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Alcohol Attributable Fractions and Costs in Portugal

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Abstract

Aim: This study estimates alcohol attributable fractions which are used to obtain a measure of health expenditures related to alcohol misuse in Portugal.

Methods and Sources: Studies estimating alcohol-attributable expenditures focus usually on specific diseases or conditions. This study takes a broader approach by examining all expenditures considered as being attributable to excessive drinking, i. e., those resulting from utilization directly and indirectly related to alcohol associated diseases.

Unlike studies using the relative risk methodology, where population alcohol-attributable fractions (or etiologic fractions) are based on epidemiological studies identifying potential causes of death and disease associated with alcohol excessive consumption, this study has adopted the microeconometric methodology which gets estimates of attributable fractions running econometric regressions of the annual costs of medical care (medical appointments or hospital admissions) for individuals. It has an advantage over the risk approach in that it allows to control for the effect of factors other than alcohol consumption on medical care expenditures. Actually, it includes in the analysis those factors that are linked to health care expenditures but are not linked to any particular alcohol related disease.

To perform our analysis we have used two data sets provided by the Portuguese Ministry of Health: the 1995 National Health Survey. These surveys provide detailed information on individual demographic, economic, health utilization, health attributes and also alcohol and smoking use. Both surveys use a probabilistic representative sample of the non-institutionalized Portuguese population and a questionnaire of about 180 questions. It is a representative sample of the five main administrative regions of Portugal (North, Centre, Lisbon and Tejo valley, Alentejo and Algarve).

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***Results**:* Some of the preliminary results we have got for 1995 are related with explanatory variables coefficient estimates and alcohol attributable fractions. The parameter estimates indicate that conditional on health care expenditures being positive, cancer, heart disease and blood pressure tend to increase health care expenditures. Furthermore, it appears that to have got long term incapacity and private insurance also affects positively health care expenditures.

Regardless of other explanatory variables, it seems that individuals in the higher three income groups tend to spend more on health care than individuals in the lowest income group. Parameter estimates also show that individuals in the 50s, 60s and 70s tend to have more health care utilization than the first age group. As for health administrative regions, Centre and Lisbon regions tend to spend more on health care than the North region. On the contrary, Alentejo and Algarve regions tend to spend less than the North region.

Moreover, parameter estimates of the dummy variables male and work in the last two weeks indicate that men tend to use less health care than women as well as those individuals who have referred to have worked in last two weeks. There is also an indication that there is a propensity for health care utilization to increase with number of days spent in the hospital as well with daily number of cigarettes smoked in the past. However, pure alcohol consumption tend to decrease health care utilization. We could also conclude that body mass index, exercise regularly and daily number of cigarettes smoked at the time of interview are not important determinants of health expenditures.

In what concerns alcohol attributable fractions they were computed for gender and age categories. Males tend to have higher alcohol attributable fractions (ranging from 0.91 to 5.02) than females (ranging from 0.25 to 2.35). Alcohol aggregated fractions computed for males and females are 4.87 and 1.81, respectively.

Keywords: alcohol, drinking attributable fractions, costs
JEL Classification: I12

1. Introduction

The **World Health Organization'** reports consider the burden of disease in a population (the difference between a population health status and an ideal scenario in which everyone lives until old age, free of disease and disability) as being caused by premature mortality, disability and some risk factors that contribute to illness. Among these factors, alcohol is considered to be the third largest risk factor for death and disability (both measured in disability-adjusted life years) in developed countries, after tobacco and blood pressure (WHO, 2002).

The **World Health Organization** also reports that the European Region has the highest per capita alcohol consumption and that 90% of European countries exceed the lowest mortality level for populations (i.e., two litres of annual pure alcohol consumption per capita).

To estimate the burden of disease in a population it is usually necessary to quantify the social costs incurred and, therefore, mortality, disability and other costs caused by a disease. Whenever disability, premature mortality or illness are caused by some risk factors such as alcohol, tobacco or drugs estimation methods usually compute substance abuse attributable fractions (the fraction of outcome that can be attributed to a particular substance exposure). The product of fraction and the outcome yields an attributable-substance count which, in the case of excessive drinking, would be the alcohol-attributable disability or mortality or the alcohol-attributable cost.

Public health and public finance consequences of alcohol misuse handle require accurate assessment of the proportion of medical expenditures that can be attributed to its consumption. Portugal, despite being classified among the European countries with high level of consumption, with 11.2 litres of per capita pure alcohol consumption, after Luxembourg (13.3 litres) and France (10.8 litres), there is not any study dealing with alcohol attributable fractions. (WHO, Europe, 2001).

Studies estimating alcohol-attributable expenditures focus usually on specific diseases or conditions. This study takes a broader approach by examining all expenditures considered as being attributable to excessive drinking, i. e., those resulting from utilization directly and indirectly related to alcohol associated diseases. The text is organized as follows:

Section 2 presents a review of the literature on the definition of alcohol consumption and abuse, and on the methodologies that have been used in the filed for assessing the importance of health care expenditures related with addictive behaviours. The

methodology applied in the present study and the data used are explained in section 3. Section 4 then presents the results of the estimation process. Section 5 concludes the paper.

2. Literature Review

Before the publication of the 1980 Diagnostic and Statistical Manual of Mental Disorders-III, the term **alcoholism** was divided into three categories: episodic excessive drinking (4 or more intoxications a year), habitual excessive drinking (more than 12 intoxications a year or under the influence of alcohol more than once a week) and alcohol addiction (unable to live a day without drinking or with tolerance and withdrawal symptoms). However, with the publication of the 1980 Diagnostic Manual, excessive drinking categories (i.e., **alcohol abuse**) were distinguished from the alcohol addiction category (i.e., alcoholism or dependence) in that tolerance and withdrawal symptoms which can be seen in the alcoholic are not present in the abuser (Eidson, 1993).

Nevertheless, for researchers such as Eric Single and others, the term **alcohol abuse** is used for moderate and heavy use of alcohol and includes also alcohol addiction if, besides the resource costs of its provision, there are also social costs to the community incurred (Single, 2000). As medical expenditures are usually covered by insurance schemes, **alcohol abusers** tend to shift some of their health care expenditures to other member of insurance schemes through higher premiums or taxes. Therefore, in this study we adopt the concept of alcohol abuse as defined by Eric Single and will use the concepts indistinctly.

In literature concerning **alcohol cost estimation** two methods are usually used: the **relative risk method** (the more commonly applied) and the **microeconometric method**. In both methodologies the proportion of cases attributable to alcohol abuse is generally computed but using different approaches.

In studies that use the **relative risk methodology**, population alcohol-attributable fractions (or etiologic fractions) are based on epidemiological studies identifying potential causes of death and disease associated with alcohol excessive consumption.

Population-attributable fractions can be defined in terms of the following formula:

$$AF_p = \frac{I_e - I_u}{I_e}$$

where I_e is the incidence rate of the outcome in the risk exposed group (i.e., the target population for which the attributable fraction is being estimated); I_u is the incidence of the outcome in the unexposed group (i.e., the reference population) (Tanuseputro, P. *et al*., 2005).

However, as incidence rate for unexposed group is not usually available population-attributable fractions are usually calculated using prevalence and relative risk rates, according to the following equation:

$$AF_p = \frac{P_e(RR-1)}{P_e(RR-1)+1}$$

where P_e is the current prevalence of risk exposure in the relevant population and *RR* is the relative risk of the outcome for those exposed to the risk factor.

If we consider excessive drinking as a risk factor, for example, P_e will be the estimated fraction of alcohol abusers in the relevant population and *RR* the relative risk of a chronic or acute medical condition at different levels of use (i.e., an alcohol abuser increased risk of acquiring an illness relative to that of a non-alcohol abuser). Epidemiological studies define relative risk (*RR*), associated with alcohol misuse, as the proportion of disease outcome in alcohol abuse group divided by the proportion of alcohol-related outcome in non alcohol-abuse group (Single, 2000; Fox et al, 1995). Alcohol relative risk estimates are usually computed for different levels of drinking and used to be gender, age and geographic area specific. More recent etiologic case control studies have used the Cox proportional-hazards model to obtain multivariate estimates of relative risk (Nakaya, N. *et al*., 2005 ; Otani et al., 2003).

The empirical literature on alcohol costs, dealing with the relative risk methodology, focus mostly on the burden of disease alcohol abusers impose on society as a whole (Saloma, J., 1995; Brecht *et al*., 1996; Devlin *et al*., 1997; Single *et al*., 1998; Varney and Guest, 2000). As heavy alcohol consumption has been considered a sufficient or contributory factor for a great number of causes of death and disease, different authors have estimated the proportion of different major causes of disease that could be attributed to alcohol misuse. First studies of alcohol-attributable fractions were mainly based on expert opinion; more recent ones use meta-analysis of the relative risks of alcohol use for different causes of death and disease (Single *et al*., 2000). Alcohol-attributable fractions are computed for morbidity and mortality and are also gender, age and geographic area specific (Single *et al*., 1998) Estimates of these population-

attributable fractions (also known as etiologic fractions) were obtained for specific International Classification of Disease categories, sex and different age groups.

Usually, the studies on alcohol costs report three categories of etiologic fractions. For conditions directly related to alcohol abuse in which alcohol is the main cause (e.g., alcohol dependence syndrome), the etiologic fraction is 1.0. Some conditions in which alcohol is a contributory but not necessary cause (e.g., motor vehicle accidents) etiologic fractions are estimated directly from case series. Finally, most conditions in which alcohol is a contributory case, etiologic proportions are computed after the formula above[2].

Compared with the literature on alcohol costs using the relative risk methodology, studies with the microeconometric methodology are sparse and related only to smoking costs (Miller *et al*., 1999; Coller, *et al* 2002; Harrison *et al*., 2003). This method, which gets estimates of attributable fractions running econometric regressions of the annual costs of medical care (medical appointments or hospital admissions) for individuals, has an advantage over the risk approach in that it allows for controlling for the effect of factors other than alcohol consumption on medical care expenditures. Actually, it includes in the analysis those factors that are linked to health care expenditures but are not linked to any particular alcohol related disease. Moreover, this technique does not make any a priori assumptions on conditions related to harmful drinking. It is the methodology referred by Coller *et al*. as "let the data speak" (Coller *et al*., 2002).

3. Sources and Methodology

To perform our analysis we have used a data set provided by the Portuguese Ministry of Health, the 1995 National Health Survey. This survey provides detailed information on individual demographic, economic, health utilization, health attributes and also alcohol and smoking use. The survey uses a probabilistic representative sample of the non-institutionalized Portuguese population and a questionnaire of about 180 questions. It is a representative sample of the five main administrative regions of Portugal (North, Centre, Lisbon and Tejo valley, Alentejo and Algarve). Information is collected about all the resident individuals in selected households by direct interview. The sample error

[2] Relative risks and etiologic fractions for some chronic and acute conditions can be seen, for example, in Single et al. 2000. However, the study of Single et al, 1996 reports all etiologic fractions used to compute alcohol costs.

is of about 5% for annual estimates. Interviews were conducted all over the 52 weeks of the year to take into account any possible seasonal variation of attributes. The survey includes 49 718 individuals (23 854 men and 25 864 women).

Although the 1995 Nation Health Survey was undertaken to be used as a health measuring instrument, the questionnaire includes several questions concerning alcohol consumption. Individuals were asked whether they have drink, over the last twelve months, some of the following drinks: wine, beer, spirits, liqueurs, and whisky. They were also asked for the number of days they have drink some of the different kinds of drink, over the last week. Further, they were asked for the number of cups (or bottles) and their capacity.

Econometric Specification

In the design of our model, despite following the microeconometric methodology, we are not using a two-stage regression model (i.e., we are not decomposing the expected levels of expenditures into the probability that an expenditure occur and the level of expenditure if it happens to occur) to ascertain extra health expenditure due to alcohol addiction, as in the smoking studies by Miller et al. 1999, Coller et al., 2002 and Harrison et al., 2003. Instead we estimated the drinking attributable fraction (DAF) adopting a simple empirical Tobit model, which is left-censored at health care expenditures less than or equal to zero.

Owing to the limited nature of our dependent variable which has positive values and many zeros (about 72% of individuals in our sample do not have any health care expenditures) a linear model would lead to negative health care predictions and the natural log of dependent variable is not possible, on account of the zero values. To solve this estimation problem the Tobit model uses the standard normal cumulative distribution function to get the conditional expectation of health care expenditures. Parameter estimates are obtained with maximum likelihood estimation, the procedure suggested to overcoming the nonlinear nature of the error term (Wooldridge, 2000).

One of the limitations of this statistical model is that it assumes that any variable that increases the probability of positive health care expenditure also increases the level of expenditure once it occurs. Given the nature of health care expenditures, where the decision to go to the doctor depends on the individual but the quantity of health care consumed is also influenced by the doctor, it could happen that a variable influencing the probability of individual spending on health care does not affect the quantity of health care consumed. However, the study was developed mostly to get estimates of

drinking attributable fractions and inferences from explanatory variable parameters are a subsidiary subject.

Construction of variables

Definitions of explanatory variables are displayed in Table 1.

Table 1: Explanatory Variables Definition

male	Male=1, female=0
age1 … age8	Dummy variables for 8-year age groups
region1 … region5	Dummy variables for health administrative regions
income1 … income10	Dummy variables for 10-level income groups
work	has worked in the last two weeks (Yes=1, No=0)
insurance	has private health insurance (Yes=1, No=0)
incapacity	has long term incapacity (Yes=1, No=0)
incapacity_days	number of days stayed in hospital in last two weeks
BMI	Body mass index (weight relative to height squared)
BMIsq	BMI squared
Bpressure	High blood pressure (Yes=1, No=0)
Cancer	Has cancer (Yes=1, No=0)
Heartdisease	Has heart disease (Yes=1, No=0)
exer	does exercise regularly (Yes=1, No=0)
Cigsnow	Daily number of cigarettes smoked at the time of interview
Cigspast	Daily number of cigarettes smoked in the past
Alcohol	Weekly grams of pure alcohol consumption
Alcoholsq	Alcohol squared

Among the set of explanatory variables of our model, that might explain the variability of health expenditures besides drinking behaviour, are several dummy variables such as the indicator of the individual age group: age1 (0≤age≤9), age2 (10≤age≤19), age3 (20≤age≤29), age3 (30≤age≤39), age4 (40≤age≤49), age5 (50≤age≤59), age6 (60≤age≤69), age7 (70≤age≤79), age8 (age≥80). Some of other indicator variables, included in our model, were gender, five administrative health region dummies (region1-North, region2-Centre, region3-Lisbon and Tejo Valley, region4-Alentejo and region5-Algarve), ten income dummy variables, and also indicators of whether the

individual has worked in last two weeks, has got private insurance, and exercises regularly.

We also included dummy variables for cancer, heart disease, long-term incapacity and blood pressure to adjust for conditions that might cause health expenditures to differ among individuals. The long term incapacity dummy variable ("incapacity") was obtained by adding up several items in which people were asked several questions such as whether they were confined to bed, wheel chair or home, and whether they can dress themselves, wash their faces alone or with help, listen or speak properly etc. As for the level of blood pressure individuals were also asked whether they have got high blood pressure and whether it has been diagnosed by a doctor or a nurse. The dummy variable "Bpressure" was the product of these two variables. Both also were included to adjust for health conditions.

Other continuous variable included were two measures of smoking ("cigsnow" and "cigspast"), number of days in hospital in last two weeks ("incapacity_days"), and body mass index ("BMI") whose squared value was included to capture possible nonlinear effects. Again, they were included to control for differences in medical expenditures not due to alcohol addiction.

In what concerns alcohol consumption, individuals were asked whether they have drunk, in the last twelve months, any of the four types of drinks (i. e., wine, beer, spirits, liqueurs and whisky). As the variable of weekly alcohol consumption has several zero and missing values observations, instead of discarding these observations we have assumed the following: those individuals who told they have drunk, in last twelve months, but said either they didn't have drink in the last two weeks or do not know the number of days or the quantities or have missing values we attributed the average of positive days and quantities consumed. After having determined weekly alcohol consumption for each individual in litres, we multiplied it by alcohol density to get the value of pure alcohol in grams, i.e., the measure of ethanol intake intensity.

For the dependent variable, health care expenditures, we add several items of health care expenditures people have told to spend in the last two weeks: medical visits, emergency visits, medical and surgical inpatient days, medicines, diagnostic tests and others.

DAFs Estimation Procedure

To calculate the DAF for each individual we estimated two equations for health care expenditures using *Stata 9.0*. The first equation determines the level of expenditures in

euros conditional on existence of positive expenditures in 1995, given each individual actual alcohol consumption and other characteristics. The predicted expenditures for each individual (EXP_{actual}) were, then, obtained using the estimated regression coefficients and his or her observed actual alcohol consumption and other characteristics.

The second equation determines the level of expenditures in a scenario of moderate drinking and all the other characteristics held the same. We assumed that individuals who have alcohol consumption above the upper limit of moderate drinking, according to his gender and age, will consume now the upper limit amount. The predicted expenditures ($EXP_{scenario}$) were then obtained for each individual and the individual DAF calculated as the relative difference between two predictions of medical care expenditures, according to the following formula:

$$DAF_i = \left(\frac{EXP_{actual} - EXP_{scenario}}{EXP_{actual}} \right) * 100$$

which determines the percentage of alcohol addiction attributable expenditures, I e., an index of extra medical costs caused by excessive drinking. In theory, the value of the DAF for a moderate drinker will be zero.

To compute the aggregated DAF we have first calculated weights for each individual, taking into account his or her level of expenditure so that those who have higher expenditure shares will have a higher weight in the DAF. These weights were then multiplied by each individual DAF to calculate the weighted individual DAF and, finally, the weighted average DAF was estimated by summing up the weighted individual DAFs.

4. Results

Regression results, including the intercept term and 36 independent variables are listed in Table 2. The parameter estimates from Table 2 indicate that conditional on health care expenditures being positive, cancer, heart disease and blood pressure tend to increase health care expenditures. Furthermore, it appears that to have long-term incapacity and to have got private insurance also affects positively health care expenditures.

Table 2: Maximum likelihood estimates of the Tobit model of health care expenditures

Variable	Coefficient estimates	P - values
male	-3683.61*	0.000
age2	2891.44*	0.007
age3	5340.43*	0.000
age4	7473.35*	0.000
age5	8613.75*	0.000
age6	9521.54*	0.000
age7	9380.62*	0.000
age8	7879.25*	0.000
region2	6358.83*	0.000
region3	6950.84*	0.000
region4	3775.00*	0.000
region5	3506.02*	0.000
income2	547.48	0.565
income3	885.42	0.336
income4	1872.83*	0.025
income5	2120.08*	0.009
income6	2381.02*	0.002
income7	1838.16*	0.015
income8	3346.42*	0.000
income9	3528.48*	0.000
income10	5980.80*	0.000
work	-3155.55*	0.000
insurance	3813.42*	0.000
incapacity	6237.49*	0.000
incapacity_days	2893.28*	0.000
BMI	-390.31	0.183
BMIsq	7.53	0.156
Bpressure	6409.03*	0.000
Cancer	14337.1*	0.000
Heartdisease	7646.34*	0.000
exer	1225.73	0.072
Cigsnow	-2.04	0.929
Cigspast	126.06*	0.000
Alcohol	-5.05*	0.000
Alcoholsq	0.001	0.071
Constant	-25508.61*	0.000
logL	-132902.69	0.000
χ^2 ***for standard LR test***	2217.11	
N = 37 271		

Note: The superscript * indicates a coefficient statistically different from zero at a 5% confidence level.

Regardless of other explanatory variables it seems that individuals in the last three income groups tend to spend more on health care than individuals in the lowest income group. Parameter estimates also show that individuals in the 50s, 60s and 70s tend to have more health care utilization than the first age group. And, in what concerns health administrative regions, Centre and Lisbon regions tend to spend more on health care than the North region. On the contrary, Alentejo and Algarve region tend to spend less than the North region.

Moreover, parameter estimates of the dummy variables male and work in the last two weeks indicate that men tend to use less health care than women as well as those individuals who have referred to have worked in last two weeks. There is also an indication that there is a propensity for health care utilization to increase with number of days spent in hospital as well with daily number of cigarettes smoked in the past. However, pure alcohol consumption tend to decrease health care utilization. One possible explanation resides in some under-reporting behaviour. Alternatively, the quantity of weekly alcohol consumption may be associated with some risk attitudes that may in turn be related to health care utilization.

It should also be noted that body mass index, exercise regularly and daily number of cigarettes smoked at the time of interview are not important determinants of health expenditures.

Using the results in table 2, and the procedures previously explained we are able to compute DAFs by sex, age group and overall. Table 3 reports these results.

Table 3: Estimates of Drinking-Attributable Fractions for Harmful Drinking

Gender	Age	Weekly alcohol consumption	Health care expenditures	Expenditures on prescriptions
Both	All	-	3.31	4.32
Male	All	-	4.57	5.85
Male	<34	>133.3g	5.02	6.14
Male	35 – 44	>266.7g	6.15	7.58
Male	45 – 54	>400g	4.92	6.15
Male	55 – 84	>533.3g	2.96	4.13
Male	>85	>666.7g	0.91	1.36
Female	All	-	1.81	2.43
Female	<44	>140g	2.35	2.92
Female	44 – 74	>280g	1.36	1.96
Female	>75	>420g	0.25	0.45

Values in the first column of Table 4 were obtained by multiplying direct and inpatient care costs, computed for the whole population, by the attributable fraction 3.31. Thus there should be an overestimation as costs should be obtained only for people over 14 years old.

Table 4: Alcohol Attributable Costs, 1995

	Annual cost (€ million)	Per capita alcohol attributable costs (b)
Direct care costs (a)	€ 134.3	€ 16
Inpatient care	€ 32.6	€4

(a) include public and private diagnostic, treatment and rehabilitation medical care

(b) population >14 years old

5. Conclusions and further research

Studies estimating alcohol-attributable expenditures focus usually on specific diseases or conditions. This study takes a broader approach by examining all expenditures considered as being attributable to excessive drinking, i. e., those resulting from utilization directly and indirectly related to alcohol associated diseases. Unlike studies using the relative risk methodology, where population alcohol-attributable fractions (or etiologic fractions) are based on epidemiological studies identifying potential causes of death and disease associated with alcohol excessive consumption, this study has adopted the microeconometric methodology which gets estimates of attributable fractions running econometric regressions of the annual costs of medical care (medical appointments or hospital admissions) for individuals. It has an advantage over the risk approach in that it allows to control for the effect of factors other than alcohol consumption on medical care expenditures. Actually, it includes in the analysis those factors that are linked to health care expenditures but are not linked to any particular alcohol related disease.

Although the purpose of the analysis was not the examine the determinants of health care expenditures we found that individuals in the 50s, 60s and 70s tend to have more health care utilization than the first age group. Women tend to have higher heath care expenditures than men, and people who worked in the last two weeks tend to have lower expenditures. In addition, individuals in the higher three income groups tend to spend more on health care than individuals in the lowest income group. There is also an indication that there is a propensity for health care utilization to increase with number of days spent in the hospital as well with daily number of cigarettes smoked in the past. The parameter estimates indicate that conditional on health care expenditures being positive, cancer, heart disease and blood pressure tend to increase health care expenditures. Furthermore, it appears that to have got long term incapacity and private insurance also affects positively health care expenditures. As for health administrative regions, Centre and Lisbon regions tend to spend more on health care than the North region. On the contrary, Alentejo and Algarve regions tend to spend less than the North region. We could also conclude that body mass index, exercise regularly and daily number of cigarettes smoked at the time of interview are not important determinants of health expenditures.

However, pure alcohol consumption tend to decrease health care utilization.

In what concerns alcohol attributable fractions they were computed for gender and age categories. Males tend to have higher alcohol attributable fractions (ranging from 0.91 to 5.02) than females (ranging from 0.25 to 2.35). Alcohol aggregated fractions computed for males and females are 4.87 and 1.81, respectively.

In sum, the paper shows that in 1995 for every 1 euro spent in health care expenditures by a non-abuser of alcohol, 3.31 € are spent by an abuser. This number is higher for men than for women, and also higher for middle-aged subjects than for older subjects. In total, 134.3 million more Euros were spent on direct health care costs by alcohol abusers than non-abusers in Portugal in 1995.

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