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THE INFLUENCE OF HOUSEHOLDS ON DRINKING BEHAVIOUR: A MULTILEVEL ANALYSIS

NIGEL RICE*, ROY CARR-HILL, PAUL DIXON and MATTHEW SUTTON
Centre for Health Economics, University of York, Heslington, York YO1 5DD, U.K.

Abstract—This paper examines the influence of household membership and area of residence on individual drinking behaviour using a multilevel modelling approach. The effects are investigated using data from the Health Survey for England (HSE) in which multiple interviews were conducted in the same household. With the use of postal address, the data were organised into a hierarchical structure of individuals within households within enumeration districts. After controlling for characteristics of individuals thought to influence or correlate with drinking behaviour, unexplained variation in alcohol consumption was attributed to individual, household and area effects. Household influences on drinking behaviour far outweigh the influences of place of residence. Policies aimed at reducing alcohol consumption, particularly by heavy drinkers, may be best targeted at the household level. © 1998 Elsevier Science Ltd. All rights reserved

Key words—alcohol consumption, household effects, area effects, multilevel models, random effects

INTRODUCTION

Long term heavy drinking is associated with an increased risk of a wide variety of conditions including raised blood pressure, liver cirrhosis, some cardiovascular diseases, and cancers of the mouth, pharynx and oesophagus (Anderson *et al.*, 1993; Edwards *et al.*, 1994). It is also associated with mental illness, neurological disease and psycho-social problems (Department of Health, 1995), and crime (Ensor and Godfrey, 1993). However, the majority of diseases are dose related and do not occur at any distinct threshold of alcohol consumption, and over a range of consumption patterns individuals have a low risk of contracting such conditions (Edwards *et al.*, 1994). Moreover, evidence suggests that there are some health benefits to be gained through moderate drinking, for example, reduced risk of coronary heart disease (Marmot and Brunner, 1994).

In England and Wales drinking guidelines have been proposed as benchmarks to enable individuals to monitor their alcohol consumption levels (Department of Health, 1995). These are reproduced in Table 1. Such guidelines are based on the statistical risk that individual drinking behaviour poses to health, unrelated to external circumstances or influences. With the exception of recommendations on drinking and driving and advice to keep several days each week alcohol-free, guidelines rarely refer to either context or pattern of drinking. Accordingly, the majority of research on drinking behaviour has tended to concentrate on the role of the consumer as the basic unit of analysis assuming that behaviour or lifestyle is an independent and self-determining function of individuals without regard for the environment which they inhabit.

In this paper, we explore the influence that group membership has on individual alcohol consumption patterns and in particular, compare household and geographical area group membership. In the next section we discuss conceptual notions of group effects. Area effects relate more closely to the structural approach, as described by Lindbladh *et al.* (1996), and individual-based theories of conformity, which have their origins in recent economic literature, as an alternative basis on which to expect group effects. As a result, it is hypothesised that household membership may far outweigh area contextual effects in determining individual alcohol consumption patterns. In the second half of the paper a multilevel analysis is used to investigate the extent of variation attributable to individual, household and area levels using alcohol consumption data from the Health Survey for England (Bennett, 1993).

AREA OR HOUSEHOLD EFFECTS?

It has been argued that the environment plays an important role in structuring lifestyle behaviour and, in particular, that geographically-based cultural contexts bear heavily on individual behavioural patterns (Skog, 1985). Blaxter (1990), in her seminal work on health and lifestyles, distinguishes between elements of lifestyles that are associated with individual predisposition or socio-economic

*Author for correspondence.

Table 1. *Health of the Nation* sensible drinking bands

	Men	Women
	Non-drinker Ex-drinker	Non-drinker Ex-drinker
Very low	< 1 unit/week	< 1 unit/week
Low	1–10	1–7
Moderate	10–21	7–14
Fairly high	21–35	14–25
High	35–50	25–35
Very high	> 50	> 35

characteristics and those that are purely due to geographical or external environmental factors. Edwards *et al.* (1994) phrase this in the following terms:

> ...individual drinkers are strongly influenced by the drinking habits in their social network. The social interaction theory of drinking thus suggests that an individual living in a fairly dry environment may tend to become a light drinker, while the same individual could have become a heavy drinker in a wet environment where alcohol is cheap, easy to come by and an integral part of daily life. Since individual drinking habits are interconnected through social interaction, individual changes in drinking habits tend to be synchronised... (p. 91).

Emphasis is very much focused upon the influences that place and environment have on individuals' behavioural patterns, and in particular geographical space has been the chosen candidate for the majority of empirical work. The choice of area specified for empirical analyses may well be crucial, but is often limited to whatever is available in routine datasets. Most commonly, these tend to be electoral wards of residence (for example, see Carr-Hill *et al.*, 1996; Duncan *et al.*, 1996), or regional authorities/districts (for example, Congdon, 1995), although analysis at the smaller level of enumeration district is also possible. Fundamentally, what is required is a measure of environment that is, a priori, expected to somehow exert influence over its inhabitants (perhaps through local administrative policies), or that successfully encapsulates groupings of homogeneous individuals (areas where common cultural influences persist).

Jones and Duncan (1995), outline four mechanisms through which area effects are hypothesised to influence individual health. These are, the physical environment, the cultural milieu, place deprivation and selective mobility. The physical environmental characteristics of a place may be considered to include common water supplies and environmental pollution that individuals in a particular area of residence may experience. Cultural effects on health are seen as mediating through general social processes that operate over space. Individuals are seen as acting individually and communally to create local cultures, everyday routines, institutional practices and structures which constitute the local context. The context created then acts to reinforce the ways in which individuals react to and interpret general societal forces creating an endogenous link between individual behaviour and area contextual effects. Poor access to goods and services that in some way influence health are causes of place deprivation. This is in contrast to individual deprivation which may of course have a direct influence on the area you choose to live in. Macintyre *et al.* (1993) support this view and claim:

> whatever one's personal characteristics, the opportunity structures in the poorer area are less conducive to health or health promoting activities than in the better-off areas.

Selective mobility refers to the mechanism through which individuals choose their place of residence. Factors such as employment opportunities and local housing markets will impact on choice of location and as a result although certain groups of individuals are able to make such decisions, others are constrained to stay in particular areas. Different health related outcomes are argued to occur as a result of the differential mobility of these groups of individuals.

It is not clear at what level of aggregation such hypothesised processes operate and it may be that different processes exist at different levels. Choosing an area identifier for reasons of convenience is not very helpful in exploring the mechanisms through which the above processes work. One potential solution would be to include various levels of aggregation in any ensuing analysis of geographical contextual effects and this is possible with some routine datasets (see for example, Duncan *et al.*, 1993; Langford and Bentham, 1996). Perhaps a more promising approach is that of defining geographical localities through the use of geographical information systems (GIS). Such systems are not constrained to the use of areas defined solely on postcode boundaries, but can be re-aggregated to represent some more meaningful spatial context such as a locality to which health care planning is devised or "perceived" neighbourhoods based on questionnaire surveys of local inhabitants, and/or areas defined on the basis of the public services available (Bullen *et al.*, 1996).

It is likely that many behavioural traits such as drinking are influenced to a much greater extent by more basic fundamental groupings such as the household. We present below various theories that support the suggestion that groupings at the household level are to be expected to produce far greater conformity of behaviour than those measured by geographical space and that policies aimed at reducing alcohol consumption need to be sympathetic to both individuals and households. Clearly such groupings also have the advantage of being easily defined assisting both data collection and meaningful inference.

There are various aspects of both drinking behaviour and the arrangement of individuals within groups which can give rise to conformity of behaviour. Such theories are applicable to group mem-

bership in general, but for the examples of lifestyle behaviour such as alcohol consumption are more likely to exert strongest influence at the household level. However, as the explanations are diverse, so are their implications for policy. In some theories, one individual's behaviour is predicted to have an influence on all other group members (and vice versa), and as a result, policies aimed at particular individuals within a group may have a "knock-on" impact on other members.

Alternatively, theories of conformity based on the dissemination of information suggest that by only influencing the behaviour of "innovators", larger groups can be reached (Conlisk, 1980). Other explanations relate more to statistical artefacts of group formation and membership and imply no such dynamic social-process. For instance, if individuals with similar, but unobserved drinking characteristics, tend to gather together, we will observe unexplained correlation between individuals in the same groupings.

Theories of conformity, which suggest that individual and group behaviour are simultaneously determined, can be grouped under two broad headings: the role of information and the nature of social interaction. Common acceptance of the notion of *bounded rationality* (Lindbladh *et al.*, 1996), which emphasises limited knowledge of available opportunities and their consequences, highlights the role of information in determining behaviour. It has long been suggested that individuals become aware of their favourite commodities through frequent contact with them (Duesenberry, 1949). This contact is often facilitated by peers or, as in our case, household or area group members. In some instances, this process may be direct, as proselytisers extol the virtues of new commodities or consumption patterns to others. A final reason for expecting impacted information to bring about clustering of consumption patterns in groups is an *informational cascade* (Hirshleifer, 1995). In this case, the consumption patterns of peers are interpreted by others as "signals", and "herd-behaviour" may eventually replace individual decision-making as the process which determines consumption patterns (Conlisk, 1980).

Theories of social interactions suggest that behaviour conformity arises from the ways in which individuals relate to other members of their group. In the simplest case, individuals are hypothesised to be guided by a desire to conform with others, giving rise to common behaviours (Jones, 1984). Other authors have suggested that social norms (Elster, 1989), or conventions (Sugden, 1989) are the processes underlying group interactions. For example, Sugden proposes that fear of social sanction for deviating from group conventions gives rise to a psychological externality which tends to reduce the extent of variation in choices within certain groups. As such, heavy drinking individuals within households may be discouraged from their excesses by parental or sibling pressure. In contrast, *payoff interaction* theories (Hirshleifer, 1995) emphasise more positive reinforcement of behaviours. In the context of alcohol consumption, the social nature of drinking in some settings may give rise to situations where individuals are encouraged to continue consumption to maintain a "collective spirit". In the limit, average consumption levels within the group rise to that of the heaviest drinker.

In contrast to the theories of social interaction or the transmission of information, it may be that the drinking behaviour of individuals is directly determined by group characteristics. Instead of a simultaneity in group and individual consumption, individual consumption is determined by exogenous group characteristics. An example of just such a process is the existence of young children in the household. This is likely to reduce the number of social occasions attended by the parents, probably leading to reductions in *both* of their drinking levels. An alternative process by which group characteristics could affect individuals is where individual characteristics have both absolute and relative effects. For example, income levels have been found to significantly affect consumption levels (Godfrey and Maynard, 1995), but the effect of income may be mediated depending on its position in the distribution of income amongst one's reference group. This would be produced, for example, by a "keeping up with the Jones's" ethos.

However, notwithstanding the various reasons to predict a causal explanation of conformity in group behaviour, and the evidence of the effect of the "wetness" of different cultures on individual's drinking habits (Edwards *et al.*, 1994), the process of group formation *per se* may give rise to common consumption patterns. A test of the nature of the process which produces conformity would be provided by an experiment in which an individual is moved from a relatively "wet" to a relatively "dry" reference group. If there is no causal explanation of conformity then the individual will consume the same amount regardless of group membership. If this were true, conformity arises solely because this is not how individuals tend to form into groups, i.e. a heavy drinker would not naturally select a "dry" group. In this case, individual consumption patterns within groups are correlated but not interdependent, and statistical modelling should take account of the fact that there may be intra-groups correlations in error terms due to the influence of unobservable characteristics.

There is much complementarity between the reasons proposed for area effects and household effects. For example, the effects of selective mobility between areas and household formation on the basis of unobservable characteristics essentially describe the same process. We therefore do not view hypotheses about area or household effects as

contradictory but as effects located along a spectrum. As such, it is expected that household effects will have a more discernible impact on individual behaviour than area effects.

DATA AND METHODS

Data from the 1993 Health Survey for England (HSE) (Bennett, 1993)—the most recent in the series available for secondary analysis, was used for the study. Collection was performed throughout 1993 and on into early 1994, and consists of 17,687 interviews with adults (aged 16 or over) living in 9700 households in England. The sample was distributed relatively evenly across the 14 English Regional Health Authorities and was obtained by sampling households from 2 or 3 electoral wards of residence in each Authorities' area. The survey is unusual in seeking responses from all adults in each household, providing a rare opportunity to explore effects within households. The 1993 survey focused on cardiovascular disease and associated risk factors, including alcohol consumption, as well as general health and various long-standing illnesses. There are well-known problems with the measurement of lifestyles in household surveys, associated with under-reporting and low response rates of heavy drinkers (Warner, 1978). Nevertheless, such information sources remain the method by which governments monitor their success in reaching drinking targets and are the only datasets large enough to answer the sort of questions addressed in this study.

Alcohol consumption data was incomplete for 1139 individuals and these were excluded from the analysis. A further 1119 individuals were also excluded due to missing responses to the various explanatory variables used. This resulted in a total of 15,429 individuals within 8737 households within 495 enumeration districts presenting for analysis. Although it does not make sense to attempt to estimate components of variation attributable to individuals and households using data from one-person households (as the two effects cannot be disentangled), one-person households were retained in the analysis as they contribute to the estimates of the covariates of alcohol consumption and to area variations in consumption. The distribution of numbers of individuals within households is given in Table 2. The vast majority of the sample live in two-person households.

Table 2. Distribution of number of individuals within households

No. of individuals per household	No. (%) of households
1	3393 (39)
2	4299 (49)
3	787 (9)
4	218 (2)
5	38 (—)
6	1 (—)
9	1 (—)

The following variables were included in this analysis:

Personal characteristics: *Gender*, *age*.

Social environment/support: *No. of persons in household*, *whether single or have a partner*, *perceived social support*.

Health: *Perceived stress*.

Health related activity: *Physical activity level*.

Educational: *Educational attainment*.

Socio-economic: *Social class*, *car ownership*, *whether or not economically active*, *whether in receipt of income support*.

Various other potential explanatory variables are available in the HSE, for example, smoking status and self-reported general health. However, the relationship between these variables and drinking status is likely to be simultaneously determined so that the estimated effect of smoking or health status on individuals' alcohol consumption will be estimated imprecisely.*

The dependent variable in this analysis represents an estimate of the number of units of alcohol drunk in a 1-week period based on respondents' answers to questions relating to the frequency of consumption and the number of units consumed on a usual occasion (Bennett, 1993). Empirical distributions of alcohol consumption tend to be highly skewed with long tails towards high consumption levels. This relationship has been found to hold even in very homogeneous populations where one may expect more symmetrical distributions (Edwards *et al.*, 1994, p. 86). These data also display strong skewness and transformation to a more symmetrical distribution was sought by taking the natural logarithm.† The distribution of alcohol consumption also often contains a significant proportion of zero values. Whilst significant differences between the determinants of the decision to participate and the decision about what level to consume have been found for tobacco (Jones, 1995), two-part models for alcohol consumption find no such difference (Atkinson *et al.*, 1990). Because of the problem of

*For single level models (i.e. non-hierarchical models) such as ordinary least squares (OLS), two-stage estimation procedures are used to disentangle the individual effects of variables defined endogenously with the dependent (for example, see Greene, 1993, Ch. 20: Simultaneous Equation Models). Interest here, predominantly lies in the estimation of higher level effects and we do not attempt to unduly complicate the analysis by pursuing a two-stage multilevel estimation procedure.

†Initially a Box–Cox transformation (Box and Cox, 1964) of the dependent variable was sought. However, an *ad hoc* search of a suitable value of the parameter λ of the Box–Cox transformation that resulted in normality of the level 1, 2 and 3 residuals suggested that a logarithmic distribution would suffice.

zero observations, we added a constant of unity to all observations before taking natural logarithms.

Empirical analyses of individual behaviour incorporating a household effect have relied extensively on the use of an explanatory variable often in the form of a dummy variable indicating whether or not other household members drink (or drink heavily; defined by recommended safe drinking levels; Department of Health, 1995), or a continuous measure of the average units consumed per individual within the household (see for example, Sutton and Godfrey, 1995). This has also been the preferred treatment for the analysis of smoking behaviour (Jones, 1989, 1994; Yen and Jones, 1996), where the standard approach is often to introduce social interactions as a form of externality (Jones, 1995) whereby it is assumed that other people's smoking has a direct influence on an individual's decision to consume or quit. The approach adopted here is to model both area and household effects as random components within a multilevel framework.

To investigate the effects of area of residence and household membership on individual drinking behaviour we specify a multilevel model including random components for individual, household and geographical area (Goldstein, 1995). Such a specification allows the observed variation in consumption levels to be "partitioned" into each of these three elements and compared with one another. It also allows characteristics of individuals, households and areas that may affect consumption to be investigated. Multilevel models allow for such variations and adjusts for the clustering (correlation structure imposed by the grouping of individuals) at each of the levels (for a review of multilevel models applied to health data, see Rice and Leyland, 1996). A similar approach to investigating the effect of household membership (familial clustering) has been used elsewhere to study the impact of immunisation programs in Bangladesh (Steele *et al.*, 1996).

Let y_{ijk} be the log transformed level of self-reported alcohol consumption per week by the ith person within the jth household within the kth enumeration district, then the multilevel model to be estimated can be written as:

$$y_{ijk} = \mathbf{x}'_{ijk}\beta + v_k + u_{jk} + e_{ijk}$$

where $\mathbf{x}_{ijk}$ is a vector of covariates and β a corresponding vector of parameter estimates. The vector of covariates includes a constant together with explanatory variables measured at any of the three levels. The individual, household and area level error terms are, respectively, e_{ijk} $[N(0,\sigma_e^2)]$ and u_{jk} $[N(0,\sigma_u^2)]$ and v_k $[N(0,\sigma_v^2)]$.

All explanatory variables were entered as dummy (0, 1) variables except age which is continuous. To ensure variations at each of the three levels are estimated at typical values of age, age was centred about its mean of 46 before being placed in the models.

Three models were specified: a "basic model" which contains only the individual's age and sex; a model including all variables measured on the individual ("individual model"); and a model including variables measured on both the individual and the household ("full model"). For each model, the remaining unexplained variation in individual alcohol consumption is then partitioned into that attributable to individuals, households and areas (enumeration districts). As outlined above, substantive interest lies in the identification of household and area effects and how these are affected once explanatory variables have been included. A general test of functional form and variable specification was provided by a RESET test (Kmenta, 1990, p. 454). This is a general test of misspecification and involves computing the squares of the predicted values given by a particular model (further powers of the predicted values can also be included) and adding these to the original regression equation. If the resulting coefficient proves to be significant (based on a t-test) then we can conclude that the original model is not correctly specified and may have significant variables omitted, or be of incorrect functional form. As an additional test, the assumptions of normality of residuals at each of the three levels was tested by plotting standardised residuals against normal scores.

The models specified above are generally known as variance components models as it is assumed that the intercepts (of transformed alcohol consumption) alone vary randomly across households and areas. More complicated specifications allow for variations in slope across higher levels by including random coefficients, i.e. the effect of selected covariates $\mathbf{x}_{ijk}$ are also allowed to vary across higher level units. Due to the limited numbers of respondents in households we do not persue the modelling of random coefficients.

RESULTS

Self-report untransformed alcohol consumption amongst respondents in the survey is summarised in Table 3. Several points are worth noting. First, the decline of drinking with age and secondly, the moderately high levels of consumption amongst the younger age groups. In the case of women drinkers aged between 16 and 34 the average alcohol consumption was 7.7 units per week (and would be described as moderate); for men of the same age the average was 19.7 units (again, described as moderate).

The parameter estimates and associated standard errors of the three models specified are given in Table 4. The "basic model" fails the specification test (RESET t-value = 4.48, $P < 0.01$) which is not surprising given it only includes covariates on age

Table 3. Alcohol consumption by age and gender

		Alcohol consumption							
	Age	Very low	Low	Moderate	Fairly high	High	Very high (%)	Average units/wk	*N*
Females	16–34	28	36	20	9	3	4	7.7	2665
	35–54	32	35	17	11	3	2	7.1	2770
	55–74	49	30	12	6	2	1	4.5	2035
	75+	59	25	9	5	1	1	3.0	701
N									8171
Males	16–34	15	29	22	17	9	8	19.7	2441
	35–54	15	29	23	16	9	8	18.7	2560
	55–74	24	33	19	12	7	5	14.8	1826
	75+	40	31	16	9	4	0	8.9	431
N									7258

and gender. However, both the "individual variable model" and the "full model" containing individual and household characteristics pass the RESET test indicating that the functional form of the models appears appropriate for these data. Moreover, plots of standardised residuals against normal scores showed no serious signs of departure from normality.

Fixed effects

Individual characteristics. Unsurprisingly, males generally consumed more alcohol than females and there was a quadratic age effect indicating that older people drank less. There was also an indication that there was a differential age effect for males and females shown by the significance of male by age interaction terms. It appeared that although males drank more than females, the difference decreased with age. Single people tended to consume more alcohol; an observation noted elsewhere (Duncan *et al.*, 1993; Sutton and Godfrey, 1995).

Of the general health and activities characteristics, individuals who reported moderate and vigorous activities generally consumed more alcohol compared to their baseline category of inactive individuals. There is no evidence in these data to suggest that a lack of social support or increased stress had an effect on levels of alcohol consumption.

Individuals who were unemployed, inactive or working part-time were less likely to drink heavily than those engaged in full-time employment (baseline category). However, the effect observed for inactive respondents decreased dramatically when household size and car ownership were included. This suggests that in the "individual model" the economically inactive was inappropriately picking up an effect that should be properly attributed to household-level variables.

There was a clear social class gradient* with individuals classified into social class groups I and II generally being the heaviest drinkers and those in class V and students being the most moderate drinkers, a result supported elsewhere (Sutton and Godfrey, 1995). The coefficient attached to armed forces is positive indicating an increased level of alcohol consumption; however, this coefficient is non-significant. Individuals who are eligible for income support had significantly reduced alcohol consumption in the model containing individual characteristics only. This effect disappeared when household variables were included suggesting again that the effect of income support may be correlated with a household size/composition effect.

Household characteristics. Household characteristics included the household size (number of inhabitants, including those under 16 yr of age), and the number of cars belonging to the household. There was a clear household size gradient indicating strongly that larger households were associated with decreased individual alcohol consumption. Car ownership was likely to be a reflection of individual current and capital household wealth and ownership of multiple cars appeared to be associated with increased alcohol consumption.

Random effects

For the "basic model", the fixed coefficients represent the estimated average alcohol consumption level on the transformed scale for males and females of different ages over the entire sample. This value does not remain constant across households and areas and variations in consumption was decomposed into each of these levels. An approximation to the total unexplained variation was obtained by summing over the estimated variances $\sigma_T^2 = (\sigma_e^2 + \sigma_u^2 + \sigma_v^2)$ and hence the proportion of total variation attributed to each level was calculated. In all the models presented, the estimated variation at each of the three levels appeared as statistically significant (evidenced by the size of the coefficient divided by its standard error).

*Standard Occupational Classification of Social Class (OPCS, 1991); I: Professional occupations; II: Managerial and technical occupations; IIIN: Skilled—non-manual occupations; IIIM: Skilled—manual occupations; IV: Partly skilled occupations; V: Unskilled occupations

Table 4. Results of multilevel modelling of alcohol consumption

Variable	Basic model		Individual variable model		Household variable model	
	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error
n	15429		15429		15429	
Fixed						
Constant	1.47	0.02	1.51	0.07	1.15	0.09
Personal characteristics						
Age[a]	−0.011	0.00054	−0.0082	0.0009	−0.009	0.001
Age squared[a]	−0.00035	0.00003	−0.00016	0.00004	−0.0001	0.00004
Gender (Male)[b]	0.86	0.02	0.81	0.03	0.83	0.03
Single [c]			0.07	0.02	0.06	0.03
Perceived social support[d]						
Lack support			0.01	0.02	0.02	0.02
Very much lack support			−0.03	0.03	−0.02	0.03
Stress[e]						
Little			−0.03	0.02	−0.03	0.02
Moderate			−0.03	0.03	−0.03	0.03
A lot			−0.01	0.03	−0.01	0.03
Activities[f]						
Active—light			0.12	0.04	0.12	0.04
Active—moderate			0.14	0.04	0.13	0.04
Active—vigorously			0.26	0.04	0.25	0.04
Education[g]						
A-Level			0.03	0.04	0.05	0.04
GCSE			0.01	0.04	0.04	0.04
Foreign qualifications			−0.21	0.08	−0.19	0.08
No qualifications			−0.05	0.04	0.05	0.05
Socio-economic[h]						
Work—part-time			−0.09	0.03	−0.07	0.03
Work—unemployed			−0.07	0.04	−0.004	0.04
Work—inactive			−0.19	0.03	−0.09	0.03
Social class[i]						
Social class—II			−0.03	0.04	−0.04	0.04
Social class—IIIN			−0.11	0.05	−0.11	0.05
Social class—IIIM			−0.07	0.05	−0.0002	0.05
Social class—IV			−0.17	0.05	−0.09	0.05
Social class—V			−0.22	0.06	−0.13	0.06
Armed forces			0.18	0.14	0.23	0.14
Student			−0.36	0.07	−0.36	0.07
Income[j]						
Income support			−0.17	0.03	−0.06	0.04
Interaction terms						
Male × age[a]			0.0003	0.0009	0.0004	0.0009
Male × age squared[a]			−0.0002	0.00005	−0.0002	0.00005
Household structure						
Household size—3					0.06	0.04
Household size—4					−0.11	0.05
Household size—5					−0.18	0.05
Household size—6+					−0.54	0.08
Car ownership						
1 car					−0.02	0.03
2 cars					0.09	0.04
3+ cars					0.22	0.06
Random						
σ_e^2: individual	0.77	0.01	0.76	0.01	0.76	0.01
σ_u^2: household	0.58	0.02	0.54	0.02	0.52	0.02
σ_v^2: area	0.03	0.006	0.03	0.005	0.02	0.005
−2 × log likelihood	47055		46698		46505	
RESET *t*-value	4.49		0.82		0.40	

Note: [a]Age is centred about its mean of 46. Baseline categories for which dummy variables are estimated against: [b]Female; [c]Cohabiting; [d]Good social support; [e]No stress; [f]Not active; [g]Degree; [h]Work full-time; [i]Social class—I; [j]Not receiving income support

Unsurprisingly, the majority of the variance was attributed to differences between individuals (56%). However, 42% of variation occurred at the household level indicating that household membership and composition was very influential in determining inhabitants' consumption levels. Very little of the variation was attributed to area effects (2%), and speculation of strong geographical contextual effects of drinking behaviour appeared unfounded in these data.

The second model in Table 4 presents the results of including covariates measured on the individuals surveyed. Total unexplained variation was reduced by approximately 4% (*ca* $\sigma_T^2 = 1.38$ to *ca* $\sigma_T^2 = 1.33$), indicating that there were significant unobserved or unobservable characteristics of individual drinking behaviour not captured in these data. In this model, 55% of unexplained variation was attributed to differences between individuals, 39% to households and 2% to area differences.

Including household level covariates had little impact on the estimates of the random coefficients. Individual level variation remained the same (household characteristics are constant across

households) and household variation was reduced marginally ($\sigma_u^2 = 0.54$ to $\sigma_u^2 = 0.52$). Estimated area variations were also marginally reduced.

These results clearly show that there is a large amount of unexplained variation in individual alcohol consumption which can be attributed to household membership. Further, little variation was attributed to differences in geographical area influences. The influence of household membership was nearly as great as that due to differences between individual characteristics in determining consumption of alcohol.

CONCLUSION

The analysis presented here indicates that households have a substantial effect on the drinking behaviour of their inhabitants. Geographical contextual effects were found to be minimal. This latter finding is in agreement with work elsewhere investigating area effects on smoking and drinking (Duncan *et al*., 1993; Sutton and Godfrey, 1995). However, it should be noted that the definition of area used here was one of convenience without much regard to what ideally might be preferred as a suitable definition of cultural geographical effects. That is, the level reflects the data collection process not necessarily local culture.

The implication of this analysis is that policies aimed at reducing levels of individual alcohol consumption, and particularly for heavy drinkers, may be more beneficial if they are sympathetic to both individuals and households (possibilities for further research of these data would include consideration of whether, for example, heavy drinking is done by younger individuals in "older" households). Policies aimed solely at the individual, assuming individuals act as autonomous decision making entities, may fail to successfully influence their behaviour if they belong to a household with a drinking culture.

It has been argued that the policy target should not be limited to any particular group of drinkers and that policy must be willing to take the totality of the drinking populations as defining the scope for public health action. Edwards *et al*. (1994, p. 205) argue:

> Society's drinking problems will on the large be dealt with effectively through understanding and influencing the total and dynamic system which comprises society's drinking, and effective policies cannot be modelled exclusively in terms of picking off little pieces of the continuum, or trying to manipulate extremes of behaviour.

Part of the evidence supporting this assertion is that the drinking population in general behaves as one system rather than as several different parts and that any changes in drinking patterns leading to increased or decreased consumption will result in shifts across all bands of drinking, including heavy drinkers (Colhoun *et al*., 1997). The achievement of these aims ultimately depends on successfully altering the drinking habits of society and the evidence presented here strongly suggests that one of the means of doing this is to view the household as a legitimate unit for policy targeting. This suggests that health education needs to understand the mechanisms by which behaviour in households converge, as well as the influence of external peer groups. It underlines the need for messages and strategies that can appeal to households as well as to individuals.

Another societal approach to controlling the consumption of alcohol is the levying of taxes. Economic analyses of the influence of taxes on consumption levels have often been undertaken using the household as the decision-making unit (Atkinson *et al*., 1990; Baker and McKay, 1990; Crooks, 1989). This has previously been criticised for not reflecting individual behaviour (Godfrey, 1994), but our results demonstrate the high degree of commonality of consumption patterns within households. Moreover, the household may be the most appropriate level for analysing changes in prices given the common practice of measuring income at this level (Blundell, 1988). However, whilst a large body of evidence now demonstrates the effectiveness of taxes on drinking levels (Leung and Phelps, 1993), there remains considerable controversy over their differential impact on heavy drinkers (Manning *et al*., 1995) and low income groups (Sutton and Godfrey, 1995; Marmot, 1997).

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REFERENCES

Atkinson, A. B., Gomulka, J. and Stern, N. H. (1990) Spending on alcohol: evidence from the Family Expenditure Survey 1970–1983. *Economic Journal* **100,** 808–827.

Anderson, P., Cremona, A., Paton, A., Turner, C. and Wallace, P. (1993) The risk of alcohol. *Addiction* **88,** 1493–1508.

Baker, P. and McKay, S. (1990) *The structure of alcohol taxes: a hangover from the past?*. IFS Commentary 21, Institute for Fiscal Studies, London.

Bennett, N. (1995) *Office of Population Censuses and Surveys, Department of Health Survey for England 1993*. HMSO, London.

Blaxter, M. (1990) *Health and Lifestyles*. Routledge, London.

Blundell, R. (1988) . *Consumer behaviour: theory and empirical evidence—a survey The Economic Journal* **98,** 16–65.

Box, G. E. P. and Cox, D. R. (1964) An analysis of transformations. *Journal of the Royal Statistical Society, Series B* **26,** 211–252.

Bullen, N., Moon, G. and Jones, K. (1996) Defining localities for health planning: a GIS approach. *Social Science & Medicine* **42,** 801–816.

Carr-Hill, R. A., Rice, N. and Roland, M. (1996) Socioeconomic determinants of rates of consultations in gen-

eral practice based on fourth national morbidity survey of general practices. *British Medical Journal* **312,** 1008–1012.

Colhoun, H., Ben-Shlomo, B., Dong, W., Bost, L. and Marmot, M. (1997) Ecological analysis of collectivity of alcohol consumption in England: importance of average drinker. *British Medical Journal* **314,** 1164–1168.

Congdon, P. (1995) The impact of area context on long-term illness and premature mortality: an illustration of multi-level analysis. *Regional Studies* **29,** 327–344.

Conlisk, J. (1980) Costly optimizers versus cheap imitators. *Journal of Economic Behavior and Organization* **1,** 275–293.

Crooks, E. (1989) *Alcohol consumption and taxation: an economic analysis*. London, Institute for Fiscal Studies.

Department of Health (1995) *Sensible Drinking*. *The Report of an Inter-Departmental Working Group*. Department of Health.

Duesenberry, J. S. (1949) *Income, Saving and the Theory of Consumer Behaviour*. Cambridge, MA. Harvard University Press.

Duncan, C., Jones, K. and Moon, G. (1993) Do places matter? A multilevel analysis of regional variations in health-related behaviour in Britain *Social Science & Medicine* **37,** 725–733.

Duncan, C., Jones, K. and Moon, G. (1996) Health-related behaviour in context: a multilevel modelling approach. *Social Science & Medicine* **42,** 817–830.

Edwards, G., Anderson, P., Babor, T. F., Casswell, S., Ferrence, R. *et al*. (1994) *Alcohol Policy and the Public Good*. Oxford University Press, Oxford.

Elster, J. (1989) Social norms and economic theory. *Journal of Economic Perspectives* **3,** 99–117.

Ensor, T. and Godfrey, C. (1993) Modelling the interactions between alcohol, crime and the criminal justice system. *Addiction* **88**(4), 477–487.

Godfrey, C. (1994) Economic influences on change in population and personal substance behaviour. In *Addiction: Processes of Change*, eds. G. Edwards and M. Lader, Society for the Study of Addiction Monograph. Oxford Medical Publications, Oxford.

Godfrey, C. and Maynard, A. (1995) The economic evaluation of alcohol policies. In *Alcohol and Public Policy: Evidence and Issues*, eds. H. D. Holder and G. Edwards, Oxford University Press, Oxford.

Goldstein, H. (1995) *Multilevel Statistical Models*. 2nd edn. Edward Arnold, London.

Greene, W. H. (1993) *Econometric Analysis*. 2nd edn. Macmillan, New York.

Hirshleifer, D. (1995) The blind leading the blind. Social influence, fads, and informational cascades. In *The New Economics of Consumer Behaviour*. eds. Tomassi, M., Lerulli, K. Cambridge: Cambridge University Press.

Jones, A. M. (1989) A double hurdle model of cigarette consumption. *Journal of Applied Econometrics* **4,** 23–39.

Jones, A. M. (1994) Health, addiction, social interaction and the decision to quit smoking. *Journal of Health Econometrics* **13,** 93–110.

Jones, A. M. (1995) *A microeconometric analysis of smoking in the UK Health and Lifestyle Survey*. Discussion Paper Series No. 139, Centre for Health Economics, University of York.

Jones, K. and Duncan, C. (1995) Individuals and their ecologies: analysing the geography of chronic illness within a multilevel modelling framework. *Health and Place* **1,** 27–40.

Jones, S. R. G. (1984) *The Economics of Conformism*. Blackwell, Oxford.

Kmenta, J. (1990) *Elements of Econometrics*. Macmillan, New York.

Langford, I. H. and Bentham, G. (1996) Regional variations in mortality rates in England and Wales: an analysis using multi-level modelling. *Social Science & Medicine* **42,** 897–908.

Leung, S. I. and Phelps, C. E. (1993) "My Kingdom for a Drink...?": a review of estimates of the price sensitivity of demand for alcoholic beverages. In *Economics and the Prevention of Alcohol-related Problems*, eds. M. E. Hilton and G. Bloss, pp. 1–31. U.S. Department of Health and Human Services, Washington, DC.

Lindbladh, E., Lyttkens, C. H., Hanson, B. S., Ostergren, P. O., Isacsson, S. O. and Lindgren, B. (1996) An economic and sociological interpretation of social differences in health related behaviour. An encounter as a guide to social epidemiology. *Social Science & Medicine* **43,** 1817–1827.

Macintyre, S., Maciver, S. and Soomans, A. (1993) Area, class and health: should we be focusing on places or people? *Journal of Social Policy* **22,** 213–234.

Manning, W. G., Blumberg, L. and Moulton, L. H. (1995) The demand for alcohol: the differential response to price. *Journal of Health Economics* **14,** 123–148.

Marmot, M. (1997) Inequality, deprivation and alcohol use. *Addiction* **92**(S1), S13–S20.

Marmot, M. G. and Brunner, E. J. (1994) Alcohol and cardiovascular disease: the status of the U shaped curve. *British Medical Journal* **303,** 565–568.

OPCS (1991) *Standard Occupational Classification*. Vol. 3. HMSO, London.

Rice, N. and Leyland, A. H. (1996) Multilevel models: applications to health data. *Journal of Health Services Research and Policy* **3,** 154–164.

Skog, O-J. (1985) The collectivity of drinking cultures. A theory of the distribution of alcohol consumption. *British Journal of Addiction* **80,** 83–99.

Steele, F., Diamond, I. and Amin, S. (1996) Immunization uptake in rural Bangladesh: a multilevel analysis. *Journal of the Royal Statistical Society, Series A*. **159,** 289–299.

Sugden, R. (1989) Spontaneous order. *Journal of Economic Perspectives* **3,** 85–97.

Sutton, M. and Godfrey, C. (1995) A grouped data regression approach to estimating economic and social influence on individual drinking behaviour. *Health Economics* **4,** 237–247.

Warner, K. E. (1978) Possible increases in the underreporting of cigarette consumption. *Journal of the American Statistical Association* **73,** 314–318.

Yen, S. T. and Jones, A. M. (1996) Individual cigarette consumption and addiction: a flexible limited dependent variable approach. *Health Economics* **5,** 105–118.