USING COLLEGE ALUMNI POPULATIONS IN EPIDEMIOLOGIC RESEARCH:
THE UNC ALUMNI HEART STUDY*

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Abstract—The UNC Alumni Heart Study (UNCAS) is a prospective study of the role
of psychosocial factors, in particular hostility, in the development of coronary heart
disease. The target population is composed of persons who completed the Minnesota
Multiphasic Personality Inventory while attending the University of North Carolina in
the mid-1960s. Logistic regression analyses were used to determine whether hostility,
demographic and other variables were significant determinants of the subjects' locatability
and participation. It was found that MMPI hostility scores at initial testing were
unrelated to either potential or actual locatability or participation. Thus there is no
evidence that hostility is the source of selection bias in the UNCAHS. Selection into the
study was predicted by age, sex, degree status and variables concerned with the
conditions under which the MMPI was administered. It is concluded that follow-up
studies of college cohorts may have study-specific sources of selection bias.

Hostility Methods Selection bias

INTRODUCTION

The UNC Alumni Heart Study (UNCAHS) focuses on the role of hostility as a risk factor
for coronary heart disease (CHD [1–3]). The study was an outgrowth of research showing
hostility to be the aspect of the Type A behavior pattern that is most clearly associated with
health outcomes [3]. In cross-sectional studies, hostility has been associated with coronary
artery disease, peripheral artery disease, and

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physician's ratings of functional health. Prospectively, hostility has been shown to predict
total mortality as well as CHD events (see [4], for a review).

Many of these studies have measured hostility with the Cook and Medley hostility scale [5],
a 50-item research scale taken from the Minnesota Multiphasic Personality Inventory
(MMPI [6]). Because the MMPI is such a widely used test, it allows for the use of retrospective
cohort designs to test hypotheses on data initially collected for other purposes (e.g. [7, 9]).
The UNCAHS is such a design and takes advantage of the fact that the MMPI was given at registration at the University of North Carolina at Chapel Hill between 1964 and
1966.
Since hostility is the primary exposure variable in the UNCAHS, it must be assessed as a source of selection bias. In this paper we first evaluate hostility, conditions of test taking, and other factors that could influence long-term follow-up as sources of selection bias [9, 10] in the UNCAHS. The target population for this study is composed of students who were administered the MMPI at the University of North Carolina in Chapel Hill (UNC) during the 1964–66 academic years. No special attempt was made to follow these students until the UNCAHS started in 1986. Since selection bias is increased to the extent that enrollment and follow-up are incomplete, it is important to test for the effects of bias early in the follow-up study period so additional tracing efforts [11, 12] can be expended if necessary.

Studies that follow alumni groups have played a major role in understanding the precursors of disease [13–15]. However, the UNCAHS is different from the typical follow-up of alumni who join a study while in school (e.g. [14, 15]), since individuals taking the MMPI had no idea that 20 years later they would be invited to participate in a prospective study of coronary heart disease. This is both a strength and a weakness of the study. It is a strength because initial recruitment was not limited to those willing to participate in long-term research or to those particularly concerned about heart disease because of a strong family history. It is a weakness because no special efforts were made to measure coronary disease risk factors at the time of initial recruitment.

Hostility might well be related to the assembly of a cohort that depends on alumni records for follow-up after an interval of over 20 years. If hostile persons are more or less likely to remain in school, to graduate, to keep in touch with the Alumni Office and thus, more or less hard to find, they could also be more or less likely to enroll in the prospective study. If the selection and tracking procedures we used to develop our study panel are biased such that hostile persons with disease are less likely to be included in the study, then the degree of the true association between hostility and heart disease will be underestimated. Alternatively, if the hostile person is more likely to be in the study, then true association could be overestimated. There is very little literature on the topic of hostility and related constructs as predictors of study participation. The one exception is the work of Gershen and McCreary [16] who reported a non-significant relationship between trust as measured by the Comrey Personality Inventory and participation in a mailed survey by first year dental students contacted 4–6 years after testing. Responders to the mail survey scored non-significantly higher than non-responders on trust ($p = 0.08$) and on social conformity ($p = 0.06$).

In order for a person to become a participant in the UNCAHS we needed to locate them, and in order for us to locate them, they had to be on the General Alumni Association (GAA) alumni files. Thus three stages of selection are of interest: (1) potential locatability: individuals on the alumni files were compared to those not on the alumni files; (2) actual locatability: among all individuals on the alumni files, individuals with a vital status verified after 1986 were compared to those who could not be located; (3) participation: among all individuals actually located, individuals who returned a questionnaire by 31 December 1989 were compared to those who did not. Each of these three stages of selection was evaluated in turn.

We had no a priori hypothesis about which variables would predict selection into the first stage of the study as we assumed that University procedures rather than respondent factors accounted for inclusion on the GAA computerized record systems. On the other hand, since men have fewer name changes than women and since identification with the institution is presumed to be strongest among undergraduates and degree recipients, we expected that sex, student status, and degree status would predict actual locatability. We expected that these same three variables would predict participation, since women are more likely than men to participate in surveys [17] and since undergraduates and degree recipients may have the strongest ties to the University. Finally, we saw it essential to determine whether hostility contributed to selection bias at any of the three stages.

**METHODS**

**Selection into the Study**

The study started with files of MMPI answer sheets that were completed in 1964–67 and matched to student and alumni records 20 years later. Initially it was thought that all 7039 of the MMPIs came from a required testing at freshman orientation and registration during summer and fall 1964–65, 1965–66 and 1966–67 and
that all MMPIs represented members of the graduating classes of 1968, 1969 and 1970. While over 6000 of the tests did come from fall registration during those 3 years, the target population also included about 900 persons who were tested at other times of the year. Furthermore, some students were unexpectedly found to have more than one MMPI answer sheet and others to be enrolled in technical degree or graduate programs. Since there was no particular reason to limit our target population to freshmen measured just once at registration, we decided to enrol everyone with MMPI data in the UNCAHS and document the results of that decision empirically by evaluating variables indicating student status, date tested, and multiple administration of the MMPI as predictors of selection into the study. These variables were included as predictors to explore whether study results would be affected by inclusion of respondents who were not initially targeted by this study.

The three stages of selection where we tested for bias are diagrammed in Fig. 1.

When the prospective study started, 96.29% (6778) of the target population was identified on the alumni files and formed the pool of potential respondents. During the next 2.5 years of follow-up, 84% (5696) of those on the GAA files and 1.5% of those not on file (4 of whom were dead) were located. Of the 5546 who were living, 84.83% (4705) joined the study.

**Potential predictors of selection into the study**

**Hostility.** The measure of hostility used in this analysis was developed by Cook and Medley [9] and is based on answers to 50 items from the MMPI. The MMPI [6] is a 566-item true–false test designed to highlight areas of abnormal psychological functioning. The 566 items have formed the basis for 10 clinical and 4 validity scales and for well over 500 recognized research scales (see [18, 19]). Hostility scores were eliminated from the analysis if the MMPI validity indicators F and L had standard scores > 70 or if the MMPI contained more than 55 missing items. The hostility score was also considered invalid if more than 10% of the hostility items were missing. Application of these criteria resulted in exclusion of 274 subjects. For students with more than one MMPI, only the first MMPI was used in the analysis.

**Date tested and multiple administration.** While most students were given the MMPI at summer orientation or fall registration, a number of MMPIs were completed at other times. The most likely other testing situation was for evaluation at the Student Health Service. Therefore test administration at a time other than registration or orientation may be an indicator,
albeit imperfect, of potential adjustment problems as a student. Multiple MMPIs for a student may also indicate that the student was seen for an evaluation. Since such students may be harder to follow or less likely to participate in a study such as the UNCAHS, we evaluated the date of test administration and the existence of multiple MMPI records as potential predictors of selection into the study.

*Student status.* Students were classified as either undergraduates or "other". Since undergraduates, graduates, and 2-year technical students attend the same registration at UNC, the study cohort included 275 who were not undergraduates.

*Degree status.* While the UNC GAA follows everyone who attends UNC regardless of whether they graduated or not, the "old school tie" can be a powerful recruiting tool for our study. Seventy-six percent of the target group was awarded a degree by UNC, a rate comparable to the overall graduation rate at UNC. While the alumni office follows everyone with the same intensity, the receipt of a degree from UNC was evaluated as proxy for strength of the tie to the institution. It is also likely that those who did not graduate from UNC completed their education in other universities and thus may have strong alumni ties elsewhere.

*Demographic factors.* Most students enter the university around age 18 and start graduate school at age 22. Thus, in this study, age at initial testing may signal a non-traditional career pathway. Since the UNC student population was primarily male in the 1960s, the majority of the sample is male. Because hostility varies with age (higher at age 19 and lower at age 40) and sex (men are more hostile than women) [20, 21], it is important that these potential confounders be controlled. Race is not considered in this study, since at the time these data were collected minority enrollment at UNC was less than 1%.

*Methods of Analysis*

Since bias could occur at any stage of the selection process, three separate sets of logistic regression analyses were used to predict potential locatability, actual locatability, and participation. A forward stepwise hierarchical approach to model building was used so that variables entered the model in four steps. A variable's level in the hierarchy was based on our judgment of its relative methodological impact if selection bias were to be observed. In particular, hostility was forced into the model in step 1 so that a hostility effect uncontrolled for other variables could be assessed. In step 2, the statistical significance of age and sex were tested in the model already containing hostility; if either sex or age was non-significant, it was removed from the model and from further consideration. In step 3, the significance of degree status and student status were tested in the model from step 2 that contained hostility and possibly age or sex. Degree status and student status were left in the model at step 3 only if they were statistically significant. Finally, the significance of date tested and multiple administration were tested in the model that had been built in step 3. Step three was not included in the analysis of potential locatability because degree status and student status could not be appropriately tested (see Table 1). This hierarchical procedure had two advantages. One, it allowed us to test the effect of hostility both uncontrolled for other variables and controlled for different subsets of the variables. Two, it gave variables with obvious substantive meaning and wider generalizability (i.e. age and sex) the first chance to enter the model, while allowing the more idiosyncratic and ambiguous variables (date tested and multiple administration) to enter the model only after more interpretable variables had been considered.

A Type I error rate (alpha) of 0.01 was used to determine the significance of all statistical tests. A fourth summary analysis compared participants with all non-participants.

**RESULTS**

The joint distributions of the seven predictor variables with the three dependent variables are shown in Table 1. These distributions reveal the uncontrolled associations between the predictor variables and the dependent variables. The hostility means given at the bottom of the table are comparable to the age and sex norms for this cohort reported by Swenson et al. [20].

Tables 2–5 present the final model for each analysis, while the footnotes to the tables give the reference categories for the categorical variables and the chi-square, p-value, odds ratio and 95% confidence interval for each variable at the step it was excluded.

*Prediction of potential locatability*

This model evaluates the relationship between five of the predictor variables (age, sex, date
Using College Alumni Populations

**Prediction of actual locatability**

Using all potentially locatable subjects, the second model evaluates the predictors of actual locatability 20–25 years after the administration of the MMPI. The final model, shown in Table 1, reveals that a person is significantly more likely to be located if he or she is younger, has a degree from UNC, or took the MMPI only once. Hostility does not predict locatability at any step of model building.

**Prediction of participation**

The third model compares the 4705 participants to the 841 located non-respondents. In the final model, shown in Table 3, only two of the seven main effects were significant. Participation is predicted by sex (females are more likely to participate than males) and by degree status (subjects with a degree are more likely to participate). Hostility does not predict participation.

**Participants vs all non-participants**

In a fourth model, shown in Table 4, comparing all 4705 participants to all 2334 non-participants, sex, age, degree status and multiple administration significantly predict participation. These findings mirror the previous analyses and indicate the strength of degree status as a predictor, as it is the only variable to predict both actual location and participation.

Although the variables degree status and multiple administration predict selection into the UNCAHS, the variables in themselves do not explain how the participants are different from the non-participants. For example, although it is highly probable that degree status derives a great deal of its predictive power from the fact that individuals with a degree feel stronger ties to UNC than do those without a degree, it may also be that those with a degree have a different psychological profile than those without a degree. Likewise, if the variable multiple administration is indeed an index of help seeking behavior, it too may predict selection by signaling differences in psychological profiles.
Table 2. Final model of prediction of potential locatability*

<table>
<thead>
<tr>
<th>Effect</th>
<th>95% CI for OR</th>
<th>Odds ratio†</th>
<th>Lower</th>
<th>Upper</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td>1.88</td>
<td>1.36</td>
<td>2.58</td>
<td>14.8</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>0.61</td>
<td>0.53</td>
<td>0.71</td>
<td>43.0</td>
</tr>
<tr>
<td>Date tested</td>
<td></td>
<td>3.97</td>
<td>2.85</td>
<td>5.54</td>
<td>65.7</td>
</tr>
<tr>
<td>Hostility</td>
<td></td>
<td>0.94</td>
<td>0.86</td>
<td>1.03</td>
<td>1.42</td>
</tr>
</tbody>
</table>

*The variable multiple administration was excluded with chi-square = 0.47, \(p = 0.49\), OR = 1.26 (CI = 0.66, 2.40).
†Odds ratio for the continuous variables of age and hostility is for a 5-unit increase in the predictor variable. Reference categories for categorical variables are: sex = female; date tested = not during fall registration; multiple administration = single administration.

Table 3. Final model of prediction of actual locatability*

<table>
<thead>
<tr>
<th>Effect</th>
<th>95% CI for OR</th>
<th>Odds ratio†</th>
<th>Lower</th>
<th>Upper</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td>0.74</td>
<td>0.65</td>
<td>0.84</td>
<td>20.6</td>
</tr>
<tr>
<td>Degree status</td>
<td></td>
<td>4.20</td>
<td>3.63</td>
<td>4.87</td>
<td>360.7</td>
</tr>
<tr>
<td>Multiple administration</td>
<td></td>
<td>0.55</td>
<td>0.73</td>
<td>0.41</td>
<td>16.5</td>
</tr>
<tr>
<td>Hostility</td>
<td></td>
<td>0.98</td>
<td>0.94</td>
<td>1.03</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*Exclusions from the model: Sex with chi-square = 2.54 (\(p = 0.11\)), OR = 0.85 (CI = 0.70, 1.40); student status with chi-square = 0.05 (\(p = 0.82\)), OR = 0.94 (CI = 0.57, 1.57); date tested with chi-square = 3.16 (\(p = 0.08\)), OR = 1.26 (CI = 0.98, 1.62).
†Odds ratio for the continuous variables of age and hostility is for a 5-unit increase in the predictor variable. Reference categories for categorical variables are: degree status = no degree from UNC; multiple administration = single administration; sex = female; student status = not undergraduate student; date tested = not during fall registration.

DISCUSSION

We have shown that the UNCAHS does not suffer from selection bias due to follow-up group differences in hostility. In particular, hostility does not affect potential locatability (being listed on the University files in the 1960s), actual locatability (location in the 1980s), or participation (enrollment in the prospective phase of the study).

By testing all entering students we obtained a more heterogeneous sample than we would have had if the study were limited to those who graduated. Furthermore, we learned that the characteristics of the sample are influenced by the complex rules that universities have about maintaining record systems. Therefore, other studies that start with university alumni records may need to evaluate the extent to which the system in place differentially captures students with differing attendance patterns. Our experience suggests that starting at orientation/registration is more likely to pick up students who never fully matriculate (drop out without completing a semester, transfer, flunk out, etc.) and can be expected to be more costly in time and money to locate.

It is interesting to look at the study as having two populations—alumni and non-graduates. Eighty-nine percent of the alumni have been located, and of those located and alive, 87% have participated. In contrast, only 58% of the non-graduates have been located, and of those

Table 4. Final model of prediction of participation (given locatable)*

<table>
<thead>
<tr>
<th>Effect</th>
<th>95% CI for OR</th>
<th>Odds ratio†</th>
<th>Lower</th>
<th>Upper</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td>0.58</td>
<td>0.46</td>
<td>0.75</td>
<td>19.05</td>
</tr>
<tr>
<td>Degree status</td>
<td></td>
<td>1.72</td>
<td>1.43</td>
<td>2.08</td>
<td>32.79</td>
</tr>
<tr>
<td>Hostility</td>
<td></td>
<td>1.00</td>
<td>0.94</td>
<td>1.05</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*Exclusions from the model: Age with chi-square = 0.83 (\(p = 0.36\)), OR = 0.98 (CI = 0.94, 1.02); student status with chi-square = 0.66 (\(p = 0.42\)), OR = 1.21 (CI = 0.77, 1.90); date tested with chi-square = 0.08 (\(p = 0.78\)), OR = 0.84 (CI = 0.57, 1.23); multiple administrations with chi-square = 0.73 (\(p = 0.39\)), OR = 0.96 (CI = 0.73, 1.26).
†Odds ratio for the continuous variables of age and hostility is for a 5-unit increase in the predictor variable. Reference categories for categorical variables are: sex = female; degree status = no degree from UNC; student status = not undergraduate student; date tested = not fall registration; multiple administration = single administration.
Table 5. Final model of prediction of overall participation*

<table>
<thead>
<tr>
<th>Effect</th>
<th>Odds ratio†</th>
<th>95% CI for OR</th>
<th>Chi-square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>0.71</td>
<td>0.60 - 0.83</td>
<td>18.33</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Age</td>
<td>0.69</td>
<td>0.61 - 0.77</td>
<td>43.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Degree status</td>
<td>3.79</td>
<td>3.35 - 4.28</td>
<td>451.19</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Multiple administration</td>
<td>0.63</td>
<td>0.49 - 0.81</td>
<td>12.62</td>
<td>&lt;0.0004</td>
</tr>
<tr>
<td>Hostility</td>
<td>0.99</td>
<td>0.95 - 1.03</td>
<td>0.32</td>
<td>0.57</td>
</tr>
</tbody>
</table>

*Exclusions from the model: student status was excluded with chi-square = 0.32 (p = 0.58), OR = 1.12 (CI = 0.77, 1.62); date tested with chi-square = 0.86 (p = 0.35), OR = 1.10 (CI = 0.90, 1.35).

†Odds ratio for the continuous variables of age and hostility is for a 5-unit increase in the predictor variable. Reference categories for categorical variables are: sex = female; degree status = no degree from UNC; multiple administration = single administration; student status = not undergraduate student; date tested = not fall registration.

located and alive, 83% have participated. Overall, 77% of the alumni and 46% of the non-graduates are in the study, but the major difference in these percentages is due to our difficulty in locating the non-graduates, not in their refusal to participate once contacted. Thus our assumptions about the "old school tie" were perhaps somewhat overrated.

There are two other studies that started with similar baseline data (i.e. MMPI data on a college cohort). Hearn et al. [22] started with MMPIs from entering freshmen at the University of Minnesota in 1953. They determined vital status on 1313 persons (93% location rate) and conducted telephone interviews with 1205. Similar to our findings, they reported that older persons were less likely to be located and that hostility was not related to locatability. Other factors were not tested. Schnurr [23] used MMPI data collected from Dartmouth students to predict post traumatic stress disorder. She received follow-up data on a mailed questionnaire from 49% of the sample and reported no MMPI clinical scale differences between respondents with usable data and the rest of the target population. Sociodemographic characteristics, conditions of original data collection and hostility were not evaluated.

The findings of the Vietnam Experience Study (VES [24]) are relevant to the issue of selection bias due to locatability. In the VES study difficulty in location was related to reports of multiple psychological symptoms, but not to physical health outcomes, after controlling for differences in demographic characteristics and health habits. This suggests that studies with psychiatric disorders as the variables of interest may need to be more concerned about selection bias than studies that focus on physical disorders such as coronary heart disease.

In summary, our demonstration of the lack of selection bias due to hostility indicates that the procedures we used to generate our participant sample did not differentially select people into the study based on their hostility scores. Therefore, any associations found in the UNCAHS between hostility during college in the 1960s and heart disease in the 1990s will not be impaired by selection bias due to the exposure variable of hostility. The particular results of the present study may not be generalizable to other retrospective cohort studies. However, we have demonstrated that conditions of data collection at baseline and procedures of follow-up do affect selection and should be evaluated in each study.

Selection into the UNCAHS was predicted by degree status and multiple administration (and to a small extent, date tested). Therefore, future studies of college cohorts should attend to such variables. Conditions that are idiosyncratic to each study should be examined as predictors of participation since they may be proxies for variables that represent substantive sources of selection bias.

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