDA (Wilkins & Sun 2010), including the fact that HILDA omits several important spending items, household expenditure measures have been employed in previous studies (Wilkins and Sun 2010; Nguyen et al. 2020). These data limitations, including the small sample size and potential measurement errors, should be considered when interpreting the results in this section.

[16] Unreported results show that mental illness decreases the share of expenditures on Groceries, Clothing and footwear, Private health insurance, Other insurance, and Home repairs. By contrast, mental illness raises the proportion of expenditures on Medicines, Education fees, Public transport, Telephone rent and Electricity bills.

[17] Of note, these household expenditures may be an under-estimate, because our data do not cover all possible addictive substances or behaviours, such as other drugs, gaming or gambling, in sufficient detail.

Table 4 Impact of mental health on additional outcomes and household expenditure

	FE	FE-IV	FE	FE-IV	FE	FE-IV	FE	FE-IV	FE	FE-IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Smoking or drinking (Dummy = 1 if yes, = 0 if no)		Daily smoking or daily drinking (Dummy = 1 if yes, = 0 if no)		Share of expenditure on cigarettes and tobacco in total expenditure (%)		Share of expenditure on alcohol in total expenditure (%)		Share of expenditure on cigarettes, tobacco and alcohol in total expenditure (%)	
Stand. rev. MHI-5	0.27***	12.78***	0.63***	11.22**	0.06***	0.54	0.03*	1.65*	0.09***	2.19
	[0.10]	[4.23]	[0.10]	[4.44]	[0.02]	[1.00]	[0.02]	[0.97]	[0.03]	[1.44]
Observations	236,671	236,671	236,671	236,671	179,195	179,195	179,195	179,195	179,195	179,195
Individuals	24,731	24,731	24,731	24,731	21,934	21,934	21,934	21,934	21,934	21,934
Mean of dep. variable	83.56	83.56	20.62	20.62	2.86	2.86	4.77	4.77	7.62	7.62
F-statistic of IV		77.23		77.23		43.76		43.76		43.76
Hausman test (p value)		0.00		0.01		0.63		0.09		0.14

FE results are from the regression (1) while FE-IV results from regressions (1) and (2). "F-statistic of IV" denotes the F statistic for the strength of the excluded instrument in the first stage regression. "Hausman test (*p* value)" denotes *p* value from a Hausman test for endogeneity of the mental health variable in Eq. (1). Other explanatory variables include age (and its square), marital status, education, household size, local socio-economic background variables, state/territory dummies, year dummies, and survey quarter dummies. Robust standard errors clustered at the individual level in parentheses. For all binary outcome variables, results (coefficient estimates, standard errors and sample means) are multiplied by 100 for aesthetic purposes. The symbol *denotes significance at the 10% level, **at the 5% level, and ***at the 1% level

6 Heterogeneity

To further our understanding of the mental health effects on addictive behaviours, we implement a heterogeneity analysis by running separate regressions on two subsamples of individuals, identified by various characteristics.[18] These variables include gender (i.e., female versus male), age (young versus old, identified relative to the median age of all individuals in the whole sample), marital status (single versus married) and education level (with or without a bachelor or higher degree). For marital status and education level, sub-groups are defined using the value identified at its first appearance in the sample to address a concern that the individuals' mental health and addictive behaviours may influence the way that we assign them to each sub-group. To explore the potential role of genetic or intergenerational factors in explaining our results, we also compare the impact of mental distress by the respondents' parental smoking status during their childhood.[19] For this sub-population investigation, we report results from an FE-IV model if the exogeneity of mental distress is rejected and results from a FE model otherwise.

Estimates on the impact of mental distress by sub-populations for various addictive measures are concisely reported in Fig. 1. Figure 1 suggests that mental distress appears to have some differential effects, depending on sub-group characteristics and outcomes being considered. For example, the effect of mental distress on tobacco and alcohol consumption appears to be greater for males because the estimates are always higher (i.e., more positive) or typically more statistically significant for them. By the same reasoning, sub-group results by age groups indicate that the effects of mental distress on all smoking outcomes and being a current alcohol drinker are much more apparent for older individuals. By contrast, the impact of mental distress for younger individuals is more pronounced in regard to the excessive drinking outcome since the estimate is greater (about twice as much) and more statistically significant for them. Moreover, Fig. 1 suggests that mental distress appears to have a greater impact on smoking or daily smoking outcomes of married individuals. Conversely, the impact of mental distress tends to be more visible on drinking outcomes for single persons.

Sub-group results by education level reported in Fig. 1 also indicate the effects of mental distress on all addictive outcomes are much more apparent for individuals with lower qualifications because their estimates are greater or more statistically significant. The finding that mental distress has a more pronounced impact for individuals with lower education is consistent with an oft observed pattern, which is also confirmed in our data (see sample mean figures reported below the bars in Fig. 1), that lower educated individuals dispportionaly engage in smoking and risky drinking activities

[18] As discussed in subsection 5.4, this heterogeneity analysis also sheds light on the estimated LATE impact for different subsets of compliers (Angrist and Pischke 2008).

[19] Retrospective information on parental smoking behaviour during childhood is constructed from responses to a question asking: "Were any of your parents or guardians smokers at any stage of your childhood?" This question was asked for the first time in wave 9 of HILDA for all respondents and in waves 13 and 17 for new respondents. Consistent with a large literature documenting the intergenerational correlation in risky behaviours, this study also finds that, as compared to children of non-smokers, those of smokers are more likely to engage in smoking and drinking activities (see sub-population mean figures reported below the bars in Fig. 1). Unfortunately, there is no retrospective information on parental drinking behaviour in HILDA for us to implement a similar sub-group analysis.

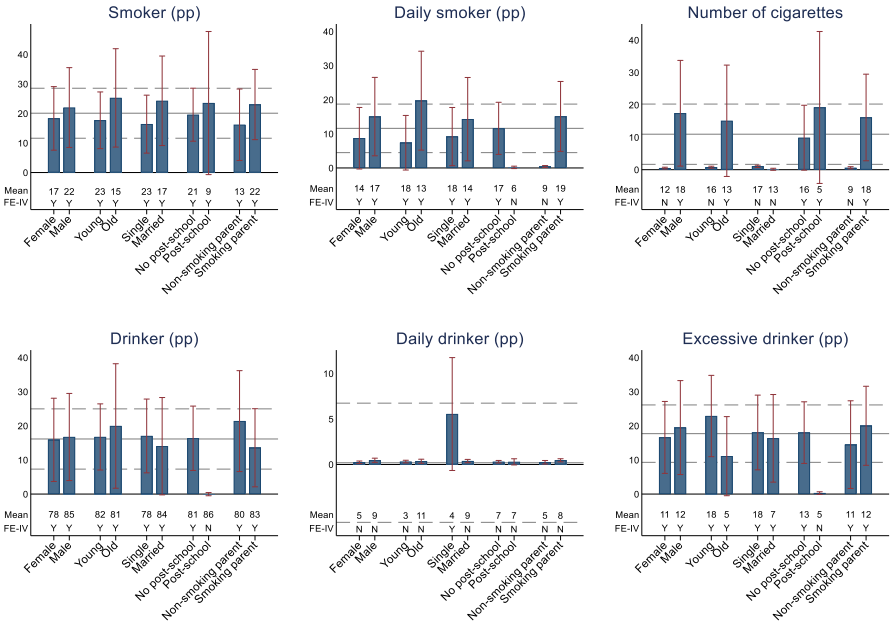

Fig. 1 Heterogeneity. Results for different sub-populations are obtained from separate FE-IV or FE regressions. The model for each sub-population is printed above the sub-population label (Y indicates results from a FE-IV model while N from a FE model). For all binary outcome variables, sample mean, coefficient estimate and its 95% confidence interval are multiplied by 100 for aesthetic purposes. The solid (dash) horizontal line shows the mental health coefficient (95% confidence interval) estimates for the whole population. The sample mean of dependent variable for each sub-population is printed below the bars. Detailed regression results are reported in Appendix Table A7

(AIHW 2017). Turning to the sub-group analysis by parental smoking status, we continue to observe that, with an exception of being a current alcohol drinker, where the estimate is about 42% smaller for children of smokers, the effects of mental distress on all other addictive outcomes are much more pronounced for children of smokers.

Fig. 1 indicates that the impact of mental distress is not statistically significantly different by all characteristics considered above.[20] However, there are three important exceptions. First, the estimates of mental distress on the number of cigarettes smoked are statistically different (at the 5% level) for males and females, indicating that males statistically significantly smoke more when experiencing negative psychological states. Second, the estimates on daily smoking, drinking and excessive drinking outcomes by education are also statistically different at the 5% level, suggesting that individuals with lower education statistically significantly engage more in these additive activities when facing mental health shocks. Third, the estimates on the probability of daily smoking and the number of cigarettes smoked are statistically different for children of smokers compared with those of non-smokers. To the best of our knowledge, the finding of a much greater impact of mental distress for children of smokers

[20] Full estimation results are represented in Appendix Table A7.

has not been documented the literature. This finding when observed with the observation that children of smokers consume substentially more cigarettes than children of non-smokers (see mean statistics reported below the bars in Fig. 1) shows that parental addictive behaviours may not only be transmitted to their children (Mitrou et al. 2010) but also influence the way their children respond to mental health shocks.

7 Conclusion

Drawing on a high-quality nationally representative panel dataset we have presented the causal effects of mental health on cigarette smoking and alcohol consumption behaviours of Australians. We find robust evidence that mental distress substantially increases the prevalence and intensity of either cigarette or alcohol consumption. Consistent with this finding, additional analysis reveals substantial monetary costs associated with cigarette and alcohol consumption caused by mental distress. Moreover, the impact is greater for lower educated individuals and children of smokers, and is slightly higher for males.

Our findings on the impact of mental distress on addictive behaviours highlight the importance of controlling for potential endogeneity of mental health when modelling its causal effects on addictive behaviours. Failing to simultaneously address these issues could result in under-estimates of the effect of poor mental health on the increasing prevalence and intensity of either cigarette or alcohol consumption. Our finding of a strong association between life stress events and depression provides an argument for public initiatives that support vulnerable groups to cope with negative psychological events. Such policies may not only reduce the overall prevalence and impact of mental distress but also discourage mental distress-attributable addictive behaviours and hence alleviate their associated socio-economic costs, following our finding of a measurable impact of mental distress on increasing addictive behaviours. Overall, our findings, together with others, highlight the role of mental health screening and treatment programs, especially among lower educated individuals or children of smokers, to assist in the prevention of addictive activities which are costly to both the individual, and to broader society.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00181-023-02483-x.

Acknowledgements This research was partly funded by the Australian Research Council Centre of Excellence for Children and Families over the Life Course (CE200100025). For their helpful comments and suggestions, we thank Editor Subal C. Kumbhakar and anonymous reviewers of this journal, Alexander Ahammer and participants at 2021 Essen Mental Health Workshop. This paper uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The HILDA Project was initiated and is funded by the Australian Government Department of Social Services (DSS) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this paper, however, are those of the authors and should not be attributed to either DSS or the Melbourne Institute.

Funding Open Access funding enabled and organized by CAUL and its Member Institutions.

Declarations

Conflict of interest We confirm that the manuscript has been read and approved by all authors. This manuscript has not been published and is not under consideration for publication elsewhere. The authors declare that they have no relevant or material financial interests that relate to the research described in this paper. This research is partly funded by the Australian Research Council Centre of Excellence for Children and Families over the Life Course (CE200100025). However, the funder does not involve in study design; in the collection, analysis and interpretation of data; in the writing of the articles; and in the decision to submit it for publication.

References

Abadie A (2003) Semiparametric instrumental variable estimation of treatment response models. J Econom 113:231–263

ABS, 1997. 4399.0 - National health survey: SF36 population norms, Australia, 1995 Australian bureau of statistics (Ed.), Canberra

AIHW, 2017. National drug strategy household survey 2016: detailed findings. Australian institute of health welfare, Canberra

Angrist JD, Pischke J-S (2008) Mostly harmless econometrics: an empiricist's companion. Princeton University Press

Bayer YAM, Shtudiner Z, Suhorukov O, Grisaru N (2019) Time and risk preferences, and consumption decisions of patients with clinical depression. J Behav Experim Econom 78:138–145

Becker GS, Murphy KM (1988) A theory of rational addiction. J Polit Econ 96:675–700

Berwick DM, Murphy JM, Goldman PA, Ware JE Jr, Barsky AJ, Weinstein MC (1991) Performance of a five-item mental health screening test. Med Care 29:169–176

Bjørngaard JH, Gunnell D, Elvestad MB, Smith GD, Skorpen F, Krokan H et al (2013) The causal role of smoking in anxiety and depression: a Mendelian randomization analysis of the HUNT study. Psychol Med 43:711–719

Boden JM, Fergusson DM, Horwood LJ (2010) Cigarette smoking and depression: tests of causal linkages using a longitudinal birth cohort. Br J Psychiatry 196:440–446

Breslau N, Peterson EL, Schultz LR, Chilcoat HD, Andreski P (1998) Major depression and stages of smoking: a longitudinal investigation. Arch Gen Psychiatry 55:161–166

Bruijnzeel AW, Gold MS (2005) The role of corticotropin-releasing factor-like peptides in cannabis, nicotine, and alcohol dependence. Brain Res Rev 49:505–528

Chisholm D, Sweeny K, Sheehan P, Rasmussen B, Smit F, Cuijpers P et al (2016) Scaling-up treatment of depression and anxiety: a global return on investment analysis. The Lancet Psychiatry 3:415–424

Crum RM, Mojtabai R, Lazareck S, Bolton JM, Robinson J, Sareen J et al (2013) A prospective assessment of reports of drinking to self-medicate mood symptoms with the incidence and persistence of alcohol dependence. JAMA Psychiat 70:718–726

Dome P, Lazary J, Kalapos MP, Rihmer Z (2010) Smoking, nicotine and neuropsychiatric disorders. Neurosci Biobehav Rev 34:295–342

Fergusson DM, Boden JM, Horwood LJ (2011) Structural models of the comorbidity of internalizing disorders and substance use disorders in a longitudinal birth cohort. Soc Psychiatry Psychiatr Epidemiol 46:933–942

Fluharty M, Taylor AE, Grabski M, Munafò MR (2017) The association of cigarette smoking with depression and anxiety: a systematic review. Nicotine Tob Res 19:3–13
Friedman AS (2020) Smoking to cope: Addictive behavior as a response to mental distress. J Health Econ 72:102323
Frijters P, Johnston DW, Shields MA (2014) The effect of mental health on employment: evidence from Australian panel data. Health Econ 23:1058–1071
Grant JE, Potenza MN, Weinstein A, Gorelick DA (2010) Introduction to behavioral addictions. Am J Drug Alcohol Abuse 36:233–241
Grossman M (1972) The demand for health: a theoretical and empirical investigation. Columbia University Press for National Bureau of Economic Research Books, New York
Horwood LJ, Fergusson DM, Coffey C, Patton GC, Tait R, Smart D et al (2012) Cannabis and depression: an integrative data analysis of four Australasian cohorts. Drug Alcohol Depend 126:369–378
Imbens GW, Angrist JD (1994) Identification and estimation of local average treatment effects. Econometrica 62:467–475
Iñiguez SD, Warren BL, Parise EM, Alcantara LF, Schuh B, Maffeo ML et al (2009) Nicotine exposure during adolescence induces a depression-like state in adulthood. Neuropsychopharmacology 34:1609–1624
Johnson JG, Cohen P, Pine DS, Klein DF, Kasen S, Brook JS (2000) Association between cigarette smoking and anxiety disorders during adolescence and early adulthood. JAMA 284:2348–2351
Johnston D, Propper C, Pudney S, Shields M (2014) Child mental health and educational attainment: multiple observers and the measurement error problem. J Appl Economet 29:880–900
Kalman D, Morissette SB, George TP (2005) Co-morbidity of smoking in patients with psychiatric and substance use disorders. Am J Addict 14:106–123
Katz C, El-Gabalawy R, Keyes KM, Martins SS, Sareen J (2013) Risk factors for incident nonmedical prescription opioid use and abuse and dependence: results from a longitudinal nationally representative sample. Drug Alcohol Depend 132:107–113
Kendler KS, Neale MC, MacLean CJ, Heath AC, Eaves LJ, Kessler RC (1993) Smoking and major depression. A causal analysis. Arch Gen Psychiatry 50:36–43
Khantzian EJ (1987) The self-medication hypothesis of addictive disorders: focus on heroin and cocaine dependence. In: Allen DF (ed) The Cocaine Crisis. Springer, US, Boston, MA, pp 65–74
Kim-Mozeleski JE, Poudel KC, Tsoh JY (2020) Examining reciprocal effects of cigarette smoking, food insecurity, and psychological distress in the US. J Psychoact Drugs 53:1–8
Klungsøyr O, Nygård JF, Sørensen T, Sandanger I (2006) Cigarette smoking and incidence of first depressive episode: an 11-year, population-based follow-up Study. Am J Epidemiol 163:421–432
Knott C, Bell S, Britton A (2015) Alcohol consumption and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis of more than 1.9 million individuals from 38 observational studies. Diabetes Care 38:1804–1812
Kumari V, Postma P (2005) Nicotine use in schizophrenia: the self medication hypotheses. Neurosci Biobehav Rev 29:1021–1034
Kung CSJ, Johnston DW, Shields MA (2018) Mental health and the response to financial incentives: evidence from a survey incentives experiment. J Health Econ 62:84–94
Lalanne L, Lutz P-E, Trojak B, Lang J-P, Kieffer BL, Bacon E (2016) Medications between psychiatric and addictive disorders. Prog Neuropsycho Biol Psych 65:215–223
LaMontagne AD, Too LS, Punnett L, Milner AJ (2020) Changes in job security and mental health: an analysis of 14 annual waves of an Australian working-population panel survey. Am J Epidemiol 190:207
Lawrence D, Mitrou F, Zubrick SR (2009) Smoking and mental illness: results from population surveys in Australia and the United States. BMC Public Health 9:1–14
Le HT, Nguyen HT (2017) Parental health and children's cognitive and noncognitive development: new evidence from the longitudinal survey of Australian children. Health Econ 26:1767–1788
Le HT, Nguyen HT (2018) The impact of maternal mental health shocks on child health: estimates from fixed effects instrumental variables models for two cohorts of Australian children. Am J Health Econom 4:185–225
Leung J, Gartner C, Hall W, Lucke J, Dobson A (2012) A longitudinal study of the bi-directional relationship between tobacco smoking and psychological distress in a community sample of young Australian women. Psychol Med 42:1273–1282

Lewis SJ, Araya R, Davey Smith G, Freathy R, Gunnell D, Palmer T et al (2011) Smoking is associated with, but does not cause, depressed mood in pregnancy–A Mendelian randomization study. PLoS ONE 6:e21689

Lillard DR (2020) The economics of nicotine consumption. In: Zimmermann KF (ed) Handbook of Labor, human resources and population economics. Springer International Publishing, Cham, pp 1–31

Marsden DG, Loukas A, Chen B, Perry CL, Wilkinson AV (2019) Associations between frequency of cigarette and alternative tobacco product use and depressive symptoms: a longitudinal study of young adults. Addict Behav 99:106078

Mitrou F, Gaudie J, Lawrence D, Silburn SR, Stanley FJ, Zubrick SR (2010) Antecedents of hospital admission for deliberate self-harm from a 14-year follow-up study using data-linkage. BMC Psychiatry 10:1–11

Mojtabai R, Crum RM (2013) Cigarette smoking and onset of mood and anxiety disorders. Am J Public Health 103:1656–1665

Moylan S, Jacka FN, Pasco JA, Berk M (2012) Cigarette smoking, nicotine dependence and anxiety disorders: a systematic review of population-based, epidemiological studies. BMC Med 10:1–14

Mukamal KJ, Conigrave KM, Mittleman MA, Camargo CA Jr, Stampfer MJ, Willett WC et al (2003) Roles of drinking pattern and type of alcohol consumed in coronary heart disease in men. N Engl J Med 348:109–118

Mukherjee S (2013) Alcoholism and its effects on the central nervous system. Curr Neurovasc Res 10:256–262

Needham BL (2007) Gender differences in trajectories of depressive symptomatology and substance use during the transition from adolescence to young adulthood. Soc Sci Med 65:1166–1179

Nguyen HT, Connelly LB (2018) Out of sight but not out of mind: Home countries' macroeconomic volatilities and immigrants' mental health. Health Econ 27:189–208

Nguyen HT, Le HT, Connelly LB (2021) Who's declining the "free lunch"? New evidence from the uptake of public child dental benefits. Health Econ 30:270–288

Nguyen HT, Mitrou F, Taylor C, Zubrick S (2020) Does retirement lead to life satisfaction? Causal evidence from fixed effect instrumental variable models. GLO Discussion Paper, No. 536

NHMRC, 2009. Australian guidelines to reduce health risks from drinking alcohol. national health and medical research council (NHMRC) (Ed.), Canberra

NHMRC, 2020. Australian guidelines to reduce health risks from drinking alcohol. national health and medical research council (NHMRC) (Ed.), Canberra

Nunes EV, Levin FR (2004) Treatment of depression in patients with alcohol or other drug dependence: a meta-analysis. JAMA 291:1887–1896

OECD, 2014. Making mental health count: the social and economic costs of neglecting mental health care. Organisation for economic co-operation development (OECD) Publishing, Paris, France

Pasman JA, Verweij KJH, Gerring Z, Stringer S, Sanchez-Roige S, Treur JL et al (2018) GWAS of lifetime cannabis use reveals new risk loci, genetic overlap with psychiatric traits, and a causal effect of schizophrenia liability. Nat Neurosci 21:1161–1170

Prochaska JJ, Das S, Young-Wolff KC (2017) Smoking, mental illness, and public health. Ann Rev Public Health 38:165–185

Ranjit A, Korhonen T, Buchwald J, Heikkilä K, Tuulio-Henriksson A, Rose RJ et al (2019) Testing the reciprocal association between smoking and depressive symptoms from adolescence to adulthood: a longitudinal twin study. Drug Alcohol Depend 200:64–70

Ren Y, Castro Campos B, Loy J-P (2020) Drink and smoke; drink or smoke? The interdependence between alcohol and cigarette consumption for men in China. Empirical Economics 58:921–955

Skov-Ettrup LS, Nordestgaard BG, Petersen CB, Tolstrup JS (2016) Does high tobacco consumption cause psychological distress? a mendelian randomization study. Nicotine Tob Res 19:32–38

Sloan FA, Wang Y (2008) Economic theory and evidence on smoking behavior of adults. Addiction 103:1777–1785

Stock JH, Yogo M (2005) Testing for weak instruments in linear IV regression. In: Andrews DWK (ed) Identification and inference for econometric models. Cambridge University Press, New York, pp 80–108

Summerfield M, Bright S, Hahn M, La N, Macalalad N, Watson N et al (2019) HILDA user manual–release 18. The University of Melbourne, Melbourne Institute of Applied Economic and Social Research

Tauchmann H, Lenz S, Requate T, Schmidt CM (2013) Tobacco and alcohol: complements or substitutes? Empirical Econom 45:539–566

Taylor AE, Fluharty ME, Bjørngaard JH, Gabrielsen ME, Skorpen F, Marioni RE et al (2014a) Investigating the possible causal association of smoking with depression and anxiety using Mendelian randomisation meta-analysis: the CARTA consortium. BMJ Open 4:e006141

Taylor G, McNeill A, Girling A, Farley A, Lindson-Hawley N, Aveyard P (2014b) Change in mental health after smoking cessation: systematic review and meta-analysis. BMJ British Med J 348:g1151

Volkow N, Li T-K (2005) The neuroscience of addiction. Nat Neurosci 8:1429–1430

Volkow ND, Baler RD, Compton WM, Weiss SRB (2014) Adverse health effects of marijuana use. N Engl J Med 370:2219–2227

Wang J-C, Kapoor M, Goate AM (2012) The genetics of substance dependence. Annu Rev Genomics Hum Genet 13:241–261

Ware JE, Kosinski M, Keller S (1994) SF-36 physical and mental health summary scales: a user's manual. Health Assessment Lab, Boston

Ware, J.E., Kosinski, M., Dewey, J.E., Gandek, B., 2000. SF-36 health survey: manual and interpretation guide. Quality Metric Inc.

WHO (2017) Depression and other common mental disorders: global health estimates. World Health Organization, Geneva

Wilkins, R., Sun, C., 2010. Assessing the Quality of the Expenditure Data Collected in the Self-Completion Questionnaire HILDA project technical paper series No. 1/10, April 2010, Melbourne Institute of Applied Economic and Social Research, The University of Melbourne

Wooldridge JM (2010) Econometric analysis of cross section and panel data. MIT Press, Cambridge, Mass

Yamazaki S, Fukuhara S, Green J (2005) Usefulness of five-item and three-item mental health inventories to screen for depressive symptoms in the general population of Japan. Health Qual Life Outcomes 3:48

Yang L, Zikos V (2022) Healthy mind in healthy body: identifying the causal effect of mental health on physical health. Econ Lett 213:110358

Zubrick SR, Lawrence D, Mitrou F, Christensen D, Taylor CL (2012) Early mental health morbidity and later smoking at age 17 years. Psychol Med 42:1103–1115