Social and Economic Factors associated with Suicide in Australia: A Focus on Individual Income

1.Introduction

Factors contributing to a person's risk of dying by suicide are complex (for an overview see: Turecki et al., 2019). Increasing evidence is emerging showing an association between economic and social factors and death by suicide. It is important to learn more about the economic and social factors associated with suicide deaths. Doing so will provide opportunities to strengthen suicide prevention policies and programs.

Researchers[1] from the Australian National University's Centre for Social Research and Methods (CSRM), in close collaboration with the AIHW, have extended modelling already completed by the Institute. The Institute's analysis 'Association between socioeconomic factors and deaths by suicide: a modelling study' examined associations between socioeconomic factors from the 2011 Census and deaths by suicide in Australia.

The work undertaken by the CSRM extends the initial analysis by:

1) Taking a longitudinal approach, which enabled the investigation of changes to individuals' income and employment status across time.
2) Examining the absolute risk, as well as the relative odds of dying by suicide.

1.1 Study Questions

The CSRM researchers set out to address three key questions:

1) What is the relationship between social factors and death by suicide (controlling for economic factors)?
2) Is income uncertainty associated with death by suicide (controlling for social) factors?
3) Are periods of continuous unemployment associated with death by suicide, (controlling for economic and social factors)?

2. Theories of suicide and empirical studies.

Suicidal behaviour has been of interest to both sociologists and economists. The social theory of suicide postulated by Emile Durkheim in 1897 serves as the foundation for explaining suicide behaviour in the field of sociology. He argued that suicide is a product of social conditions. More specifically, the theory suggests that 'social integration' is the main social factor determining the suicidal behaviour of an individual. These concepts have dominated the social research on suicide and many researchers have extended these concepts both theoretically and empirically.

In terms of 'social integration' factors, researchers have studied the effects of the following social factors on suicide. Household composition (Ford and Kaserman, 2000; Daly and Wilson,

[1] Professor Nicholas Biddle, Mr Dinith Marasinghe, and Ms Lucy Ellen.

2006), age and gender differences (Molina and Duarte, 2006; Lee et al., 2017), divorce (Neumayer, 2003; Chen et al., 2008; Koo and Cox, 2008), disability (Lee et al., 2016).

On the other hand, the economic theory of suicide emphasises the role of individual decision making, rather than social structures, to explain suicide. More specifically, the economic theory of suicide considers that a utility-maximizing agent who – based on past, present and future events, decides to complete suicide when it appears to be the most preferred choice. The utility-maximizing framework was first applied to the topic of suicide by Hamermesh and Soss in 1974. Two of the most notable predictions from their model was that suicide rates were negatively correlated with lifetime income and positively correlated with age. These predictions have been supported by empirical studies in numerous studies (Hamermesh and Soss, 1974; Chuanc and Huang, 1997; Molinda et al., 2006; Koo and Cos, 2008; Choi et al., 2017).

In addition to solely examining the effects of income and age on suicide, many researchers have extended this economic framework to study the effects of other economic variables on suicide. These include income inequality (Neumayer, 2003; Rodriguez, 2006; Chen et al., 2008; Lee and Hong, 2017), education (Klick and Markowitz, 2003), economic growth and unemployment (Neumayer, 2003; Viren 2005; Koo and Cox 2008; Lee and Hong, 2017).

Most of the empirical work discussed above were based on aggregate level data rather than individual-level data. This was mainly due to the unavailability of individual-level data. The studies that were based on individual data mainly focused on suicide attempts and suicidal thoughts instead of completed suicides (Molina and Duarte 2006; Mitrou et al., 2010; Chen et al., 2013; Mitchell and Cameron 2018).

The lack of research undertaken at an individual level (using nationally representative data) suggests that there is much we do not know about how individual social and economic factors affect the risk of dying by suicide.

3.Data

To facilitate the study, we used data from the Multi-Agency Data Integration project (MADIP). More specifically, we used 2011 Census data, 2011-2016 Personal income tax (PIT) and social security data (SSRI) and 2011-2016 Causes of death data. In addition to these data sources, a MADIP synthetic income measure was also used. The MADIP synthetic income measure is a continuous longitudinal measure of income that is representative of the entire population (aged 15 or more), for years 2011-2016. [2]

The above data sources were linked using the MADIP Person Linkage Spine (Spine) provided by the Australian Bureau of Statistics. The Spine was created by linking individuals in the Medicare Enrolment Database (MEDB), Medicare Benefits Schedule (MBS), Personal Income

[2] See to Biddle and Marasinghe (2021) for more information on the derivation and validity of the synthetic income measure.

Tax (PIT) and Social Security and Relation Information (SSRI) data sets at any point between 2006 and 2016 (ABS 2019)[3]. 2011 Census records and 2011-2016 Causes of Death data were then linked to this Spine. The linkage rate between 2011 Census to the Spine was 66.5%, linkage rate between the 2011-2016 Causes of Death and Spine was 97.6%. For this study, the linked 2011 Census population was considered to be the baseline population. The sample size of this population was 16.7 million.

After the data linkage process, the following set of explanatory variables from the linked data set were used to capture the social and economic factors of suicide. More specifically, we used time-invariant 2011 Census data to capture sociological factors of suicide and time-variant PIT, SSRI and MADIP synthetic income to capture the economic factors of suicide. The independent variable, completed suicides, was obtained from the Causes of Death dataset. Suicide was defined by ICD-10 external cause codes X60–X84 and Y87.0. Table 1 gives an overview of these variables

Table 1 – Variables and sources.

Variable	Source	Time variant	Captured effect
1. Completed suicides	2011-2016 Causes of death	N/A	N/A
2. Highest level of education	2011 Census	No	Sociological
3. Age	2011 Census	Yes	Sociological
4. Sex	2011 Census	No	Sociological
5. Indigenous status	2011 Census	No	Sociological
6. Need for assistance with core activities (disability status)	2011 Census	No	Sociological
7.Household composition	2011 Census	No	Sociological
8. Total income (absolute income)	2011-2016 MADIP synthetic income	Yes	Economic
9. Social security type and amount	2011-2016 SSRI	Yes	Economic

In addition to the variables presented in Table 1, the following variables were derived using Census, PIT and SSRI data.

1. A synthetic measure of income – A measure of income that was derived using a machine learning algorithm. This income variable provides a representative measure of income of the entire Australian population (Biddle and Marasinghe 2021). This measure was then divided into quintiles to obtain a relative measure of income.

[3] Linkage of PIT 2010-11 to MEDB records achieved a linkage rate of 93.4%. SSRI 2011 to MEDB records achieved a linkage rate of 94.6%.

This measure was then divided into quintiles to obtain a ranked measure of income. In addition to relative income, absolute income was also used to capture effects of income on suicide.

2. Income uncertainty - Coefficient of variation of income (or relative standard deviation of income) was used to capture the income uncertainty of each individual. The measure was defined such that it captured income uncertainty between the current year and the previous year (i.e. variation between t and t-1). That is, for given consecutive years, *t and t-1*, the income uncertainty for individual *i* was defined as:

$$Income\ uncertainty_{i,t-1,t} = \frac{\sigma_{i,t-1,t}}{\overline{synthetic\ income}_{i,t-1,t}}$$

Where $\sigma_{i,t-1,t}$ is standard deviation of income between periods *t-1* and *t* for individual *i.* $\overline{synthetic\ income}_{i,t-1,t}$ is the mean income between periods *t-1* and *t* for individual *i.*

This measure was then divided into quintiles. An income uncertainty of quintile 1 implied an individual had low-income variation relative those in higher income uncertainty quintiles. Since this measure uses data from t-1, the scope of the study was limited to 2012 January to 2016 December.

1. Proxy for unemployment – Unemployment status of an individual was captured using SSRI information. More specifically, if an individual received Newstart allowance and Youth allowance, the individual was then classified as being unemployed that period. More specifically, if an individual received Newstart allowance (now known as JobSeeker) and Youth allowance (other), the individual was then classified as being unemployed that period.

Newstart allowance is the main income support payments for individuals between the ages 22 and the Age pension age. To obtain Newstart allowance, the individual must be either (1) looking for work or (2) unable to work due to sickness or injury. On the other hand, Youth allowance (other) is an income support scheme for who are 21 and younger and looking for work.This definition of unemployment is different to the unemployment definition used by the ABS. According to the ABS, an unemployed is defined as those who are not working more than one hour in the reference week; and actively looking for work in previous four weeks; and be available to start work in the reference week.

4. Methods

The MADIP dataset is a longitudinal dataset [4] therefore, utilizing longitudinal regression methods allows us to control for unobserved individual heterogeneity across the time period. For example, longitudinal regression methods would allow us to control for unobserved measures such as behavioural differences and cultural differences across individuals. Given that suicide is a complex individual decision and may not be entirely explained by observed variables, controlling for these unobserved heterogeneity would allow us to obtain unbiased estimates.

In this analysis, two competing longitudinal regression methods were tested – a Random effects logistic model and a population-averaged logistic model.[5] Both models were estimated with robust standard errors to account for heteroskedasticity.

Given that the random effects logistic model is dependent on the strong assumption that the underlaying variation have no serial correlation, the population-averaged logistic model was selected as the primary regression method due to its robustness to serial correlation (Hill et al., 2010) . Furthermore, a likelihood-ratio test was also undertaken to decide between the two models. The result suggested that the population-averaged model was more appropriate than the Random effects model. Equation (1) and (2) outline the population-averaged model.

$$y^*_{i,t} = \alpha + \beta x_i + \delta z_{i,t} + \varepsilon_{i,t} \qquad (1)$$

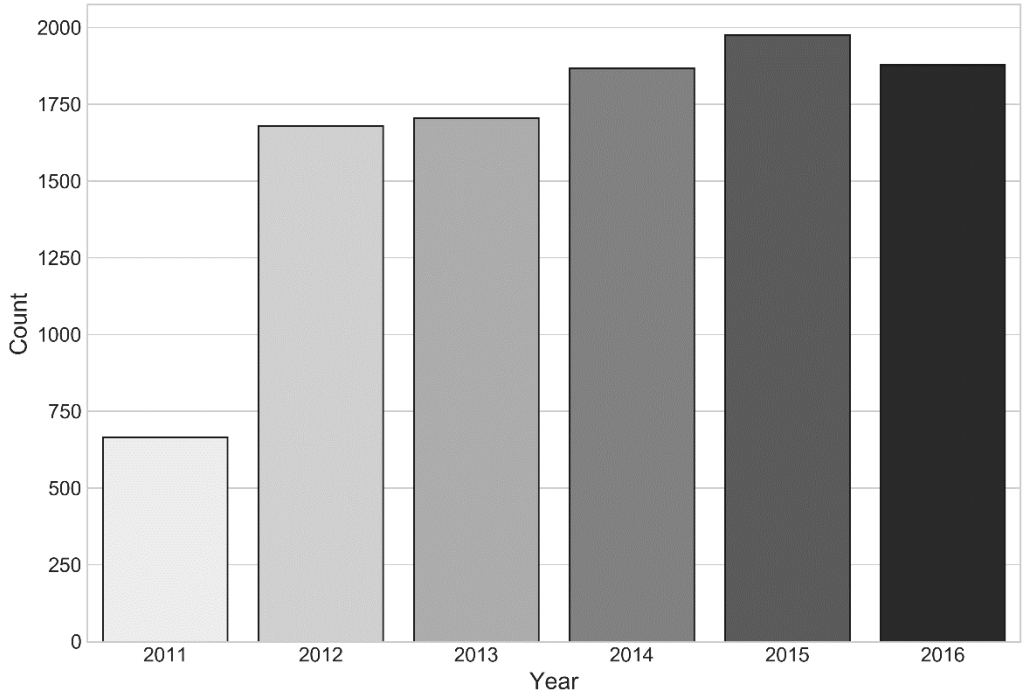
$$y_{i,t} = \begin{cases} 1, y^*_{i,t} > 0 \\ 0, \text{otherwise} \end{cases} \qquad (2)$$

Where $y_{i,t}$ is the dependent variable which takes the value 1 if individual i has completed suicide at time t and 0 otherwise. x_i is a vector of time-invariant explanatory variables, $z_{i,t}$ is a vector of time-varying explanatory variables and ε is the error term which is assumed to be independent and identically distributed with $\varepsilon \sim (0, \sigma^2)$.

Setting up the dataset as a panel allowed us to account for individual heterogeneity. However, given that suicide is a rare event [6], explanatory variables with large number of categories (for example – occupation) were excluded from the longitudinal analysis. This was primarily due the low number of suicides each year, which in turn made the models more sensitive to variables with a large number of categories. Given this drawback of panel data, a cross-sectional analysis was also conducted as a part of the sensitivity analysis. [7]

[4] Except for 2011 Census information, all other datasets provided in MADIP can be set up as a panel from 2011-2016.
[5] The population-averaged model was set up as a Binomial model with a logit link. The model was estimated using generalized estimating equations (GEE).
[6] Approximately 2000 suicides and 16 million non-suicides per year
[7] Cross-sectional methodology is presented in the technical appendix.

Figure 1 – Annual suicide counts[8]



5. Results

5.1 Longitudinal results

Longitudinal multivarible regression results are presented in Table 1.

Results from the model suggest that from January 2012 to December 2016 (and controlling for other included social and economic factors):

- Females had a lower odds of death by suicide compared to males (OR = 0.26, 95% CI 0.23-0.31).
- Those aged 35-44 years had the highest odds of suicide death, compared to all other age groups.
- Those whose highest educational qualification was a diploma/certificate or school year 12 or less, had higher odds of dying by suicide when compared to those with a bachelor degree or higher (OR=1.37, 95%CI 1.16-1.62 and OR=1.32, 95%CI 1.12-1.55 respectively).
- Identified Indigenous Australians had 1.56 (95%CI 1.19-2.02) times higher odds of suicide death compared to non-indigenous identified Australians.

[8] Year 2011 was not included in the analysis. Refer to section 3.

- Those with a disability had 1.62 (95%CI 1.33-1.98) times higher odds of dying by suicide compared to those individuals who did not have a disability.
- Those with higher incomes had lower odds of suicide death relative to those with lower incomes. Relative to those in the lowest income quintile, the odds of dying by suicide decreased by 0.80 (95%CI 0.69-0.94) for those in 3rd income quintile; 0.60 (CI95% 0.51-0.72) for those in the 4th income quintile and 0.36 (95% CI 0.29-0.44) for those in the highest income quintile.
- Those with higher income uncertainty (as measured by year-to-year variation in income at the individual level) had higher odds of suicide death relative to those with lower income uncertainty. Relative to those in the lowest income uncertainty quintile, the odds of dying by suicide increased by 1.16 (95% CI 1.01-1.38) for those in the 3rd income uncertainty quintile; 1.55 (95% CI 1.31-1.83) for those in 4th income uncertainty quintile and 1.91 (95% CI 0.29-0.44) for those in the highest income uncertainty quintile.

  These results are consistent with current economic literature addressing suicide risk and income uncertainty (Suzuki, 2008; Chen et al 2012).
- People who experienced longer periods of unemployment (as measured by receipt of an unemployment Centrelink social security payment) had higher odds of suicide death. Relative to those with no periods of unemployment, the odds of dying by suicide increase by 1.57 (95% CI 1.21-2.05) for those unemployed for 2 years; 1.75 (95%CI 1.36-2.26) for those unemployed for 3 years; 2.03 (95% CI 1.61-2.57) for those unemployed for 4 years; and 1.96 (95% CI 1.61-2.57) for those unemployed for 5 years

  These results are consistent with Koo and Cox (2008) who suggest that longer periods of unemployment deteriorate human capital, can lead to an increase in suicide risk factors such as unemployment and financial stress.

Table 2 and Table 3 report the regression results of the initial model (Table 1) stratified by sex. The results suggest:

- Males who had a lower level of education (i.e., Diploma/certificate or year 12 and lower) had 1.4 times higher odds of death by suicide compared to males with a bachelor's degree or higher. There was no statistically significant difference for females.
- Females in income quintiles 2 and 3 had lower odds (0.71 and 0.53, respectively) of death by suicide compared to females in income quintile 1. There was no statistically significant difference for males.

Table 1 – Factors associated with suicide 2012 – 2016 (Odds ratios reported)

Variable	Odds ratio	95% Confidence Interval
Male (base)		
Female	0.26	(0.23-0.31)
Age categories		
Aged below 18	0.47	(0.35-0.63)
Aged 18-24	0.61	(0.51-0.73)
Aged 25-34	0.98	(0.83-1.15)
Aged 35-44 (base)		
Aged 45-54	0.93	(0.78-1.08)
Aged 55-64	0.64	(0.52-0.76)
Aged 65-74	0.62	(0.49-0.76)
75 +	0.54	(0.42-0.71)
Education		
Bachelor or Higher (base)		
Diploma level or certificate	1.37	(1.16-1.62)
Year 12 or less	1.32	(1.12-1.55)
Indigenous status	1.56	(1.19-2.02)
Disability status	1.62	(1.33-1.98)
Household composition		
Lone person	2.81	(2.43-3.24)
Single parent	1.83	(1.56-2.15)
Couple with no children	1.09	(0.92-1.25)
Couple with children (base)		
Group household	1.51	(1.23-1.85)
Other household	2.03	(1.54-2.67)
Income		
Income quintile 1 (base)		
Income quintile 2	0.94	(0.81-1.1)
Income quintile 3	0.81	(0.69-0.94)
Income quintile 4	0.61	(0.51-0.72)
Income quintile 5	0.36	(0.29-0.44)
Income uncertainty		
Quintile 1 (base)		
Quintile 2	1.05	(0.88-1.25)
Quintile 3	1.16	(1.01-1.38)
Quintile 4	1.55	(1.31-1.83)
Quintile 5	1.91	(1.62-2.25)
Continuous unemployment years		
0 years (employed - base case)		
1 year	0.82	(0.56-1.18)
2 years	1.57	(1.21-2.05)
3 years	1.75	(1.36-2.26)
4 years	2.03	(1.61-2.57)
5 years	1.96	(1.54-2.49)

Table 2 – Factors associated with suicide 2012 – 2016 (Odds ratios reported)
Stratified model - Males

Variable	Odds ratio	95% Confidence Interval
Age categories		
Aged below 18	0.43	(0.31-0.59)
Aged 18-24	0.58	(0.47-0.72)
Aged 25-34	0.97	(0.80-1.16)
Aged 35-44 (base)		
Aged 45-54	0.89	(0.74-1.07)
Aged 55-64	0.66	(0.53-0.81)
Aged 65-74	0.61	(0.46-0.78)
75 +	0.66	(0.49-0.88)
Education		
Bachelor or Higher (base)		
Diploma level or certificate	1.42	(1.17-1.73)
Year 12 or less	1.43	(1.17-1.73)
Indigenous status	1.48	(1.05-2.03)
Disability status	1.41	(1.10-1.77)
Household composition		
Lone person	2.28	(1.94-2.68)
Single parent	1.51	(1.24-1.85)
Couple with no children	0.94	(0.79-1.12)
Couple with children (base)		
Group household	1.24	(0.98-1.56)
Other household	1.99	(1.48-2.66)
Income		
Income quintile 1 (base)		
Income quintile 2	1.03	(0.87-1.22)
Income quintile 3	0.92	(0.77-1.11)
Income quintile 4	0.66	(0.54-0.80)
Income quintile 5	0.35	(0.28-0.44)
Income uncertainty		
Quintile 1 (base)		
Quintile 2	1.02	(0.83-1.25)
Quintile 3	1.21	(0.98-1.46)
Quintile 4	1.49	(1.23-1.81)
Quintile 5	1.91	(1.58-2.31)
Continuous unemployment years		
0 years (employed - base case)		
1 year	0.77	(0.50-1.18)
2 years	1.59	(1.18-2.15)
3 years	1.67	(1.24-2.24)
4 years	1.95	(1.49-2.56)
5 years	1.95	(1.49-2.55)

Table 3 – Factors associated with suicide 2012- 2016 (Odds ratios reported)
Stratified model – Females

Variable	Odds ratio	95% Confidence Interval
Age categories		
Aged below 18	0.63	(0.36-1.10)
Aged 18-24	0.63	(0.42-0.94)
Aged 25-34	1.01	(0.73-1.39)
Aged 35-44 (base)		
Aged 45-54	0.97	(0.71-1.33)
Aged 55-64	0.49	(0.33-0.74)
Aged 65-74	0.55	(0.34-0.86)
75 +	0.24	(0.13-0.43)
Education		
Bachelor or Higher (base)		
Diploma level or certificate	1.27	(0.92-1.77)
Year 12 or less	1.13	(0.83-1.56)
Indigenous status	1.72	(1.06-2.79)
Disability status	2.49	(1.72-3.61)
Household composition		
Lone person	6.05	(4.41-8.25)
Single parent	3.22	(2.35-4.41)
Couple with no children	1.71	(1.24-2.35)
Couple with children (base)		
Group household	3.07	(2.02-4.66)
Other household	2.14	(1.01-4.54)
Income		
Income quintile 1 (base)		
Income quintile 2	0.71	(0.54-0.93)
Income quintile 3	0.53	(0.39-0.72)
Income quintile 4	0.42	(0.28-0.62)
Income quintile 5	0.41	(0.26-0.64)
Income uncertainty		
Quintile 1 (base)		
Quintile 2	1.14	(0.79-1.65)
Quintile 3	1.04	(0.71-1.51)
Quintile 4	1.74	(1.24-2.44)
Quintile 5	1.91	(1.34-2.71)
Continuous unemployment years		
0 years (employed - base case)		
1 year	0.97	(0.47-2.01)
2 years	1.43	(0.79-2.61)
3 years	2.01	(1.21-3.31)
4 years	2.21	(1.37-3.57)
5 years	1.88	(1.11-3.18)

The interaction between income level (the amount someone earns) and income uncertainty (fluctuations in income over time) was investigated next. Figure 1 shows the expected probability of dying by suicide for each income level quintile and income uncertainty quintile (controlling for measured economic and social factors).

Figure 1 – Effects of income and income uncertainty on the expected probability of suicide.

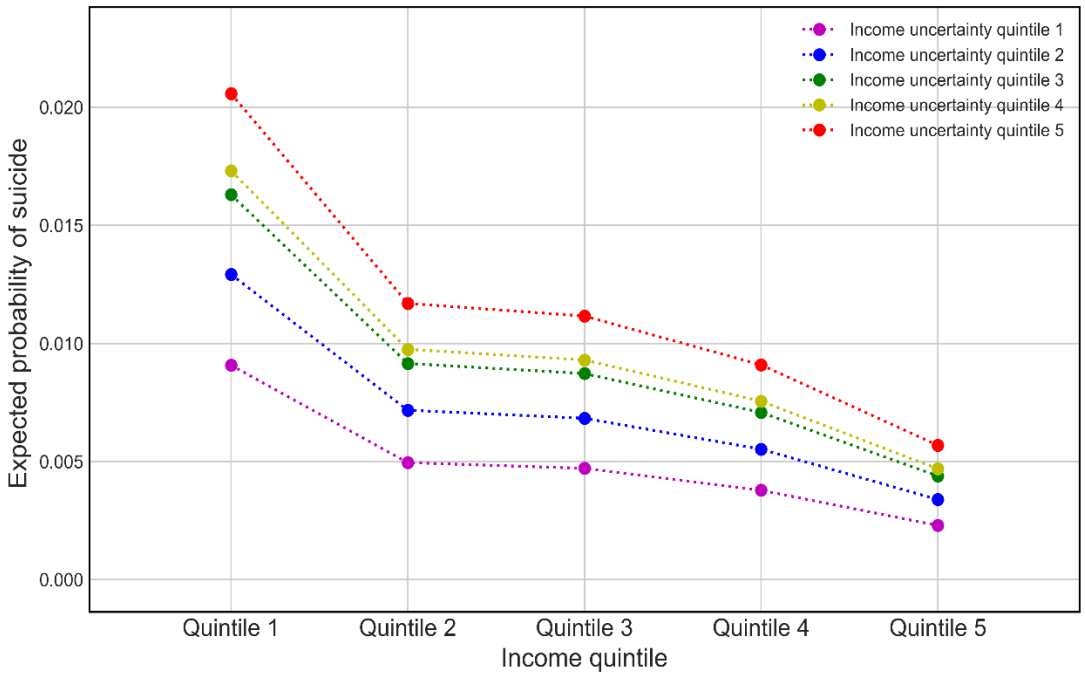


Figure 1 can be used to examine:

- The association between level of income and the expected probability of suicide death, for a given income uncertainty quintile; and
- The association between income uncertainty and the expected probability of suicide death, for a given of income quintile.

It is important to note that the expected probabilities of suicide death (shown in Figure 2 or the vertical or y-axis) are low in magnitude. This means that income level and income variability appear to account for only a small portion of the complex nature of suicide deaths.

The association between level of income and expected probability of suicide death, for a given income uncertainty quintile

The probability of dying by suicide decreased as the level of income increased, across all levels of income uncertainty.

For those with the lowest fluctuation in income between 2012 and 2016 (income uncertainty quintile 1), an increase in the level of income from the lowest to the highest income level group (from income level quintile 1 to quintile 5) reduced the expected probability of suicide by 74%.

For those with the highest fluctuation in income (income uncertainty quintile 5), an increase in income level from the lowest to the highest income level group (from income level quintile 5 to quintile 1) reduced the expected probability of suicide by 72%.

The association between income uncertainty and expected probability of suicide death, for a given income quintile

The expected probability of dying by suicide increases as income uncertainty increases, across all income level quintiles.

For those with the lowest level of income between 2011 and 2016 (income level quintile 1), an increase in income uncertainty from the lowest to the highest income uncertainty group (from income uncertainty quintile 1 to quintile 5), increased the expected probability of suicide by 127%.

For those with the highest level of income (income level quintile 5) an increase in income uncertainty from the lowest to the highest income uncertainty group (from income uncertainty quintile 1 to quintile 5) increased the expected probability of suicide death by 148%.

In relative terms, those with the highest level of income experienced a larger increase in the expected probability of suicide death associated with higher income uncertainty (compared to the increase in the probability of suicide death experienced by those with lower income levels).

In absolute terms, the probability of dying by suicide is still greater for those in the lowest income level group compared to those in the highest income level group. This holds regardless of the level of income uncertainty.

Income uncertainty appears to effect lower and higher-level income earners differently. This notwithstanding, those with the lower incomes had a higher probability of dying by suicide compared to those on higher incomes.

Stratified regression modelling was then undertaken to investigate whether the effects of income uncertainty was different for those who experienced a reduction in income as compared to those that experienced an increase in income. Full results are shown in Table 4 and Table 5.

Focusing on economic factors, results from these models suggest that, from January 2012 to December 2016:

- For those whose income reduced, a higher level of income uncertainty (i.e., greater reductions in income) was associated with higher odds of dying by suicide.
  Relative to those with the smallest reduction in income (1st income uncertainty quintile), the odds of dying by suicide increased by 1.55 (95% CI 1.21-1.99) for those in the 3rd income uncertainty quintile; 2.16 (95% CI 1.70-2.75) for those in the 4th income uncertainty quintile; and 2.81 (95% CI 2.18-3.59) for those in the highest income uncertainty quintile.
- For those whose income increased, higher levels of income uncertainty (i.e., greater increases in income) was associated with higher odds of suicide.
  Relative to those with the smallest increase in income (1st income uncertainty quintile), the odds of dying by suicide increased by 1.26 (95% CI 1.02-1.65) for those in the 4th income uncertainty quintile; and 1.59 (95% CI 1.21-2.09) for those in the highest income uncertainty quintile. No statistically significant differences were found for the probability of dying by suicide when comparing those in the 2nd and 3rd income uncertainty quintiles to those with the lowest income uncertainty (1st income uncertainty quintile).
- These results suggest that both reductions and increases in income, are associated with an increased risk of death by suicide.

Some plausible explanations for this result are: (1) An individual may have obtained a higher level of income in one period (relative to previous years) because of working longer hours. Longer working hours are associated with lower overall life satisfaction (Collewet and Loog 2014). (2) An increase in uncertainty (even positive) may reduce overall life satisfaction due the disruptions it causes in planning and budgeting. (3) Individuals who are risk-averse prefer a constant flow of income as opposed to an income that varies over time in an undertain way, conditional on average income over the period (Dobbs 1988).

Table 4 – Factors associated with suicide 2012 – 2016 (Odds ratios reported)
Stratified model – Those who experienced a reduction in income

Variable	Odds ratio	95% Confidence Interval
Male (base)		
Female	0.27	(0.23-0.32)
Aged below 18	0.78	(0.54-1.13)
Aged 18-24	0.79	(0.61-1.13)
Aged 25-34	1.18	(0.96-1.45)
Aged 35-44 (base)		
Aged 45-54	0.97	(0.79-1.19)
Aged 55-64	0.62	(0.49-0.79)
Aged 65-74	0.56	(0.42-0.75)
75 +	0.46	(0.32-0.66)
Education		
Bachelor or Higher (base)		
Diploma level or certificate	1.51	(1.21-1.87)
Year 12 or less	1.56	(1.26-1.93)
Indigenous status	1.49	(1.06-2.09)
Disability status	2.22	(1.74-2.83)
Household composition		
Lone person	2.71	(2.26-3.26)
Single parent	1.98	(1.61-2.43)
Couple with no children	1.11	(0.91-1.34)
Couple with children (base)		
Group household	1.43	(1.11-1.87)
Other household	2.31	(1.66-3.19)
Income		
Income quintile 1 (base)		
Income quintile 2	1.05	(0.86-1.25)
Income quintile 3	1.11	(0.91-1.35)
Income quintile 4	0.97	(0.77-1.22)
Income quintile 5	0.59	(0.44-0.78)
Income uncertainty		
Quintile 1 (base)		
Quintile 2	1.23	(0.95-1.61)
Quintile 3	1.55	(1.21-1.99)
Quintile 4	2.16	(1.70-2.75)
Quintile 5	2.81	(2.18-3.59)
Continuous unemployment years		
0 years (employed - base case)		
1 year	0.64	(0.38-1.08)
2 years	1.23	(0.86-1.76)
3 years	1.79	(1.31-2.46)
4 years	1.97	(1.45-2.69)
5 years	1.66	(1.21-2.26)

Table 5 – Factors associated with suicide 2012 – 2016 (Odds ratios reported)
Stratified model – Those who experienced an increase in income

Variable	Odds ratio	95% Confidence Interval
Male (base)		
Female	0.28	(0.23-0.33)
Aged below 18	0.32	(0.19-0.55)
Aged 18-24	0.56	(0.41-0.77)
Aged 25-34	0.84	(0.64-1.10)
Aged 35-44 (base)		
Aged 45-54	0.87	(0.66-1.14)
Aged 55-64	0.68	(0.49-0.93)
Aged 65-74	0.81	(0.56-1.16)
75 +	0.86	(0.58-1.28)
Education		
Bachelor or Higher (base)		
Diploma level or certificate	1.27	(0.97-1.67)
Year 12 or less	1.16	(0.89-1.51)
Indigenous status	1.68	(1.09-2.59)
Disability status	1.15	(0.82-1.67)
Household composition		
Lone person	2.85	(2.25-3.61)
Single parent	1.62	(1.23-2.12)
Couple with no children	0.99	(0.76-1.27)
Couple with children (base)		
Group household	1.49	(1.07-2.08)
Other household	1.38	(0.81-2.37)
Income		
Income quintile 1 (base)		
Income quintile 2	1.05	(0.81-1.37)
Income quintile 3	0.78	(0.59-1.03)
Income quintile 4	0.52	(0.38-0.72)
Income quintile 5	0.35	(0.25-0.49)
Income uncertainty		
Quintile 1 (base)		
Quintile 2	1.02	(0.75-1.33)
Quintile 3	0.95	(0.71-1.27)
Quintile 4	1.26	(1.02-1.65)
Quintile 5	1.59	(1.21-2.09)
Continuous unemployment years		
0 years (employed - base case)		
1 year	1.25	(0.74-2.11)
2 years	2.35	(1.56-3.54)
3 years	1.97	(1.27-3.05)
4 years	2.56	(1.76-3.73)
5 years	2.77	(1.89-4.05)

5.2 Cross-sectional results

Full results of the cross-sectional model are shown at table 6.

Results from the model suggest that from January 2012 to December 2016 (and controlling for other included social and economic factors):

- Females had a lower odds of death by suicide compared to males (OR = 0.29, 95% CI 0.28-0.31).
- Those aged 35-44 years had the highest odds of suicide death, compared to all other age groups. The odds of suicide death appears to increase with age up to the age group 35-44 years and then decreased through the older age groups.
- Those whose highest educational qualification was a diploma/certificate or school year 12 or less, had higher odds of dying by suicide when compared to those with a bachelor degree or higher (OR=1.29, 95%CI 1.21-1.38 and OR=1.22, 95%CI 1.14-1.31 respectively).
- Identified Indigenous Australians had 1.47 (95%CI 1.32-1.64) times higher odds of suicide death compared to non-indigenous identified Australians.
- Those with a core activity need for assistance had 1.59 (95%CI 1.47-1.73) times higher odds of dying by suicide compared to those individuals who did not have a disability.
- Those with higher incomes had lower odds of suicide death relative to those with lower incomes. Relative to those in the lowest income quintile, the odds of dying by suicide decreased by 0.65 (95%CI 0.62-0.69) for those in 2nd income quintile; 0.68 (CI95% 0.63-0.72) for those in 3rd income quintile and 0.64 (95% CI 0.60-0.69) for those in 4th income quintile and 0.44 (95% CI 0.41-0.48) for those in the highest income quintile.
- Those with higher income uncertainty had higher odds of suicide death relative to those with lower income uncertainty. Relative to those in the lowest income uncertainty quintile, the odds of dying by suicide increased by 1.34 (1.24-1.45) for those in the 2nd income uncertainty quintile; 1.85 (95% CI 1.72-2.1) for those in the 3rd income uncertainty quintile; 2.31 (95% CI 2.15-2.49) for those in 4th income uncertainty quintile and 2.61 (95% CI 2.49-2.90) for those in the highest income uncertainty quintile.
- People who were unemployed in the period 2012 – 2016 (as measured by receipt of an unemployment Centrelink social security payment) had higher odds of suicide death. Relative to those with no periods of unemployment, the odds of dying by suicide increase by 1.33 (95% CI 1.25-1.40) for those unemployed compared to those who were not unemployed.
- Those who worked as labourers (OR = 1.44; 95% CI 1.31-1.57), community & personal service workers (OR = 1.17; 95% CI 1.05-1.31), machine operators and drivers (OR = 1.59; CI 1.45-1.75) or technicians and trade workers (OR = 1.25; 95% CI 1.15-1.36) had higher odds of suicide death relative to managers and professionals. Those who

worked as clerical and administrative workers had 0.85 (95% CI 0.79-0.98) lower odds of suicide death relative to managers and professional workers.

Table 6 – Factors associated with suicide 2012 – 2016 (Odds ratios reported)

Variable	Odds ratio	95% Confidence Interval
Male (base)		
Female	0.29	(0.28-0.31)
Age categories		
Aged below 18	0.32	(0.29-0.37)
Aged 18-24	0.54	(0.50-0.58)
Aged 25-34	0.82	(0.77-0.88)
Aged 35-44 (base)		
Aged 45-54	0.93	(0.87-0.99)
Aged 55-64	0.55	(0.51-0.59)
Aged 65-74	0.49	(0.45-0.54)
75 +	0.55	(0.50-0.62)
Education		
Bachelor or Higher (base)		
Diploma level or certificate	1.29	(1.21-1.38)
Year 12 or less	1.22	(1.14-1.31)
Indigenous status	1.47	(1.32-1.64)
Disability status	1.59	(1.47-1.73)
Household composition		
Lone person	2.98	(2.81-3.16)
Single parent	1.78	(1.67-1.91)
Couple with no children	1.19	(1.12-1.26)
Couple with children (base)		
Group household	1.66	(1.53-1.80)
Other household	1.74	(1.55-1.96)
Income		
Income quintile 1 (base)		
Income quintile 2	0.65	(0.62-0.69)
Income quintile 3	0.68	(0.63-0.72)
Income quintile 4	0.64	(0.60-0.69)
Income quintile 5	0.44	(0.41-0.48)
Income uncertainty		
Quintile 1 (base)		
Quintile 2	1.34	(1.24-1.45)
Quintile 3	1.85	(1.72-2.00)
Quintile 4	2.31	(2.15-2.49)
Quintile 5	2.69	(2.49-2.90)
Unemployment	1.33	(1.25-1.40)
Occupation		
Managers and professionals (base)		

Labourers	1.44	(1.31-1.57)
Community & personal service	1.17	(1.05-1.31)
Machine operator and drivers	1.59	(1.45-1.75)
Sales workers	0.95	(0.84-1.07)
Technicians and Trade workers	1.25	(1.15-1.36)
Clerical and Administrative	0.88	(0.79-0.98)
Other occupations	1.4	(1.31-1.51)

6. Strengths and Limitations

As described this study used a MADIP extract which is a deidentified, individual person level dataset, representative of the Australian population. Using population-representative data reduces the likelihood that results are biased and provides a high level of confidence that findings are generalisable to the Australian community. Using individual-level linked data allows for use of analyses that control for the other social and economic factors included within the dataset, increasing the robustness of the results.

The results of this study show where there may be opportunities to develop targeting suicide prevention measures. For example, for people moving to their second years of receiving a Centrelink unemployment social security payment or for people who have been unemployed for prolonged periods.

The limitations of this study must be considered when interpreting its findings. The methods used allowed for robust estimation of associations between economic and social factors, and death by suicide. It also enabled the investigation of the specific interaction between income level and income uncertainty. Though our models help us to understand the relationship between social and economic factors and suicide, they only capture a modest part of the complex nature of suicide in Australia.

While being a powerful data asset, the MADIP extract used did not include information about some factors that are highly relevant to the study of suicide. For example, physical and mental health status. As such, these factors could not be controlled for in our analyses. As stated, MADIP is a linked data asset. It is possible that data linkage rates have introduced some bias into the dataset and our results. The ABS provides cross sectional weights to account for data linkage error. Longitudinal weights are not provided.

7. Technical Appendix

7.1 Cross-sectional regression

In order to conduct a cross-sectional regression, the dataset was set up as a cross-section. Appendix Table A1 outlines the data transformations that were undertaken to transform the time-varying explanatory variables into a time-invariant variables.

Table A1 – Cross-sectional variable transformation

Time Variable	Transformation	Sample size
Binary suicide variable (dependent variable)	Binary variable was created which took the value 1 if an individual completed suicide in the period 2012-2016, and a value of 0 otherwise.	Suicides (1) = 11,586 Non suicides (0) = 16,687,483
Age	Age at 2011 was used.	
Income	Average income was calculated.	
Relative standard deviation	Derived from Average income.	
SSRI	Binary variable was created which took the value 1 if an individual received a benefit in the period 2012-2016, and a value of 0 otherwise.	
Unemployment	Binary variable was created which took the value 1 if an individual received a benefit in the period 2012-2016, and a value of 0 otherwise.	

In terms of methodology, a standard logistic model with robust standard errors was utilized. Equation (3) and (4) outline the model.

$$y_i^* = \alpha + \beta x_i + \varepsilon_i \qquad (3)$$

$$y_i = \begin{cases} 1, y_i^* > 0 \\ 0, \text{otherwise} \end{cases} \qquad (4)$$

Where y_i is the dependent variable which takes the value 1 if individual i has completed suicide and 0 otherwise. x_i is a vector of time-invariant explanatory variables and ε is the error term which is assumed to be independent and identically distributed with $\varepsilon \sim (0, \sigma^2)$.

8. References

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