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

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Abstract—The UNC Alumni Heart Study (UNCAHS) 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' locatabil-
ity 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

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 re-

ported 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,
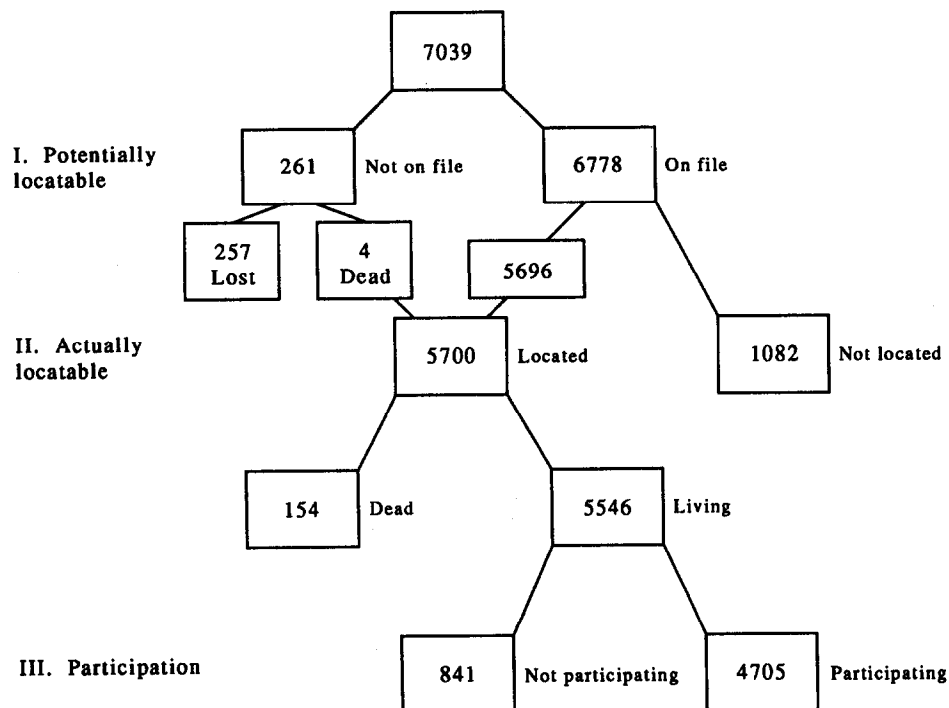

Fig. 1

albeit imperfect, of potential adjustment prob-
lems as a student. Multiple MMPIs for a stu-
dent may also indicae 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 under-
graduates, graduates, and 2-year technical stu-
dents attend the same registration at UNC, the
study cohort included 275 who were not under-
graduates.

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 compar-
able 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 popu-
lation 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 po-
tential 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 poten-
tial locatability, actual locatability, and par-
ticipation. 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 hierar-
chical 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 mean-
ing and wider generalizability (i.e. age and sex)
the first chance to enter the model, while allow-
ing the more idiosyncratic and ambiguous vari-
ables (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 hos-
tility 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 vari-
ables 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

Table 1. Distribution of variables

Variables	Target	Potentially locatable		Actually located		Participated		All non-participants
		Yes	No	Yes	No	Yes	No	
Number in group	7039	6778	261	5700	1082	4705	841	2334
Sex (% male)	83	83	67	83	84	82	88	84
Date tested								
(% summer or fall date)	87	88	51	89	83	89	90	82
Number of MMPIs (% single)	95	95	92	96	92	96	95	93
Student status								
(% undergraduate)	95	98	na*	97	96	97	97	91
Degree status								
(% degreed from UNC)	75	78	0†	82	53	84	76	56
Age								
Mean	19.1	18.9	22.3	18.9	19.3	18.8	18.9	19.5
SD	2.7	2.4	6.5	2.3	3.0	2.1	2.1	3.6
Hostility								
Mean	17.5	17.6	16.9	17.5	17.8	17.5	17.8	17.7
SD	7.7	7.7	8.1	7.7	7.7	7.6	8.0	7.9

*Since student status was taken from the alumni records, it was not available for this group of persons.
†All students who got degrees from UNC were on the alumni files.

tested, multiple administration, and hostility) and a dependent variable indicating whether the individual is on the UNC GAA's computerized record system.* In the final model, shown in Table 2, sex, age, and date tested are related to being on the alumni files. The test of hostility at each step of model building was non-significant. Being younger, male, and tested at summer or fall registration all make a person more likely to be in the alumni files and easier to locate. For persons not on the files, other University sources, such as the Registrar's office, must be used to start the tracking procedures. However, since 96% of the sample is potentially locatable, these factors have little impact on the composition of the final cohort.

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 3, 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.

*All of the persons not on the alumni files were non-graduates of the University and student status was not known. The Alumni Association files include all undergraduates who completed at least 12 hours during at least one semester and all graduate students who received a degree. Graduate school drop-outs are on the files if they had been UNC undergraduates who met inclusion criteria. Furthermore, individuals who did not meet the criteria could request addition to the files.

Prediction of participation

The third model compares the 4705 participants to the 841 located non-respondents. In the final model, shown in Table 4, 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 5, 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 signalling differences in psychological profiles.

Table 2. Final model of prediction of potential locatability*

| Effect | Odds ratio† | 95% CI for OR | | Chi-square | p |
		Lower	Upper		
Sex	1.88	1.36	2.58	14.8	<0.0001
Age	0.61	0.53	0.71	43.0	<0.0001
Date tested	3.97	2.85	5.54	65.7	<0.0001
Hostility	0.94	0.86	1.03	1.42	0.23

*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 mode of prediction of actual locatability*

| Effect | Odds ratio† | 95% CI for OR | | Chi-square | p |
		Lower	Upper		
Age	0.74	0.65	0.84	20.6	<0.0001
Degree status	4.20	3.63	4.87	360.7	<0.0001
Multiple administration	0.55	0.73	0.41	16.5	<0.0001
Hostility	0.98	0.94	1.03	0.5	0.49

*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)*

| Effect | Odds ratio† | 95% CI for OR | | Chi-square | p |
		Lower	Upper		
Sex	0.58	0.46	0.75	19.05	<0.0001
Degree status	1.72	1.43	2.08	32.79	<0.000
Hostility	1.00	0.94	1.05	0.03	0.87

*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, 1.25); multiple administrations with chi-square = 0.75 (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*

| Effect | Odds ratio† | 95% CI for OR | | Chi-square | p |
		Lower	Upper		
Sex	0.71	0.60	0.83	18.33	<0.0001
Age	0.69	0.61	0.77	43.7	<0.0001
Degree status	3.79	3.35	4.28	451.19	<0.0001
Multiple administration	0.63	0.49	0.81	12.62	<0.0004
Hostility	0.99	0.95	1.03	0.32	0.57

*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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