Temperance Board Registration for Alcohol Abuse in a National Sample of Swedish Male Twins, Born 1902 to 1949

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Background: Temperance boards were established in Sweden to register and follow up individuals who were seen in legal or medical settings with problems of alcohol abuse. These records, available in a large epidemiologic twin population, have provided an objective and validated measure of alcohol abuse.

Methods: We examined Swedish temperance board registrations from 1929 to 1974 (n=2516 individual twins) in all male-male Swedish twin pairs of known zygosity from the population-based Swedish Twin Registry; these twin pairs were born from 1902 to 1949 (n=8935 pairs).

Results: The lifetime prevalence and probandwise concordance rates for temperance board registrations were 13.2% and 47.9%, respectively, in monozygotic twins and 14.6% and 32.8%, respectively, in dizygotic twins. Model fitting suggested that genetic and familial-environmental risk factors accounted for 54% (95% confidence interval [CI], 47-61%) and 14% (95% CI, 8-19%) of the liability to temperance board registration, respectively; these estimates were stable across birth cohorts. High genetic liability was reflected by large numbers of temperance board registrations and registrations for criminal alcohol use. Elevated familial-environmental liability was indicated by an early age at first registration.

Conclusions: Genetic factors are of major etiologic importance for alcohol abuse in men, while familial-environmental factors play a significant but less important role. The etiologic importance of these factors has remained constant in Sweden for men who were born in the first half of the 20th century.

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IN THE FIRST systematic twin study of alcoholism, Kaj1 ascertained 310 male twins in southwestern Sweden through temperance boards (TBs), which were established to register and follow up individuals who were seen in legal or medical settings with problems that were related to alcohol abuse.2-4 Subsequent twin studies of alcoholism have used other information sources, including personal interviews, questionnaires, and medical or disability records.5-9

While having advantages, questionnaire or interview assessments of alcohol-related problems—used particularly in recent twin studies5-8—also have limitations. Individuals with alcoholism are difficult to contact and refuse to participate at increased rates.10,11 The assessment of alcoholism in community samples by personal interview is only moderately reliable.12-14

In this report, we return to the method of examining temperance board registration (TBR), pioneered by Kaj, in a much expanded sample. Assuming that alcohol abuse in Swedish men can be functionally defined by TBR, we address the following questions: (1) What is the relative importance of genetic and environmental factors in the etiology of alcohol abuse? (2) Has the etiologic role of genetic and environmental factors changed in successive birth cohorts in Sweden during the first half of the 20th century? (3) What characteristics of TBR reflect the familial risk to alcohol abuse, and do these characteristics specifically index genetic vs familial-environmental risk factors?

RESULTS

TEMPERANCE BOARD REGISTRATION

Of the 17,870 twins from the 8935 pairs who were born from 1902 to 1949, 2516 or 14.1% were registered with the TB. Rates of TBR were slightly higher in DI twins (1676/11,500 = 14.6%) than in MZ twins (840/6370 = 13.2%). Of those registered, less than half were registered once while one fifth were registered 5 or more times (Table 1). Drunkenness was the most common reason for registration, followed by “driving under the influence of alcohol” and “committing a crime in connection with alcohol.”
MATERIALS AND METHODS

TEMPERANCE BOARD REGISTRATION

Temperance boards were officially established in Sweden in 1916, but TBRs were not reliably recorded until 1929. National records after 1974 are unavailable. While any individual could report someone to the TB, most registrations occurred through physicians, police, and public prosecutors. All cases of “disorderliness and other offenses under the influence of alcohol” and driving “under the influence of alcohol” had to be reported to the TB. Except under special circumstances, physicians were obliged to report cases of known alcoholism to the TB. The TB had to investigate each case, and an individual’s record would follow him throughout life. The TBRs did not have authority in cases of “occasional use of alcohol without obvious injury to himself or others.” The probability of TBR was related to “...the degree of severity of the alcohol abuse and the social injury caused.” The TB records were available to us only for males and included the age at first registration, the number of total registrations, and the following reason(s) for registration: (1) drunkenness, (2) illegal manufacture or sale of alcohol, (3) driving under the influence of alcohol, or (4) committing a crime “in connection with alcohol.” Twins who were registered solely for illegal manufacture or sale (n=98) were excluded from analyses.

SAMPLE

The old Swedish Twin Registry consisted of more than 95% of same-sex twin pairs who were born from 1886 to 1925, where both members were alive in 1959 and responded to a questionnaire in 1960. The new registry comprised more than 99% of all twins who were born from 1926 to 1958 where both members were alive in 1971. As TBR was available only for 1929 to 1974, we examined lifetime prevalence of TBR by 4-year birth cohorts from 1886 to 1958. Rates of TBR were low in those persons who were born before 1902, as individuals whose problems with alcohol occurred before 1929 were undetected. Rates of TBR were relatively stable for birth years 1902 to 1949, but fell sharply for birth years 1950 to 1958, as individuals whose alcohol abuse began after 1975 were not registered. We restricted our analyses to twins who were born from 1902 to 1949, where ascertainment of TBR was likely to be more complete. All major analyses were repeated on the entire cohort. Similar results were obtained. Zygosity was determined by responses to self-report questionnaires that were shown to be 94% accurate. After excluding 16 pairs with different birth dates, this sample consisted of twin pairs where zygosity information was available from both twins (n=7790) and 1 twin (n=1145). For cohort analyses, we divided the birth years from 1902 to 1949 into 4 groups that contained similar numbers of monozygotic (MZ) twins: 1902 to 1917, 1918 to 1930, 1931 to 1942, and 1943 to 1949.

A hospital diagnosis of alcoholism was obtained from the Swedish Psychiatric Twin Registry, which provides complete coverage of all psychiatric contacts in mental hospitals and in-patient psychiatric departments of general hospitals for the years 1968 to 1983. According to the International Classification of Diseases, Eighth Revision, we defined alcoholism by a hospital diagnosis of alcoholism (ICD 303) or alcoholic psychosis (ICD 291).

Self-report questionnaires completed in the old and new registries contained information on levels of alcohol consumption. These were converted to the average current monthly consumption of alcohol.

PRESENTATION OF RESULTS FROM TWIN STUDIES

We present results by using probandwise concordance (the proportion of co-twins of proband twins who are themselves affected), tetrachoric correlation (or “correlation of liability”), and risk ratio (RR). Probandwise concordance

Continued on next page
is inefficient in an epidemiologic sample as it ignores twin pairs where neither is affected. The tetrachoric correlation assumes that underlying the observed dichotomous distribution of TBR, there exists a continuous, latent liability. The tetrachoric correlation represents the correlation between the underlying liability distributions.21,22

Both probandwise concordances and tetrachoric correlations examine only the presence or absence of a lifetime history of TBR, ignoring information about age at first TBR and age at censoring (due to death or termination of TBR data). To include these, we applied the Cox proportional hazard models (PHREG procedure in SAS) that, controlling for year of birth, predict the hazard rate for TBR in the co-twin from the presence of TBR in the twin.

STATISTICAL ANALYSIS

We used Mx20 to calculate tetrachoric correlations and fit models to contingency tables by using the method of maximum likelihood.23 As outlined elsewhere,25,26 resemblance in twins is assumed to result from 2 sets of latent factors: additive genes (A) and family or “common” environment (C)—factors such as a rural vs an urban upbringing or parental attitudes, which make members of a twin pair similar for their liability to alcoholism. In addition, the model contains individual specific environment (E), which reflects, along with measurement error, environmental experiences that make members of a twin pair different for liability to alcoholism.

We fit ACE, AE, and CE models. The AE model assumes that all familial aggregation results from additive genetic effects. The CE model assumes that all observed familial aggregation is the result of shared environmental influences.

The goal in model fitting is to explain the observed data well and parsimoniously. We operationalize this goal by using the information criterion of Akaike (AIC)27 defined as \( \chi^2 \) minus twice the df. By seeking the model with the minimum AIC, we hope to select the model that best reflects the balance of goodness of fit and simplicity.28 In addition, it is possible to compare directly the CE or AE model with the ACE model by a \( \chi^2 \) difference test with 1 df.

The final step of twin analysis is to estimate, based on the best-fitting model, the proportion of variance in liability due to individual specific environment (e²), additive genetic factors (a²), and common environment (c²). The proportion of variance in liability due to additive genetic effects is often termed heritability.

These data also afford us an opportunity to examine the relative importance of genetic and environmental risk factors for alcohol abuse throughout historical time. We first fit standard twin models jointly to 8 groups: MZ and dizygotic (DZ) twin pairs from each of the 4 birth cohorts. Then, we fit models to the same 8 groups, by constraining the parameter estimates to be equal across birth cohorts. If the etiologic importance of genetic or environmental factors differs significantly across cohorts, the constrained models should fit poorly relative to the initial models. If genetic and environmental factors are relatively stable across cohorts, the constrained models should fit relatively well. All models assumed the same threshold of illness in both members of the twin pair, in MZ and DZ twins, and in different birth cohorts.

Finally, we examined 3 features of TBRs as “indexes” of the genetic or familial-environmental liability to illness: number of TBRs, presence of a criminal registration, and age at first registration. We examined the hazard rate for TBRs separately in MZ and DZ co-twins of registered twins,21 looking for 3 possible patterns—that the variable (1) does not reflect liability to TBR (so does not predict TBR in MZ or DZ co-twins), (2) reflects the familial-environmental risk to TBR (so equally predicts TBR in MZ and DZ twins), and (3) reflects the genetic risk to TBR (so predicts TBR more strongly in MZ than in DZ co-twins). Statistical results and P values were adjusted, when appropriate, based on SEs corrected both for the non-independence of observations in members of twin pairs and for “double counting” of concordant pairs.29

row). The ACE model fit best in both analyses. However, as indicated by the AIC score, the simpler models that assumed constant genetic and environmental effects across cohorts provided consistently better explanations of the data. The overall best-fitting “cohort model,” namely, the ACE model with values of A, C, and E set equal across cohorts, produced parameter estimates that were identical to those obtained with the entire sample.

PREDICTION OF RISK OF REGISTRATION IN THE CO-TWIN

We used a Cox proportional hazard model to examine characteristics of TBR in 1 twin that predicted the risk of registration in his co-twin (Table 4). The age at first registration was significantly and inversely related to the hazard rate of registration in co-twins; the strength of this relationship was identical in MZ and DZ twins (RR = 0.97/year of birth in both zygozity groups). The number of registrations also significantly predicted the hazard rate of registration in the co-twin, but the predictive power was substantially greater in MZ (RR = 1.33) than in DZ (RR = 1.20) twins. A similar pattern was seen with criminal registration (RR = 1.97 in MZ and RR = 1.41 in DZ twins). A formal test for the difference in these RRs in MZ vs DZ twins revealed them to be significantly different for the number of registrations and criminal registration, but not for the age at first registration.

COMMENT

HERITABILITY OF ALCOHOLISM

Our first goal was to examine the etiologic role of genetic and environmental factors in alcohol abuse as assessed by TBR in this large epidemiologic sample of Swedish male twins. By using concordances or RRs in Cox regression models, the similarity in twins for TBR registration was significantly greater in MZ than in DZ twins. These results suggest a substantial role for genetic factors in the etiology of alcohol abuse.

This was confirmed by twin model fitting, where the best model indicated that twin resemblance
resulted from both genetic and familial-environmental factors, with the former accounting for nearly 4 times as much variance in liability (54%) as the latter (14%). The remaining variance in liability was due to environmental factors that were not shared by members of a twin pair.

How do these results compare with findings from previous twin studies of alcoholism? The observed concordance rates (48% in MZ and 33% in DZ twins) were higher than those observed in veteran males from the National Academy of Sciences—National Research Council epidemiologic twin registry and in the hospitalized sample of Gurling et al, but lower than those found in the other clinical samples. Our heritability estimate (34%) is well within the range of those reported in other modern twin studies of alcoholism: (1) Hrubec and O’Connell, 57%; (2) Pickens et al, DSM-III alcohol abuse, only 38%, and alcohol abuse or dependence, 36%; (3) Caldwell and Gottesman, DSM-III alcohol abuse or dependence, 70%; and (4) McGue et al, DSM-III alcohol abuse or dependence, 54%. In agreement with our findings, all 3 prior twin studies that used model-fitting methods also found that familial-environmental factors contributed to twin resemblance for liability to alcoholism in men. The number of pairs with affected twins in this study (n=2040) is nearly 3 times that of the next largest twin study of alcoholism in men (n=715) and 10 to 50 times larger than those of other prior samples: (n=205), (n=35), (n=114), (n=181), and (n=54).

Table 1. Number and Reasons for Temperance Board Registration (TBR) in Swedish Male Twins, Born 1902 to 1949

| Variable                  | No. (%)
|---------------------------|--------
| No. of TBR*               |        
| 1                         | 1139 (45.5) |
| 2                         | 480 (19.2)  |
| 3                         | 246 (9.8)   |
| 4                         | 126 (5.0)   |
| ≥5                        | 514 (20.5)  |
| Reasons for registration† |        
| Drunkenness               | 2171 (86.7) |
| Driving                   | 912 (36.4)  |
| Criminal                  | 888 (35.4)  |

*Numbers sum to 2565, as data are missing on 11 twins.
†Numbers sum to greater than 2565 because some twins were registered for multiple reasons.

a 6-fold increase in per capita income. Large changes in per capita alcohol intake also occurred.

Most interestingly, this period also saw major changes in governmental control of access to alcohol. In 1917, Sweden adopted a nationwide alcohol rationing system that strictly limited the amount of alcohol that an individual was permitted to purchase. An individual’s official limit varied according to sex, age, and financial situations, and was, for men older than 25 years, usually between 1 and 3 L of hard liquor per month. This rationing system was abolished in 1955.

Despite our large sample size, we were unable to detect evidence that the importance of genetic and environmental factors in the etiology of alcohol abuse changed in males who were born in Sweden from 1902 to 1949. We know of no comparable study that has examined alcoholism through historical time in a genetically informative sample. Large changes in socioeconomic status and significant alterations in laws that govern access to alcohol can apparently occur without having any substantial impact on the overall importance of genetic and environmental factors in the etiology of alcohol abuse. While extrapolation from a single study is problematic, these results suggest that the heritability of alcohol abuse may be a relatively stable population characteristic that is not easily altered by social change. Our results provide no information about whether more drastic social experiments (eg, the US adoption of nationwide prohibition) might have more profound effects.

INDEXES OF GENETIC OR ENVIRONMENTAL RISK FOR ALCOHOL ABUSE

Alcoholism is a clinically heterogeneous syndrome, and many subtyping typologies have been proposed. Recent interest has focused on attempts to define a highly heritable or “familial” form of alcoholism. Working from TBR and other official records in a Swedish adoption sample, proposed a highly heritable “male-limited” form of alcoholism characterized by an early age at onset, recurrent illness, and criminality in biologic fathers. A history of antisocial personality or

STABILITY OF HERITABILITY OF ALCOHOL ABUSE OVER TIME

Rarely are data available to examine the etiologic role of genetic and environmental factors in a complex human trait like alcohol abuse through historical time. The period that was covered in Sweden (birth years 1902-1949) is a particularly interesting one as the general economic level of the country improved dramatically with
Table 2. Sample Size, Prevalence, Probandswise Concordance, and Tetrachoric Correlation for TBR in Swedish Monzygotic and Dizygotic Male-Male Twin Pairs by Birth Cohort

| Birth Years | No. of Pairs | Monozygotic Twins | | Dizygotic Twins | | |
|-------------|--------------|-------------------|---|----------------|---|
| 1902-1949   | 3185         | 0.132             | 0.479 + 0.669 | 5750 | 0.146 | 0.328 + 0.409 |
| 1902-1917   | 799          | 0.128             | 0.500 + 0.701 | 1500 | 0.159 | 0.347 + 0.418 |
| 1918-1930   | 791          | 0.141             | 0.502 + 0.686 | 1534 | 0.147 | 0.293 + 0.340 |
| 1931-1942   | 842          | 0.138             | 0.436 + 0.603 | 1507 | 0.136 | 0.323 + 0.421 |
| 1943-1949   | 753          | 0.120             | 0.478 + 0.688 | 1209 | 0.140 | 0.355 + 0.470 |

*TBR indicates temperance board registration; |, tetrachoric correlation.
†Line 1 represents the entire birth cohort, and lines 2-5, individual birth cohorts.

Table 3. Model Fitting for Entire Sample and for 4 Birth Cohorts With Parameters Allowed to Differ and Constrained to Be Equal Across Cohorts

<table>
<thead>
<tr>
<th>Sample</th>
<th>ACE</th>
<th>CE</th>
<th>AE</th>
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<tr>
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<tr>
<td>Equal parameters</td>
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<tr>
<td>across 4 cohorts§</td>
<td>26.47</td>
<td>21</td>
<td>0.19</td>
</tr>
</tbody>
</table>

*A indicates additive genetic effects; C, common or familial environment; E, unique or individual specific environment; AIC, information criterion of Akaike; $a^2$, additive genetic effects; $c^2$, common environment; and $e^2$, individual specific environment.
†Best-fitting model.
‡Parameters permitted to differ across 4 birth cohorts (1902-1917, 1918-1930, 1931-1942, 1943-1949).
§Parameters constrained to be equal across all 4 birth cohorts.

Criminality or an early age at onset may also define genetically meaningful subtypes of alcoholism.

We found that age at onset, the number of registrations, and criminal registration in a registered twin all significantly predicted the risk of TBR in the co-twins. These 3 predictors, however, behaved quite differently in MZ vs DZ twin pairs. Both the number of registrations and criminal registration were significantly stronger predictors of risk of TBR in MZ than in DZ co-twins, as expected if they reflected the genetic liability to alcohol abuse. By contrast, age at first registration was equally strong at predicting TBR in the co-twin in DZ as in MZ twins; this is the expected pattern if age at onset was an index of the familial-environmental liability to alcohol abuse. These results, consistent with some, but not all previous findings, indicate the power of the twin design in clarifying differences in measures of "familial" alcoholism.

EQUAL ENVIRONMENT ASSUMPTION

Twin studies assume that MZ and DZ twin pairs are equally correlated for exposure to disease-predisposing environments. If MZ twins are more highly correlated than DZ twins for exposure to environmental risk factors for alcohol abuse, then our estimates of the heritability of alcohol abuse will be biased upward. Information to test this hypothesis—although limited to the frequency of contact in twin pairs in adulthood—was available from self-report questionnaires that were obtained from the new Swedish Twin Registry. As seen in other samples, MZ twins were in significantly closer contact with one another than DZ twins ($t=13.1; df=73936, P<.001$). Furthermore, twins in more frequent contact with one another were more similar in their probability of TBR. However, this relationship was a weak one. Tetrachoric correlations for TBR in MZ and DZ twins, respectively, as a function of their level of contact were as follows: low contact, +0.61 and +0.39; intermediate contact, +0.67 and +0.49; and high contact, +0.66 and +0.46.

To examine what impact this violation of the equal environment assumption could have on our heritability estimates, we applied a structural equation model that included the standard parameters plus the frequency of contact as an additional source of twin resemblance. The fit of the model, as assessed by AIC, was not improved by adding the "frequency of contact" parameter. If this parameter were included, it accounted for 8% of the variance in liability to TBR; estimates of $a^2$ and $c^2$ declined only very slightly. The increased frequency of contact in adulthood in MZ vs DZ twins was not likely to represent a significant violation of the equal environment assumption for TBR.

POTENTIAL LIMITATIONS

This report should be interpreted in the context of 5 methodologic limitations. First, how valid is TBR registration as a measure of alcohol abuse? Dahlberg reviewed 1162 men who were registered with the TB in Malmö, Sweden, between 1929 and 1938. In only 78 (6.7%) of them was
Table 4. Prediction of Hazard Rate in Co-twin for First TBR in MZ and DZ Twins for Age at First Registration, Criminal Registration, and Number of Registrations*  

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>MZ Twins</th>
<th>DZ Twins</th>
<th>Interaction With Zygosity</th>
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<tbody>
<tr>
<td></td>
<td>RR</td>
<td>95% CI of RR</td>
<td>( \chi^2 )</td>
</tr>
<tr>
<td>Age at first registration</td>
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<td>9.8</td>
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<tr>
<td>No. of registrations</td>
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<td>1.25-1.41</td>
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</tr>
<tr>
<td>Criminal registration</td>
<td>1.97</td>
<td>1.59-2.37</td>
<td>33.5</td>
</tr>
</tbody>
</table>

* TBR indicates temperance board registration; MZ, monozygotic; DZ, dizygotic; RR, relative risk; and CI, confidence interval. By Cox proportional hazard model for birth years 1902 to 1949, controlling for year of birth. Of note, while the Cox models in MZ and DZ twins test whether the observed association is owing to chance, the test for interaction examines whether the predictive power of the Cox model differs significantly in MZ vs DZ twins. The RR for age at first registration is per year, for number of registrations per category (1, 2, 3, 4, and \( \geq 5 \)), and for criminal registration simply the presence or absence of a registration for committing a crime in connection with alcohol. Statistical results are corrected for the “double counting” of registered twins in pairs discordant for TBR.

there doubt whether they were “addicted to abuse of alcohol,” which Dahlberg defined as “… intoxicated almost daily, involving also incapability on his part to execute his social duties.” Åmark examined 407 men who were registered with the TB in Stockholm in 1945 and 1946 and concluded that 87.7% had either chronic alcoholism or alcohol addiction. In a population study, Kají compared men with alcoholism who had vs had not been registered and noted few differences between them.

We validated TBR against hospital diagnoses of alcoholism and self-report alcohol consumption. Compared with unregistered individuals, a twin with a TBR had a significant, 9.4-fold increased risk of admission to a psychiatric facility with a diagnosis of alcoholism (\( \chi^2=429.3 \), df =1, \( P<.001 \)). Individuals with a history of TBR reported current consumption of alcohol 2 to 3 times greater than those without such a history (\( t=20.77; df=11,638; P<.001 \)). In the new registry, information was also available on maximum prior alcohol consumption. This was more than twice as great in those with vs without a history of TBR (\( t=18.86; df=6210; P<.001 \)).

A second potential methodologic limitation is that, while substantial data support the validity of TBR as a measure of alcohol abuse, we know less about its sensitivity. In the Stockholm adoption sample, Cloninger et al.\(^\text{15} \) found that 58% of men with a psychiatric diagnosis of alcoholism had 1 or more TBRs. Of the 440 twins who were psychiatrically hospitalized with a diagnosis of alcoholism in our national data, 257 (58.4%) had 1 or more TBRs; this is a lower bound estimate, as the period of ascertainment for psychiatric hospitalization and TBR only partially overlapped. Given the validity of TBR as a measure of alcohol abuse, its substantial prevalence in this sample (14.1%) provides indirect evidence of its sensitivity.

How might our results be biased if a significant proportion of individuals affected with alcohol abuse go undetected by TBRs? Neither the concordance-based nor the model-based analyses of twin data assume that all cases of illness are ascertained. However, these methods do assume that the probability of ascertainment is independent in twin pairs. If ascertainment is correlated in twin pairs (eg, TBR in 1 twin increases the probability of TBR in the co-twin), and if the degree of correlation is similar in MZ and DZ twins, the correlations must be relatively extreme to bias parameter estimates substantially.\(^\text{24} \)

More problematic is the possibility that ascertainment is correlated, and the degree of correlation is greater in MZ than in DZ twins. In his initial study of TBR, Kají investigated this possibility and concluded that correlated ascertainment was not a source of significant bias. If ascertainment in one twin increases the probability of registration in the co-twin, and this effect was stronger in MZ than in DZ twins, then age at first TBR should be much more highly correlated in MZ than in DZ twins. However, this was not the case—correlation in age at first TBR was very similar in MZ (+0.60) and DZ (+0.57) twins (difference test: \( t=0.49; P=.62 \)).

To examine this further, we simulated 2 models of correlated ascertainment for TBR,\(^\text{16} \) assuming the probability of registration for a twin with alcohol abuse was 40% if his co-twin was unregistered. In model 1 (correlated ascertainment, equal in MZ and DZ twins), this increased to 80% if the co-twin was registered in both twin types. In model 2 (correlated ascertainment, greater in MZ than in DZ twins), having the co-twin registered increased the probability of registration to 60% in DZ and 80% in MZ twins. Estimates of the heritability of liability to TBR were unchanged in the first model and reduced moderately (54%-44%) in the second. Correlated ascertainment is unlikely to be a major source of bias in our twin study of TBR.

Third, to be included in the old and new registries, both twins had to be alive in 1959 and 1971, respectively. A bias might exist in the registries against twins with alcoholism sufficiently severe to increase substantially the risk for premature death. Such a bias would more likely deflate than inflate estimates of heritability.

Fourth, variation likely existed in both time and space in the application of the guidelines for TBR. We cannot rule out the possibility that such variation significantly influenced the results that were obtained although such an effect would tend to bias estimates upwardly for familial environment and not genetic factors.\(^\text{25} \)

Fifth, zygosity information, obtained by mailed questionnaire, was necessary for inclusion in this sample. Prior studies suggest that individuals with alcohol problems cooperate with such surveys at reduced rates.\(^\text{10,11} \) By using a co-twin control design, we could estimate that the probability of selection into our sample was 37% lower in individuals with vs without a history of TBR. Applying to these data a model that corrects for such sampling bias resulted