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Abstract
Alcohol misuse represents one of the leading causes of preventable death, illness and injury in Australia. Extensive research exists estimating the effect of risky alcohol use on mortality but little research quantifies the impact of risky alcohol consumption on morbidity. Estimates are needed to measure the benefit of interventions which reduce risky alcohol use. Ordered probit and tobit models are used to analyse the impact of risky drinking on self reported health status using data from rural Australians. It is found that risky alcohol use is associated with lower self-reported health however the average effect is small apart for those drinking at very high risk.

Keywords: Alcohol Misuse, Morbidity, Ordered Tobit and Probit.

JEH Classification: I1

1. INTRODUCTION

The relationship between alcohol consumption and health is complex and multidimensional. Despite evidence of a positive effect on CHD, stroke and diabetes mellitus associated with light to moderate regular drinking, the major body of evidence suggests alcohol misuse represents a preventable risk factor for death, illness and injury(Babor et al., 2003). Recent estimates suggest that alcohol dependence contributed to over a third of the harm attributed to alcohol for Australia in 2003(Begg et al., 2007).

Researchers have provided a series of comprehensive studies quantifying the causal links between alcohol and mortality (English et al., 1995; Holman et al., 1990; Ridolfo and Stevenson, 2001). However the evidence for alcohol related morbidity is limited, with few studies investigating the impact of alcohol consumption on disability or quality of life (Rehm et al., 2003). Rehm, et al. (2003) state that broad summary measures that reflect alcohol's possible effects on morbidity, mortality, and disability may be more useful than measures of any one outcome alone. This is because alcohol affects health across a large spectrum of health dimensions, therefore estimating the effect of alcohol on broad measures of health such as morbidity allow the total benefit of reductions in alcohol use to be estimated easily, rather than trying to combine the individual health effects ex-post. One study which did look at non-fatal health outcomes found a J-shaped relationship between alcohol intake and probability of self-reported suboptimal health (Poikotainen et al., 1996).

Estimating morbidity, in terms of quality adjusted life years (QALY's) lost due to risky alcohol use, which has both morbidity and mortality components, is important because such estimates are commonly used in economic evaluations of interventions which reduce alcohol use. The estimated effect of alcohol consumption on morbidity (i.e. utility weights), therefore, can dramatically effect resource allocation decisions. This effect of alcohol use on morbidity has been quantified by a panel of medical experts who were asked to estimate the extent to which excessive alcohol use contributes to a range of health states, using the person trade off technique (Stouthard et al., 1997). Their estimate, effectively a utility weight for the effect of alcohol misuse on morbidity, represents the amount of time spent in full health which is equivalent to spending 1 year in the health state. Their estimated utility weight for problem drinking (including physical and psychological problems caused by excessive alcohol intake) is 0.89 (95% CI. 0.85-0.94), implying that problem drinkers' quality of life is, on average, reduced by 11%, compared with non-problem drinkers. The wide variance

around this estimate reflects both the large variation in responses and the relatively small sample size of this Dutch study.

A further problem with the current weights, commonly referred to as the 'Dutch Weights', is that no classification exists such that individuals can be assigned as a problem drinker based on their alcohol intake, or other commonly measured dimensions. In spite of these shortcomings, the Dutch weights continue to be used in major economic and epidemiological studies concerning alcohol (Chisholm et al., 2004; Mathers et al., 2001; Mortimer and Segal, 2006).

This study sets out to achieve a number of objectives, firstly to identify the alcohol risk level and health status of individuals in a number of rural communities in NSW, Australia. Secondly to examine the differences in mean health status across the different alcohol risk levels. Thirdly to identify which health domains (mobility, self care, able to perform usual activities, pain/discomfort or anxiety/depression) are affected by alcohol risk status after controlling for potential confounders and finally, to quantify the effect of alcohol risk level on quality of life, controlling for potential confounders.

2. METHODS

Study Sample

This research was conducted as part of a larger study, the Alcohol Action in Rural Communities (AARC) project. AARC is a randomized controlled trial of community based alcohol interventions being conducted in 20 rural communities in the Australian state of New South Wales. Baseline data involved a postal survey conducted in March 2005 for 7,895 individuals from the 20 communities to collect information on health status, patterns and frequency of alcohol consumption, demographics and other relevant variables.

The population to be sampled was stratified by gender and age to reflect the specific characteristics of each community, as defined in the Australian Bureau of Statistics 2001 census reports (Australian Bureau of Statistics, 2001). For each of the 20 rural communities, approximately 400 people enrolled to vote with the Australian Electoral Commission were randomly selected to participate. Each participant was mailed a self addressed envelope which contained a cover letter explaining the study, along with the survey and a reply paid envelope. Two weeks after the initial survey was sent all participants were mailed a reminder letter asking them to complete the survey. Those participants who had not responded after 4 weeks were sent another survey.

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Classifications of alcohol use

Individuals' risky alcohol use was classified using the Alcohol Use Disorders Identification Test (AUDIT), as a reliable and valid measure of hazardous and harmful patterns of alcohol consumption (Babor et al., 2001). The questionnaire includes items covering alcohol consumption, dependence and their consequences. An AUDIT score was calculated for each respondent and used to classify them into one of the following risk categories: abstainer (respondent indicated that they had not had an alcoholic drink in the last 12 months); low risk (AUDIT score ≤7); medium risk (AUDIT score 8-15); high risk (AUDIT score 16-19) and, very high risk (AUDIT score ≥ 20) (Babor et al., 2001).

Along with the AUDIT, another question was asked, "Has alcohol ever caused a serious problem for you in the past such as serious injury, relationship break-up etc.?" The response to this question was used to account for previous alcohol problems where the respondent may have since reduced their alcohol consumption as a result of the problem. Those who stated they had experienced a serious negative effect from alcohol, were classified "abstainer, past problems" and "low risk, past problems". Conversely, those who reported no serious past negative effects due to drinking were classified "abstainer, no past problems" and "low risk, no past problems".

Though the AUDIT is mainly a clinical tool, it is used in this case because it provides a convenient method by which to classify drinkers, based on the likelihood that their alcohol use (consumption, dependence and problems) results in diminished health. It is also a commonly used measure pre and post intervention, which means that the results from this study can be used across other studies to evaluate the benefit in terms of the improvement in morbidity resulting from alcohol interventions.

Measures of health status

The health state of an individual was measured using the EQ5D, a five item questionnaire encompassing the domains of mobility, self-care, usual activities, pain/discomfort and anxiety/depression (The EuroQol Group, 1990). Respondents indicated whether they had no problems, some problems, or major problems in each domain, with responses scored as 1, 2 and 3, respectively.

Health utility score

In order to produce a combined utility health score where 1 is full health and 0 is equivalent to being dead, individuals' answers about the extent of their problems in each of the 5 health

domains were weighted. The weights, based on a large UK study, are used to take into consideration population preferences for each health domain (Dolan et al., 1995).

A visual analogue scale (VAS) is included in the standard EQ5D questionnaire, asking respondents to rate their current health level by marking a horizontal line across a vertical scale from 0 (equivalent to being dead) to 100 (full health). The VAS is primarily used as a validation tool in assessing the plausibility of the EQ5D assessment.

Validity of EQ5D score and average EQ5D among risk categories

The validity of the EQ5D score was assessed by calculating the Pearson correlation coefficient of the utility weight against the VAS score. To examine whether mean health utility score varied as a function of alcohol risk level, a simple one-way ANOVA was performed and Bartlett's test for equal variances was also used to test for homogeneity of the variances between groups. To examine which alcohol risk groups were significantly different in mean health status from other risk groups, multiple pair wise comparisons were conducted assuming unequal variances, using Welch's standard errors and Satterthwaite's adjusted degrees of freedom. This procedure was used because it was unlikely that the variance of the health status was equal across groups.

Potential confounders, for example age and income, imply that comparisons between health status of different alcohol risk levels may not be appropriate, suggesting more complex analytical models are required. In order to address these concerns, a series of ordered probit models are estimated to investigate which health domains are affected by alcohol risk status after controlling for potential confounders. Ordered probit models are applicable because the dependent variables Y_{ki} for each health domain k contain a discreet set of outcomes, with natural order such that no problems is better than some problems, which is better than major problems. The model is based on a latent (unobserved) continuous dependent variable which in this case can be interpreted as the "propensity for problems" Y_{ki}^* of individual i in each health domain k. In order to control for factors, other than risky alcohol consumption that may affect the propensity for problems, the following explanatory variables are added to the ordered probit model: income, education status, smoking status, age and sex.

Secondly a tobit model is estimated in order to quantify the total affect of alcohol risk level on quality adjusted life years (QALY's) after controlling for potential confounders. The dependent variable is the health utility score which is a weighted combination of all 5 health domains where 1 is full health and 0 is equivalent to being dead. Given that the majority of

individuals report no problems with any health domains (full health), a tobit model is appropriate where the dependent variable is censored at 1 (full heath). By the same logic it seems appropriate to also censor the dependent variable at 0 (equivalent to being dead), however, this is not done because very few individuals report poor health to this degree and individuals can also perceive their health status as worse than death. Tobit models use a latent (unobserved) dependent variable which can be interpreted as the "propensity for quality of life". If the "propensity for quality of life" is less than 1, then the individual actually experiences that quality of life. If the "propensity for quality of life" is greater than 1, then the individual experiences full health, regardless of their potential. This estimation method takes into consideration that otherwise healthy people (the young, the rich) often do not feel the effects of risky behaviour, at least in the short term.

Ordered probit model for each health domain

The following model specification is used for the ordered probit models,

$$Y_{ki}^* = \beta_{1k}(ABSNPP)_i + \beta_{2k}(ABSPP)_i + \beta_{3k}(LRPP)_i + \beta_{4k}(MR)_i + \beta_{5k}(HR)_i$$
$$+ \beta_{6k}(VHR)_i + \alpha'_{mk}Z_{mi} + \varepsilon_{ki}$$

where $Y_{ki}^* =$ "propensity for problems" of individual i for health domain k

$ABSNPP_i = 1$ if individual i is abstainer with no past problems and 0 otherwise

$ABSPP_i = 1$ if individual i is an abstainer with past problems and 0 otherwise

$LRPP_i = 1$ if individual i is a low risk drinker with past problems and 0 otherwise

$MR_i \quad = 1$ if individual i is classified at medium risk and 0 otherwise

$HR_i \quad = 1$ if individual i is classified at high risk and 0 otherwise

$VHR_i \quad = 1$ if individual i is classified at very high risk and 0 otherwise

The low risk with no past problems category is the reference group, therefore, all risk categories are compared to those in the low risk group with no past alcohol problems.

$Z_{mi} =$ personal characteristic m of individual i. (e.g. income, age etc.)

$\varepsilon_{ik} =$ random error (assumed to be normally distributed)

$\beta_{jk}, \alpha_{mk} =$ parameters to be estimated for each (k) equation

The actual observed extent of problems for each health domain is given below,

$$Y_{ki} = \begin{cases} 1 & if \quad -\infty < Y_{ki}^* < \mu_{1k} \\ 2 & if \quad \mu_{1k} < Y_{ki}^* < \mu_{2k} \\ 3 & if \quad \mu_{2k} < Y_{ki}^* < \infty \end{cases}$$

where μ_{1k} and μ_{2k} are the threshold parameters where an individuals' observed classification changes. These parameters are estimated by the model along with the other parameters. Positive (negative) values for β_{jk}, α_{mk} indicate a positive (negative) relationship between "propensity for problems" in health domain k and the explanatory variable in question.

Because few individuals reported major problems with self care and mobility, only two dependent variable categories are considered for these health domains: no problems and at least some problems. These models are equivalent to simple probit models. Also, because no individuals with high risk drinking behaviour reported any problems with self care, these individuals were combined with medium risk drinkers for the analysis of this health domain.

Tobit model for the effect of alcohol risk level on overall health status
Given that the ordered probit model has identified which health domains are affected by alcohol risk level, the next step is to use the tobit model to quantify the combined effect of alcohol risk level on the quality of life of the individual. The following model specification is used,

$$Y_i^* = \beta_1 (ABSNPP)_i + \beta_2 (ABSPP)_i + \beta_3 (LRPP)_i + \beta_4 (MR)_i \\ + \beta_5 (HR)_i + \beta_6 (VHR)_i + \alpha_m' Z_{mi} + \varepsilon_i$$

where Y_i^* = "propensity for quality of life" of individual i, $ABSNPP_i$, $ABSPP_i$, $LRPP_i$, MR_i, HR_i and VHR_i are classified the same as with the ordered probit model. Again the low risk alcohol category is left out of the regression and therefore the "propensity for quality of life" of each risk categories is compared to those in the low risk group, and $Z_{mi}, \varepsilon_i, \beta_j, \alpha_m$ are classified the same as before.

The actual observed quality of life is given below,

$$Y_i = \begin{cases} Y_i^* & if \quad Y_i^* < 1 \\ 1 & if \quad Y_i^* \geq 1 \end{cases}$$

Positive (negative) values for β_j, α_m indicate a positive (negative) relationship between "propensity for quality of life" and the explanatory variable in question.

Explanatory variables

The same explanatory variables (Z_{mi}) are used in both the ordered probit models for each health domain and the tobit model for overall health status. A gender dummy variable (sex) which is equal to 1 for females is included to capture gender differences in health status. Age is included as years old to capture the deteriorating health with old age, also an interaction term (sex*age) is included to take into account the different effect of age for males and females. A dummy variable for smokers is included (smoker=1 for a smoker), because smoking can cause significant negative effects on health (Doll et al., 2004). A dummy variable for education is included (educ=1 for those individuals with an educational achievement greater than year 10), because more educated individuals are likely to make more informed choices in regards to their health(Lleras-Muney, 2005).

A gross income variable is included, (which can be interpreted as a natural log of income in dollars per week for each individual in the household over 14 years old), because there is a substantial amount of literature associating wealth with superior health(Gardner and Oswald, 2004). Also included in the regression are 2 dummy variables for those individuals who stated that they didn't know their household income and preferred not to state their household income; all of the income variables are divided by the number of individuals in the household over 14 years old. In order to classify respondents into income categories, they were asked to indicate the income group, of a possible 12, into which their household income falls. Since this only provides upper and lower income bounds, a predicted value for an individual's household income was generated by an interval regression model, with the natural log of the upper and lower income bounds used as the dependent variable. The natural log is used because incomes are commonly skewed to the right. The factors considered which affect income are number of individuals over 14 in the household, martial status and whether or not the respondent was in fulltime employment, and a dummy variable for the 20 rural communities under consideration. An expected value for the household income is then derived for every individual based on their answer to the income question plus

the other factors. This method was preferred to using a categorical income variable because when using the categorical variable 13 income explanatory variables need to be included as opposed to the current case where there are only 3 income variables (both methods produce very similar coefficients for other variables in the model).

3. RESULTS

Demographics

Of the 7,985 questionnaires sent out, 3,017 (38%) were returned with usable responses. The response rate of 38% is lower than that for the Australian National Drug Strategy Household Survey (NDSHS), which had a response rate of 45.6%(Australian Institute of Health and Welfare, 2005). Females comprised 1,688 (56%) of the sample, and the mean age of respondents was 42 years (S.D.: 12; range 18-71 years). There were 560 (19%) smokers in the sample with 134 (4%) not indicating their smoking status. In the sample, 1395 (46.4%) individuals had completed post school education, while 23 individuals did not state their highest education level achieved. A weekly household income of less than $500 was reported by 507 (17%) individuals, and 573 (19%) had a weekly gross household income greater than $1500.

Alcohol use (AUDIT classification)

The alcohol risk levels of the 2,837 individuals who answered all AUDIT questions or indicated they were abstainers were classified: 11.7% were abstainers; 65.6% low risk, 17.6% medium risk; 2.6% high risk and 3.0% very high risk. Of the abstainers, 11.0% reported a past serious problem from drinking while 6.7% of low risk drinkers reported a past serious problem from drinking.

Health results

The percentage of respondents that classified themselves as having no, some and major problems for each health domain are included in Table 1. 2,847 respondents answered all 5 of the EQ5D dimensions and 2,862 rated their current health on the VAS. The means (and standard deviations) of the EQ5D utility weights and VAS were 0.88 (0.20) and 0.83 (0.15) respectively. The pearson correlation coefficient between the EQ5D utility weight and the VAS was 0.61 which was significant at the 1% level.

------Insert Table 1 here-----

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Health status for different alcohol risk levels

Table 2 shows that there is a significant difference in mean health status between the 7 groups with low risk drinkers with no past problems reporting the highest mean health status (0.895) and abstainers with past problems reporting the worst health status (0.727). There is evidence to suggest that the variance of health status within each group is not equal (p-value=0.0000) and, therefore, the multiple pair wise comparison procedure was performed to take this into account. At the 5% level of significance, there was no statistically significant difference between the mean health status of those abstainers with no past problems, low risk drinkers with no past problems, medium risk drinkers and high risk drinkers. However, those abstainers with past problems, low risk drinkers with past problems and very high risk drinkers report significantly worse mean health than all other risk groups at the 5% level of significance.

------Insert Table 2 here-----

Ordered Probit Models

Effect of alcohol risk level on each health domain

The regression results for the 5 ordered probit models of each health domain are included in Table 3. After controlling for other factors associated with poorer health (being older, lower income, lower education and being a smoker), those individuals who reported consuming alcohol at very high risk levels reported significantly worse health for self-care, ability to perform usual activities and anxiety/depression than low risk drinkers with no past problems at the 1% level of significance, and worse health in pain/discomfort at the 5% level of significance. Abstainers with no past alcohol problems report significantly worse health for mobility and ability to perform usual activities compared with low risk drinkers with no past alcohol problems at the 5% level of significance, while reporting significantly better health in terms of anxiety/depression at the 1% level.

The strongest relationship between risky alcohol consumption and a health domain is for anxiety/depression with the propensity for problems increasing as risky alcohol consumption increases. Abstainers (with no past alcohol problems) report less anxiety/depression problems than low risk drinkers (with no past alcohol problems) who in turn report less anxiety/depression problems than medium risk drinkers who have less anxiety/depression problems than high risk drinkers and finally very high risk drinkers report the largest amount of problems with anxiety/depression. All risk groups are individually

significantly different from low risk drinkers (no past problems) at the 1% level of significance.

In addition to anxiety/depression medium risk drinkers also report significantly more problems with mobility and pain/discomfort than low risk drinkers (with no past problems) at the 5% level of significance. Low risk drinkers (with past problems) report significantly worse health in terms of all health domains than their low risk counterparts who have not had past alcohol problems at the 5% level of significance. Those current abstainers who reported past problems due to alcohol have significantly more pain/discomfort and anxiety/depression than those low risk drinkers (with no past problems).

Effect of other factors on each health domain

The only health domain where gender plays a significant role is for anxiety and depression with females having a higher likelihood to report problems than males at the 5% level; however this effect changes depending on age (the effect of age on anxiety and depression is significantly less for females than their male counterparts). Controlling for all variables, older individuals report significantly more problems in all health domains at the 1% level of significance. As income per individual over 14 yrs old in the household increases, household members are less likely to report problems in all health domains (significant at 1% level). Those who have an education level of greater than year 10 are less likely to report problems with pain/discomfort than their less educated counterparts (significant at the 1% level). Smokers report significantly worse health for all 5 health domains apart from self care (5% level of significance).

Tobit Model Results

Effect of alcohol risk level on quality of life

The three columns on the far right of Table 3 (overall health status), show the results of the tobit model for the health utility score. These results show that there is no significant difference between abstainers (no past problems) and their low risk drinking counterparts at the 10% level. Medium and very high risk drinkers report significantly worse health compared to low risk drinkers (no past problems) at the 1% level. There is no significant difference (at the 10% level) between high risk and low risk drinkers (no past problems) Medium, high, and very high risk drinkers report 0.07, 0.08 and 0.23 reductions respectively in their "propensity for quality of life" compared with low risk drinkers (no past problems) after controlling for other factors. In terms of the predicted average 'actual' reductions in

QALY's, which is experienced by the current sample, the effect is smaller, given that some risky drinkers still experience full health even after their reduction in 'propensity for quality of life'. The predicted 'actual' average reduction in QALY's for medium, high and very high risk drinkers for the current sample is 0.01, 0.01 and 0.13 respectively.

Abstainers with past alcohol problems report the lowest quality of life, holding everything else constant, with a reduction in "propensity for quality of life" of 0.246 compared with low risk drinkers with no past problems. Low risk drinkers with past problems report significantly worse "propensity for quality of life" than their counterparts who have had no past alcohol problems by a magnitude of 0.185.

Effect of other factors on quality of life

Age and smoking both negatively impact on the quality of life of an individual which is significant at the 1% level. Both education and income have a positive effect on quality of life which is significant at the 1% level. The sex of an individual does not have a significant effect on their quality of life or on the effect of age on quality of life.

------Insert Table 3 here-----

Discussion

Before considering the main findings of this research, a number of limitations are worth noting. First, participants were randomly selected from the electoral roll so these data only apply to those aged at least 18 years. Second, the study relies on self-reported alcohol use which is often, due to social desirability, an under representation of the true levels of alcohol consumed. However, as long as this underreporting is consistent across surveys (i.e. in settings other than postal surveys in rural Australia), then the utility weights associated with being in a certain alcohol risk category should be consistent for all self reported alcohol use in the population. Third, health is measured subjectively and, therefore, may vary between individuals with the same health state, as opposed to an objective measure such as health service utilisation. However, given that a large amount of self-reported morbidity may not show up in health service utilisation, as some individuals choose not to receive treatment for such aliments, it may be more accurate to use a self-reported health measure. Using self-reported health status also allows an estimate of the effect of alcohol on total morbidity, rather than the effect on a more narrow objective measure. Fourth, the large non-response

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rate, although typical of such surveys, may create a selection bias problem if unhealthy drinkers are less likely to respond than unhealthy non-drinkers, which may underestimate the effect of risky drinking on health. However it seems probable that very sick individuals would be unlikely to respond, regardless of their alcohol risk level.

Fifth, there are a number of other variables, such as other drug use and access to medical care, which can effect an individual's health status, that have not been taken into account in the present study. If these variables are highly correlated with alcohol use, then this may bias these results (in this case, overestimate the impact on health of risky alcohol consumption). Also, the health of an individual can impact on their decision regarding the consumption of alcohol. This is likely to be a problem in particular for the abstainer category where those of significantly diminished health are likely to abstain from alcohol use. Sixth, because the data are cross-sectional, drinking patterns of individuals are only based on drinking patterns from the last year and, therefore, the health effects of former drinking patterns are not fully taken into account. This means that "low risk drinkers (no past problem)" still may consist of individuals who have diminished health due to previous "risky" drinking and thus under-estimate the true effect of alcohol on non-fatal health outcomes. Finally in measuring quality of life, the EQ5D can be insensitive for some disease types, specifically those other than the 5 health domains listed. If alcohol is associated with diseases not accounted for in the EQ5D, then the effect of drinking on health will be underestimated in this study.

This study has used ordered probit models to examine the impact of alcohol risk level on the "propensity of problems" in the 5 health domains of mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Evidence was found to support the notion that compared with low risk drinkers (no past problems), those who drink at very high risk level experience on average worse health outcomes in terms of self care, completing usual activities, pain/discomfort and anxiety/depression. The strongest relationship between health status and risky use of alcohol is with the anxiety/depression where the higher the alcohol risk level the more likely the individual is to report problems. The effect of drinking at medium and high risk levels on each health domain, apart from anxiety/depression, appears less clear. However, there is some weaker evidence to suggest that medium risk drinkers experience worse mobility and more pain/discomfort than low risk drinkers. Little can be significantly concluded from the high risk category, mainly due to the very few high risk drinkers (n=67) in the sample and the fact that many in this category are otherwise healthy (mean age 36), which results in a large amount of variability around the estimated effects.

Given abstainers (no past problems) are more likely to report problems with mobility and usual activities, after controlling for other factors, this may reflect that individuals with mobility problems and who are unable to complete usual activities are more likely choosing to abstain from alcohol, rather than the result suggesting that abstaining from alcohol is causing these health problems. Also there may also be other exogenous factors not measured here which impact both on the decision to become an abstainer and on health status. For example, some religious backgrounds which prohibit alcohol as well as some medical treatments (e.g. blood transfusions) and, therefore, decreases in health status may be attributable to the reduced medical treatment rather than the choice to abstain from alcohol.

In terms of measuring the effect of risky alcohol use on total QALY's, as estimated by the tobit model, it was found that as alcohol risk level increased respondents' self-reported health status reduced. Although this trend was statistically significant for medium risk drinkers and not for high risk drinkers, the latter result most likely reflects the larger variability around the estimate for high risk drinkers associated with the low sample size of this group, rather than the possibility that high risk drinking has no effect on overall health. The effect on health status of all other explanatory variables was as expected, with health status diminishing with age and for smokers, while increasing with income and education level. While there was no significant impact of gender on quality of life, the direction of the effect was consistent with expectations, with older females reporting better health than males of the same age and the extent of this difference increasing with age. These consistent findings improve the confidence that the results for the effect of alcohol risk level on health status are accurate.

In summary, the effect of alcohol consumption in rural communities in NSW is an estimated 7%, 8% and 23% reduction in respondents' 'potential' perceived health, for medium, high risk and very high risk drinkers respectively, compared to low-risk drinkers (no past problem). Since many drinkers are otherwise healthy (propensity for quality of life greater than 1), the average 'real' improvement in perceived morbidity that would result from a reduction in alcohol risk level is substantially smaller than the estimates of 7%, 8% and 23%.

For the current sample of medium and high risk drinkers, the average result from reducing alcohol risk level to low risk is a 1% 'real' improvement in QALYs. Objective data may show otherwise, but if the relatively large number of medium and high risk drinkers (n=547; 20% of sample) generally perceive they have full health, then there is little to benefit in terms of morbidity from population wide interventions aimed at reducing their alcohol consumption

to low risk levels. An intervention targeted at medium and high risk drinkers who currently have sub-optimal health may be more appropriate, as their perceived level of morbidity would be likely to improve by about 7% or 8% respectively, if they were to become low risk drinkers. The average 'real' benefit in terms of improved QALYs for very high risk drinkers is substantially higher with the possibility of achieving on average a 13% improvement if they were to become low-risk drinkers.

In terms of quantifying the effect of an intervention which reduces risky alcohol use, the target population for the intervention is particularly important. For a school based intervention (healthy target population) there is likely to be little benefit in terms of reduction in morbidity compared with a general practitioner brief intervention (target population is likely experiencing sub-optimal health) where individuals are likely experiencing close to the full effect of their alcohol risk level on morbidity.

The effect of alcohol on morbidity derived from the current analyses is lower than suggested by use of the Dutch weights in current economics evaluations. If this is accurate, then from a policy viewpoint, these economics evaluations tend to, overemphasise interventions which are morbidity reducing such as taxation, place undue focus on alcohol as a risk factor and consequently adversely impact on resource allocation decisions.

This research has provided more robust morbidity estimates for the impact of alcohol on quality of life, which can be used in economic evaluations of interventions, especially those implemented in rural communities. These analyses suggest, for example, that the health sector is unlikely to substantially reduce drinking among medium and high risk drinkers, such that other approaches, including enforcement of liquor licensing laws and injury reduction strategies, may be preferable. However, the health sector could usefully concentrate on identifying and intervening with very high risk drinkers, given the greater capacity for improvements in perceived health status to reinforce decisions to reduce to low risk drinking.

Further research in this area would usefully explore the possible bi-causal nature of alcohol and health, given individuals' health status can impact upon alcohol consumption decisions and alcohol consumption can impact on health status. This could be achieved by collecting time series data on individuals' drinking status and health status over time to better account for this bi-causal nature. Also, further research is needed to explore the separate effects on health of total quantity of alcohol consumed, versus patterns of consumption.

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Table 1. Percentage and number classifying as having no, some or major problems in each health domain

	Mobility % (N)	Self Care % (N)	Usual Activities % (N)	Pain/ Discomfort % (N)	Anxiety/ Depression % (N)
No Problems	90.1 (2,594)	97.8 (2,821)	88.6 (2,549)	69.4 (1,996)	78.3 (2,250)
Some Problems	9.8 (282)	2.1 (63)	10.8 (310)	28.1 (808)	19.9 (572)
Major Problems	0.1 (3)	0.1 (3)	0.7 (19)	2.54 (73)	1.8 (52)

Table 2. Mean and variance of EQ5D utility score by alcohol risk category

AUDIT Score	No. of Individuals	Mean EQ5D score	Variance
Abstainers (no past problems)	259	0.868	0.0488
Low risk (no past problems)	1649	0.895	0.0324
Medium risk	480	0.883	0.0298
High risk	67	0.880	0.0320
Very high risk	82	0.757**	0.0866
Low risk (past problems)	117	0.814**	0.0589
Abstainers (past problems)	33	0.727**	0.1036

F-test for differences in means between any groups (p-value = 0.0000)

Bartlett's test for equal variances (p-value=0.0000)

** Significantly different at the 5% level from abstainers with no past problems, low risk drinkers with no past problems, medium risk drinkers and high risk drinkers using Welch's standard errors and Satterthwaite's adjusted degrees of freedom.

Table 3. Results for ordered probit models of problems in the 5 health domains and tobit model for overall health status

Variable	Mobility Coeff	Std err	p-val	Self care Coeff	Std err	p-val	Usual activities Coeff	Std err	p-val	Pain/Discomfort Coeff	Std err	p-val	Anxiety/Depression Coeff	Std err	p-val	Overall health status Coeff	Std err	p-val
Abstainer (no problem)	0.25**	0.11	0.03	-0.10	0.43	0.69	0.20**	0.10	0.05	0.01	0.09	0.90	-0.29***	0.11	0.01	0.00	0.03	0.89
Low Risk (no problem)							Comparator group											
Medium Risk	0.22**	0.10	0.03	0.03	0.18	0.85	0.06	0.10	0.54	0.16**	0.07	0.02	0.26***	0.08	0.00	-0.07***	0.02	0.00
High Risk	-0.20	0.26	0.45				-0.13	0.21	0.54	-0.19	0.18	0.29	0.50***	0.17	0.00	-0.08	0.05	0.15
Very High Risk	0.24	0.20	0.22	0.73***	0.22	0.00	0.52***	0.17	0.00	0.30**	0.15	0.04	0.86***	0.14	0.00	-0.23***	0.05	0.00
Abstainer (past problem)	0.42	0.27	0.11	0.54	0.37	0.14	0.65***	0.23	0.01	0.39	0.24	0.11	0.72***	0.21	0.00	-0.25***	0.08	0.00
Low Risk (past problem)	0.35**	0.16	0.03	0.46**	0.21	0.03	0.35**	0.14	0.01	0.48***	0.12	0.00	0.46***	0.12	0.00	-0.19***	0.04	0.00
Sex	0.00	0.29	0.99	-0.17	0.43	0.69	0.06	0.26	0.81	-0.12	0.20	0.53	0.45**	0.20	0.01	-0.07	0.06	0.30
Age (*100)	2.40***	0.46	0.00	1.50**	0.66	0.02	1.98***	0.41	0.00	1.97***	0.33	0.00	1.12***	0.34	0.00	-0.70***	0.11	0.00
Age * Sex (*100)	-0.41	0.63	0.51	-0.08	0.92	0.93	-0.39	0.55	0.48	-0.04	0.43	0.93	-0.95**	0.45	0.04	0.21	0.05	0.14
ln(Income)	-0.34***	0.05	0.00	-0.47***	0.08	0.00	-0.33***	0.05	0.00	-0.35***	0.04	0.00	-0.30***	0.04	0.00	0.13***	0.01	0.00
Income DK	1.34***	0.28	0.00	1.44	0.34	0.00	1.00***	0.27	0.00	0.65**	0.28	0.02	0.65**	0.27	0.02	-0.30***	0.10	0.00
Income PNTS	-0.00	0.24	0.99	0.35	0.37	0.35	-0.25	0.23	0.27	-0.00	0.16	0.99	-0.10	0.20	0.62	0.01	0.06	0.89
Education	-0.06	0.08	0.41	0.04	0.12	0.77	0.02	0.07	0.83	-0.22***	0.06	0.00	-0.07	0.06	0.24	0.05***	0.02	0.00
Smoker	0.20**	0.09	0.02	0.17	0.13	0.20	0.28***	0.08	0.00	0.20***	0.06	0.00	0.18***	0.07	0.01	-0.06***	0.02	0.00
μ_1	0.37	0.38	-	0.08	0.54	-	0.23	0.35	-	-0.80	0.28	-	-0.37	0.29	-	0.36	0.01	-
μ_2	-	-	-	-	-	-	1.61	0.37	-	0.78	0.29	-	1.07	0.29	-	-	-	-
Constant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.61	0.09	0.00
Pseudo R^2	0.09			0.13			0.08			0.07			0.06			0.10		
Sample size	2673			2679			2673			2674			2672			2648		

Income DK and Income PNTS are dummy variables for those who don't know or prefer not to state their income and are compared to similar individuals with mean income.
significant at the*** 1% level, ** 5% level, *10% level . Robust standard errors are used. Bootstrapped standard errors are used for the tobit model.
Coeff=Coefficient, Std err=standard error, p-val=p-value