

New Jersey Urea Formaldehyde Foam Insulation Study

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The New Jersey urea-formaldehyde study was conducted to investigate problems associated with urea-formaldehyde (UF) foam insulation in homes.

Background

The use of polymerized urea and formaldehyde to generate a plastic foam was developed by I. G. Farbenindustrie in 1933. The foams were introduced as insulation materials in 1958, and have been used extensively in Northern Europe since the early 1960's.⁽¹⁾ The primary advantage of the product is that it can be pumped as a liquid foam into the empty wall spaces of existing buildings, where it hardens in place ("retrofit insulation"). Its introduction into the American market in 1976 was facilitated by oil shortages and the growing incentive for home insulation.⁽²⁾ The current rate of new installations in the United States is unknown. Estimates by the New Jersey State Department of Energy are that approximately 2,000-3,500 New Jersey homes or 5% of all homes insulated annually are treated with the product.⁽³⁾

Reports of problems attributed to UF foam have been submitted to health departments in New Jersey and other states since 1977. As of December 3, 1979, the U.S. Consumer Product Safety Commission had received 484 incidents reports from at least 26 different states.^(4,5) Health complaints have included headache, dizziness, nausea, conjunctivitis, coryza, coughing, dyspnea and rashes. At least four families in New Jersey had to abandon their homes until the foam was removed. Non-health complaints of structural damage to houses, including paint peeling due to excessive moisture, bulging or collapse of wall-board due to pressure, and loss of the foam's insulating properties from shrinkage have also been investigated and verified.

A plausible basis for the health complaints exists, in that air monitoring in affected homes has shown elevated levels of free formaldehyde at potentially toxic concentrations. Free formaldehyde is released by either depolymerization of the UF polymer, or by the presence and evaporation of incompletely reacted reagents. Published data from the State of Washington, obtained using the chromatropic acid measurement procedure, show a range of free formaldehyde in problem homes from non-detectable (less than 0.22 ppm) to 2.54 ppm (mean of 136 samples: 1.41 ppm).⁽⁶⁾ Another series has been reported from Connecticut, where 43 samples analyzed by the Drager tube procedure showed a range from non-detectable (less than 0.5 ppm) to 7.0 ppm (mean: .93 ppm).⁽⁷⁾ Investigators conducting air tests in some affected homes have themselves experienced immediate eye and respiratory irritation, and have detected the odor of formaldehyde upon entering the home.

The toxicity of formaldehyde has been documented largely from occupational exposures and from cases of accidental or intentional ingestion. An extensive literature exists on the subject, including a comprehensive review prepared by the National Institute for Occupational Safety and Health (NIOSH).⁽⁸⁾ Briefly, formaldehyde can act both as a primary irritant of the upper and lower respiratory tract, eyes, and skin and also as a sensitizing agent capable of inducing an allergic response. Attempts to define a consistent dose response relationship have been impeded by failure to systematically distinguish irritant from allergic effects. Recently, investigators at the Center for Disease Control (CDC) have proposed a simplified summary of the reported irritant dose-response relationships for formaldehyde in adult, occupationally exposed populations as shown in Table I.⁽⁹⁾

This dose response relationship does not apply to the allergic effects of formaldehyde. Formaldehyde is a powerful sensitizer, and, in allergic persons, even minute doses can trigger contact dermatitis.^(8,9) Furthermore, Table I was derived from occupational, 8 hour/day exposures. No data exist from which to extrapolate the effects of prolonged exposure in potentially hypersusceptible sub-groups, such as infants or the elderly, who would be exposed in domestic settings.

The long term effects of chronic formaldehyde exposure have been addressed in few occupational studies. Schoenberg *et al* reported evidence of chronic airway obstruction, manifested by decreased ratios of the forced expiratory volume in one second (FEV_{1.0}) to forced vital capacity (FVC) and of the maximum expiratory flow at 50% of vital capacity (MEF 50%) to FVC, in workers with exposure of five years or more.⁽¹⁵⁾ The prevalence of formaldehyde allergy, as evidenced by skin patch testing, increases with duration of exposure.⁽¹⁶⁾

Investigators at both NIOSH⁽⁸⁾ and CDC⁽⁹⁾ have reviewed the literature for evidence that formaldehyde might act as a mutagen, teratogen, or carcinogen. Formaldehyde has been shown *in vitro* to be capable of reacting with nucleic acids (DNA) to induce formation of DNA-protein cross links.⁽¹⁷⁾ Chromosome abnormalities and an increased mutation rate have been observed in fruitflies (*Drosophila*) exposed to formaldehyde.⁽¹⁷⁾ Russian data indicate that exposure of pregnant rats to formaldehyde produces a decreased number of fetuses per litter⁽¹⁸⁾ and brings about histological and histochemical changes in fetal liver.⁽¹⁹⁾ Recent laboratory evidence has been presented that inhalation exposure to 15 ppm of formaldehyde for 12 months caused an increase of squamous cell carcinomas of the naso-maxillary epithelium of rats.⁽²⁰⁾

Circumstances Under Which the Present Study was Initiated

Development of the present study began in October 1978 in response to the expanding number of case reports of problems attributed to UF foam. Information was needed to develop a rational regulatory policy governing the continued application of UF foam into homes. All reports available at that time were anecdotal complaints from consumers expressing dissatisfaction with the product. However, no data were available from which to determine the incidence of problems associated with UF foam.

Project Goals

The present study was designed as the first step in answering three of the following questions.

- (1) Is there an excess of illness in UF foam insulated households referable to either the irritant or allergenic properties of formaldehyde? If so, what is the extent of the public health problem, how prevalent is formaldehyde related morbidity, and how serious are the problems?
- (2) What is the extent of the non-health problems related to UF insulation, such as structural damage to houses and the nuisance impact of persistent odor on families?
- (3) Are there risk factors which predispose certain households to develop insulation-related problems?
- (4) What is an acceptable level of formaldehyde in domestic settings?
- (5) What regulation of the UF foam industry would reduce or eliminate problems associated with the insulation?

The study was designed to provide a first attempt at answering the first three questions. Data in this report are related only to the first two questions; results related to the third will be presented upon further analysis of the data.

Methodology

This study was a case-control study comparing symptom occurrence in individuals whose homes had been insulated with UF foam and in control individuals in neighborhood homes. A standard questionnaire was conducted by telephone interviews.

Subjects: The study population was selected from lists provided by four major UF foam manufacturers, who identified homes in New Jersey which had been insulated with their product. Actual installation was done by independent installer-contractors, using the material supplied by these manufacturers. The State Department of Energy has estimated that these four manufacturers account for 75% of the New Jersey market.⁽³⁾ The lists were provided voluntarily, but their completeness could not be verified. The lists contained 1,677 households, insulated between August 1977 and February 1979, by 16 different contractor-installers, in all 21 New Jersey counties.

The criteria for inclusion in the study group were as follows. Only private homes insulated within the year preceeding the study (February 1978 to January 1979) whose occupants had lived there for at least one year were accepted. Verification that the house had indeed been insulated with UF foam was required. The household had to be accessible to evening (4-10 p.m.) or weekend telephone interviews. Only an adult (at least 18 years of age) qualified as the family spokesperson.

Sample size was determined based on an assumed incidence of formaldehyde-related symptoms in the UF foam insulated population of approximately 1%. A sample of 331 households was calculated to provide 99% accurate incidence data with 90% confidence.⁽²¹⁾ Thus a sample of 400 UF foam insulated households and an equal number of controls were sought to allow some margin over the calculated minimum sample size.

An attempt was made to reach most of the 1,677 insulated households. Only 395 were included in the study. The reasons for exclusion of the rest is given in Table 2 in the order in which the attrition occurred.

Controls: Selection of a control or comparison population was conducted systematically using a geographic phone book. For each completed eligible interview with an exposed household,* the county reverse telephone directory was consulted to find residents on the same street. Four potential control respondents were selected by the following protocol. Wherever possible, families five and six numeric addresses above and below the foam household were selected. On short streets households one or two above or below the UF foam family were substituted. Business addresses were excluded from the control population; adjacent residences were substituted. On streets with inadequate numbers of houses to choose from, cross streets were located in the directory. Every other phone number was selected to a total of four. For 71 (17.8%) treated households no reverse directories were available. When this occurred, phone directories were used. Four names were chosen randomly within the same city or town as the foam respondent.

*Four hundred insulated homes initially comprised the subject population; later five were excluded because of incomplete questionnaires or failure to meet the study requirements. However, since matched case-control analysis was not used, the corresponding control households were not excluded for the control group.

The above protocol yielded 1,616 potential control households. For 400 eligible foam families, one of the four corresponding control houses was selected. Eligibility to become a control required that 1) the house had not been insulated with UF foam; 2) the family had been in residence in the same private house for at least one year; 3) an adult (at least 18 years of age) respondent was available as spokesperson. Of the 1,616 potential control families 1,083 were contacted to obtain 400 completed, acceptable reviews. The reasons for attrition are presented in the order in which they occurred in Table 3.

Interview Methodology

Telephone interviews were conducted from February 20 to March 5, 1979, by Eagleton Institute, a new Jersey polling agency affiliated with Rutgers University. The actual interviewing was conducted in the evening and on weekends by students under the supervision of faculty of the Department of Political Science. The interview was conducted according to a standard format which covered eight general topics (copies of both the case and control interview forms are attached).

Questionnaire Content Included:

- (1) Demographic data on respondent and all household occupants: age, sex, duration of residence in home.
- (2) Data on home construction materials.
- (3) Data on UF foam insulation: month of installation, extent of insulation, name of contractor, brand name of material, temperature, humidity, and other conditions present at time of insulation.

- (4) Formaldehyde odor data: date of onset, intensity, changes in intensity over time, aggravating factors.
- (5) Questions regarding structural damage to the home resulting from insulation: type and extent of damage, inhabitability of any part of the house.
- (6) Data on health symptoms: these included questions about the period prevalence of five "major" symptoms (asthmatic attacks, wheezing or difficulty breathing, chest pains, stinging or burning skin, burning or tearing eyes). Subjects were also questioned about the period prevalence of "worsening" (i.e. increased frequency or severity) of eight more non-specific symptoms (sore throat, running noses, coughs, rashes, headaches, insomnia, dizziness, and vomiting occurring during the preceding 12 months). The latter symptoms are potentially formaldehyde-related, but also accompany many other illnesses.
- (7) Data qualifying each health symptom: questions about the month of onset of new symptoms allowed conversion of prevalence data to incidence data; other questions related to hot weather and humidity as potentially exacerbating factors; still others indicated the relative severity of the symptoms: physician visits, purchase of prescription or non-prescription medications, hospitalizations, work or school days missed.
- (8) Other medical data: smoking history, past history of rashes, allergies or asthma, and wearing of contact lenses.

Because of the length and complexity of the questionnaire, standardized organ system reviews, such as the Medical Research Council Respiratory Disease questionnaire, could not be used. Health questions for the UF foam exposed

population were designed to temporally relate or separate the onset or exacerbation of the health problem with the months following installation of the foam. However, direct mention of the UF foam was carefully omitted from all health questions.

Statistical methods: With three exceptions, calculations of statistical significance in the analyses of this report use the chi-square analysis. The text explicitly states where other tests are employed. In Table 10, the Fisher's exact test is used twice because of small numbers. In Table 13, the one-tailed Poisson distribution is used to calculate the statistical significance of the observed vs. the expected for rarely occurring events.

Results

The selection processes as described above yielded study and control populations of the desired size. The demographic characteristics of these two populations are given in Table 4. The foam and control samples are nearly identical with respect to age, sex, and family size. Similarly, there were no important age or sex differences between the respondents (individuals who answered the questions) of the treated and those in the untreated population (Table 5). One observable, although minor, difference between the sample groups was that the foam families had lived in their present residences for a shorter period of time than had controls (Table 6). The two populations were very similar with respect to their smoking habits (Table 7).

The next two categories pertain only to the UF foam insulated population, namely odor problems following insulation and structural mishaps occurring in the home during or after installation of the foam.

Odor

The respondents of 124 of 391 households answering the odor question described an odor occurring after insulation. Forty-two of these 124 respondents characterized the odor as irritating. Thirty-three foam households reported that the duration of the odor was one week or longer. Figure 1 illustrates the percentage of households classified according to discrete categories of odor duration. Only the 391 households which answered the odor question are used in the denominator.

The duration of odor was clearly associated with its being characterized as irritating or bothersome (Table 8). The most severe odor problem was reported by one household* whose respondent stated that part of the house was rendered unusable due to persistent, irritating odor.

Structural Damage or Complaints of Inadequate Insulation

Of 395 foam families, 25 (6.3%) reported structural damage to their houses or inadequate thermal insulation following UF foam installation. Eleven (2.8%) described problems related to workmanship, i.e. damage to shingles, holes being drilled too far through the interior walls, foam extruding into unwanted places, or

*A second household reporting that part of the home had been rendered unusable was excluded from analysis because of failure to meet the study requirements. It was one of the five homes rejected from the initial study group of 400.

pressure effects such as buckling of a wall, or a door jamming. Six (1.5%) described damage due to excessive moisture, i.e., exterior paint peeling off a house, or wallpaper damage. Eight (2.0%) complained of inadequate insulation, shrinking of the foam, unfilled wall spaces, or of pipes within the walls continuing to freeze. No comparison data were obtained on houses insulated with products other than UF foam. Thus, it was impossible to determine how this rate of structural damage or apparently incomplete insulation compares with that associated with other types of insulation.

Health

Data from the health questionnaires comparing cases and controls were analyzed in three ways: first as prevalence data including all symptoms regardless of when they began, second as incidence data accepting only symptoms which began within the study year, and third breaking the incidence data into two categories, those symptoms which began after UF foam installation, and those which preceded it.

Prevalence Data

Table 9 presents the period prevalence data reported by the foam and control populations. Included are the frequency distribution of specific health complaints, the total number of symptoms, symptomatic individuals, and households with one or more symptomatic person.

Of note is that the foam households reported more morbidity than did the controls for only three symptoms, "asthma," "wheezing or difficulty breathing", and

"burning skin". For only wheezing was the difference statistically significant ($p=0.017$). The ten symptom categories for which the controls reported more illness than the foam population were in general the more common non-specific symptoms. One of these symptoms, headache, was more common in the controls than in the foam exposed individuals at the $p=0.039$ level.

The major limitation of the above prevalence data is that it includes not only symptoms beginning within the period of interest, but all symptoms regardless of time of onset. Incidence data can be derived by selecting only those symptoms that began within the study year.

Incidence Data

Table 10 follows the format of Table 9 but presents the frequency of "new" symptoms beginning within the twelve months of the study period.

Of note is the relative preponderance in symptom reporting for "new symptoms" among the foam population as compared to controls. A statistically significant excess of both "wheezing or difficulty breathing" and "skin burning" is now evident. In addition, a smaller trend for other symptoms such as "burning eyes" and "asthma", is seen. Overall, the frequencies of symptomatic individuals and households with at least one person reporting a symptom are equivalent between the foam-exposed population and controls.

These incidence data do not separate symptoms occurring in foam households after insulation from that occurring before insulation was installed. It is possible to separate the foam population into pre- and post-insulation groups, and use

household months of exposure as the denominator. Not only does this separate out the months when insulated households are truly exposed to the foam, but it also allows the pre-insulation household months to serve as an internal control group.

Incidence Data in the Control, Pre-Insulation, and Post-Insulation Foam Groups

Table 11 again presents incidence data for new symptoms, this time related to total household months of exposure (n). Only 394 foam households who knew the date of insulation are included.

Evident in Table 11 is a difference in the rate of new symptom acquisition post-installation of the foam, from pre-insulation. The post-insulation rate is clearly higher than the rate in the controls. Somewhat unexpectedly, the pre-insulation rate is lower than the control rate.

There is a possible bias in the new symptom acquisition rate between pre- and post-insulation time periods as presented in Table II. The bias arises because the difference is based on crude rates of symptom acquisition, averaged over the twelve-month period of exposure. However, crude rates, to be appropriate, require that all twelve months are equivalent with respect to symptom occurrence and symptom reporting. It would be highly unlikely that the months are equivalent, for two reasons. First, seasonality has a strong influence on the occurrence of common, non-specific symptoms such as were elicited by the health questionnaire. Second, symptom reporting is greatly influenced by recentness.⁽²²⁾ Recall and reporting of all health symptoms should be better for recent months. Since the post-foam household months were more recent than those from the pre-foam period, it is entirely possible that the post-foam population might have reported a

greater frequency of new symptoms developing after insulation on the basis of memory alone.

Figure 2 demonstrates that the reporting of new symptoms in the control population was by no means uniform throughout all months. It illustrates both a peak of new symptoms attributed to February, 1978, and a general trend of increased reporting in the 4 months prior to administration of the health questionnaire. The peak of reported symptoms in February, 1978 probably represents symptoms reported as occurring "a year ago" to the questionnaire administered on February, 1979.

Because of this limitation of the crude rates, an adjustment was applied to standardize for the individual months of exposure, using a variant of indirect standardization. The month-specific rate of new symptom acquisition in the controls was determined, using the number of control individuals developing new symptoms each month as the numerator, and the number of control persons (which remained constant each month) as the denominator. This rate was then applied to the number of people in the pre- and post-insulation categories in each individual month, allowing calculation of an expected number of people who would acquire new symptoms in each category for each individual month. The number of individuals insulated in any given month was assumed to be the total of those whose homes were insulated during previous months, plus half of those whose homes were insulated during the month in question. Table 12 shows the expected and observed number of people developing symptoms for each month. Table 13 shows the aggregate comparison between the expected and observed distribution of symptoms, pre- and post-insulation, developed from the data in Table 12.

The results illustrate several important points. First the increase in the rate of new symptom acquisition from the pre- to post-foam time period is much less profound when it is derived from month-specific data, than is indicated by the crude rates. However, the same trend continues. Members of the post-foam population become symptomatic at a rate slightly higher than that of controls, and the pre-foam population at a slightly lower rate. It should be noted that the events described are rare. Individuals develop new symptoms infrequently in either population, and the differences between observed and expected are small. The one-tailed Poisson distribution,⁽²³⁾ chosen specifically because of its appropriateness for rare events, was fitted to the observed and expected distributions. By this analysis, the occurrence of symptoms in pre-foam individuals was not significantly less than that in controls ($p .05$), but the occurrence in post-foam individuals was significantly greater. ($p .025$).

Finally, the rates of occurrence of the two specific symptoms, "wheezing and difficulty breathing", and "burning skin", were analyzed for the pre- and post-foam periods. Table 14 represents the data for "wheezing or difficulty breathing", and Table 15 for "burning skin." The analysis was conducted with the assumption that each new symptom constituted one ill person-month. No statistically significant association was seen between either symptom and the post-foam period.

Health and Odor

The preceding analyses have treated the post-foam group as a single entity. However, one can hypothesize that one or more subgroups may exist within the foam-exposed population which are at special risk. Households experiencing odor following insulation were selected as a subpopulation potentially at greater risk of

formaldehyde exposure. The next section of this report will evaluate health symptoms as they relate to odor.

Table 16 depicts the relationship between a household experiencing any odor following insulation and reporting one or more new health symptoms post-insulation. The denominator includes only the 391 households which answered the odor question.

A strong association exists between a household reporting any odor and one or more occupants of the household describing a new symptom beginning post-installation of the foam. The next step was to investigate whether a dose response effect existed between the duration of the odor and the reporting of new health symptoms. For this, three different odor categories were defined, based on the duration of the odor.

Table 17 presents the data for these three odor categories. Excluded from the analyses are 14 households with odor of unknown or intermittent duration, as well as 4 households which did not answer the odor question. A trend towards increasing symptom occurrence with duration of odor is evident. Households with persistent odor are consistently the group with the highest rate of symptom reporting. Though this group comprises only 8.8% of the evaluated households, and 8.0% of the foam individuals, it contributes 28.3% of the newly symptomatic persons whose symptoms began after insulation. The statistical significance of the dose-response relationship is calculated for the data on persons developing new symptoms post-insulation in Table 18. A highly significant association exists between persons reporting new symptoms post-insulation and persistence of odor in the household ($X^2 = 57.9, p < .001$).

Similarly, if the indirect standardization technique is applied to the subgroup of individuals living in homes with persistent odor, the markedly increased rate of new symptom acquisition persists. Table 19 shows that in the persistent odor category, the observed rate of individuals reporting new symptoms post-insulation is 24 in 626 person months or .038 per person month. This is a greater than three-fold increase over the expected rate of individuals becoming newly symptomatic of 6.85 persons in 626 person months or .012 ($X^2 = 8.67, p = 0.003^*$).

A question can be raised about the persistent odor category, based on careful scrutiny of the data in Table 17. Some simple calculations reveal that a dose response relationship exists for the three odor categories, even for those symptoms beginning pre-insulation. The number of symptoms beginning pre-foam can be derived by subtracting the number of symptoms beginning post-foam from those beginning within the last year. The exact meaning of this phenomenon is unclear, but will be discussed later.

Finally, the rates of physician visits, medications taken, and hospitalization were analyzed for the overall foam and control populations, and for the three different odor categories. These rates of seeking medical attention are useful as rough indicators of the severity of the health symptoms. Table 20 presents the data both as the number of symptoms for which each type of medical attention was sought, and as the rate per person month of exposure for each category. Again omitted are data from those households with intermittent odor or odor of unknown duration.

*To calculate the X^2 , each newly symptomatic person was assumed to represent one ill person month.

Two points of interest can be derived from Table 20. First, the overall rates of seeking medical attention reported by the foam and control populations are approximately equal. The pattern of foam households reporting slightly lower rates than controls for pre-insulation months and slightly higher rates for post-insulation months is evident, as it was for symptom reporting. Again the trend can be attributed in part to the effect of recentness. Overall, however the rates of seeking medical attention in the foam and control population are equivalent. The second point of interest is that the persistent odor subgroup consistently reports an excess of medical attention. For symptoms acquired post-insulation, the persistent odor group sought physician attention over three times as often, and took medications four times as frequently as the overall control rate. In contrast, the no odor category reported post-insulation rates almost identical to the overall control rate. Thus the occurrence of more serious symptoms, or at least symptoms for which medical attention was sought, also followed a dose response relationship between odor categories. This relationship was again true for both symptoms that began before insulation, and for those which began afterwards. However, only for those symptoms which began post-insulation was the rate of seeking medical attention among the persistent odor subgroup clearly different from that of controls.

Discussion

It is important to recognize several basic limitations and potential biases in this study.

- (1) No means existed to verify the completeness of the four manufacturers' lists which were the source of the UF foam insulated cohort. Deletion of even a few problem homes could substantially alter the results.

- (2) The manufacturers' lists were provided by only four manufacturers. Though improbable, it is possible that other manufacturers, not represented on these lists, account for a disproportionately large fraction of problem insulations.
- (3) Contact with the foam exposed families was based entirely on the telephone numbers from the manufacturers' lists. Had any families vacated their home due to insulation induced problems, they would have been unavailable for contact. Thus, it is conceivable, though unlikely, that the most severely affected families were lost to the study.
- (4) Telephone interviews assessing period prevalence, particularly for non-specific health symptoms, are intrinsically imprecise. The resources available to this study did not permit verification of health data, either by review of hospital or physician records or by objective health tests, such as pulmonary function monitoring.
- (5) In order to accrue an adequate number of foam households in the study population, it was necessary to extend the study period from an intended six months to one year. Thus, the controls and some foam families were asked to recall subjective, often minor, experiences over a one-year period. This time interval increased the potential for memory error.
- (6) Three potential sources of subject bias should be recognized. First, publicity about the adverse health effects of UF foam might promote overreporting of symptoms in the foam population. Secondly, a bias

detected by the interviewers was a tendency to minimize or deny health symptoms among some foam respondents. More specifically, the pattern which was observed by supervisors monitoring the interviews was that some foam respondents, particularly those who did not perceive the insulation as causing a problem, were vocal in its defense and tended to underreport minor symptoms which they felt were unrelated. No systematic measurements or records of this bias were obtained. A third source of subject bias was introduced whenever a respondent questioned the interviewer about the purpose of the study. A standard, prepared explanation was given in all cases. This explained that the study was evaluating the relationship between health and insulation. The question under study was whether insulation had a good or a bad effect on people's health.

Given the above limitations, some important information can be abstracted from the study data. The main focus of the study was to define the frequency and severity of acute problems, both health and other, resulting from insulation with UF foam. It is helpful at the outset to state that, of the 395 foam insulated households, 197 (49.9%) reported no problems at all. Another 57 (14.4%) reported one or more health symptoms which they said antedated the foam, and had not been exacerbated by the product. Thus, 64.3% of the insulated households denied any problems which they associated with the insulation.

Of the remaining 35.7% of foam households, the reported complications varied in both severity, and in the certainty with which they could be attributed to the insulation. The complaints which could be most clearly tied to UF foam were not necessarily the most important. In the interest of clarity, the authors will

discuss the problems reported by the UF foam exposed families in order of the certainty with which the problems could be attributed to the insulation, and will thus discuss health last.

Structural problems which are specifically related to UF foam installation are damage to paint or wallpaper due to excessive moisture release, or wall displacement due to pressure from within the wall cavities. Six (1.5%) of the foam households reported moisture damage during and immediately following insulation. Two (0.5%) reported damage due to pressure. An additional nine (2.3%) reported minor structural damage occurring during installation of the foam. However, the latter category potentially would exist whatever the insulation material being installed, as they were not specific to the type of insulation.

Of the 123 (31.1%) foam households reporting odor, a gradient also existed in the duration of the odor, and in its offensiveness to household occupants. At one end of the spectrum, the brief release of formaldehyde which necessarily occurs during installation of UF foam was not even reported by the 267 (67.6%) of families who described "no odor." Intermediate were the 77 (19.5%) of households who described odor of brief duration (less than 7 days). Finally, excluding the 18 houses for whom the duration of odor was unreported or uncertain, 33 (8.8%) of foam households experienced persistent odor (equal to or greater than 7 days). Most severely affected was the single household (0.25%) which reported that part of the home was made unusable or unlivable by the odor. For this home, removal of the insulation was necessary to resolve the problem. As mentioned previously, families having to abandon their homes because of the odor may have been lost to the study. Thus, the frequency of this most serious complication could not be evaluated, but was probably below the detectable limit of the study.

The major focus of this study, however, was not the structural or odor problems resulting from UF insulation, but the issue of acute health effects. The 13 medical symptoms monitored, although chosen because of a known relationship with formaldehyde exposure, are not specific to that agent. Thus, any inferences suggesting cause could only come from an excess of those symptoms in the formaldehyde group as a whole, or in some portion of that group whose exposure to formaldehyde was demonstrably higher. The extensive presentation of the health data provided earlier in this report can be summarized in five points.

1. If an increase in acute morbidity in the UF foam-exposed population exists, it is sufficiently limited in magnitude and scope so that it is inapparent in the aggregate data. In fact, the prevalence data show a greater overall frequency of health complaints in the controls than in the foam-exposed population. Only for the symptom "wheezing or difficulty breathing" do the foam households report a statistically significant excess ($p = 0.017$) in prevalence.
2. The suggestion of a problem only begins to appear when one considers incidence data, confining the analysis to problems which began during the last year. Again, though there is no overall excess of morbidity in the foam population, there are two symptoms which the foam individuals reported significantly more frequently than did the controls, "burning skin" ($p = 0.043$) and "wheezing or difficulty breathing" ($p = 0.01$).
3. When the incidence data are refined still further by looking only at the foam group, and determining pre- and post-foam rates of new symptom acquisition per household month of exposure, a marked increase in the rates during

post-foam months is observed. It would appear that subsequent to insulation, the foam households report new symptoms at 2.7 times the pre-foam rate. However, the validity of such an analysis is weakened by the confounding effects of recentness and seasonality. When an attempt is made to standardize for these variables, the effect of foam alone on the overall subject population is small. Similarly, if one examines more closely the two symptoms "burning skin" and "wheezing or difficulty breathing," searching for an association with exposure to the insulation, neither is associated at a statistically significant level with post-foam months.

4. The clearest evidence of a health effect in the subject population exists in the subgroup of households which reported persistent odor. The subgroup analysis is intended to test the hypothesis that certain households may be at greater risk of exposure to formaldehyde than others, on the premise that odor is a sensitive although not always reliable indicator of the presence of formaldehyde gas. The authors are fully cognizant of the limitations of odor as an index of formaldehyde exposure: variability of perception and recognition between individuals, acclimation with prolonged exposure, susceptibility to subject bias, and the occurrence of some pharmacologic effects at levels below the odor threshold. However, in the absence of objective air monitoring (the retrospective study design precluded timely environmental monitoring), odor perception seemed an acceptable alternative.

Several patterns evident in the data show a strong association between exposure to persistent odor and reporting increased health symptoms. Overall, the persistent odor subgroup reported new symptoms beginning during the twelve-month study period at a rate 3.4 times that of controls (based on

person months of exposure). For the post-insulation months, the group with persistent odor reported symptoms at a rate 5.1 times that of controls. A clearcut dose response is evident between odor categories, both for symptom reporting ($X^2 = 57.9$, $p < .001$) and for physician visits and medications taken. The experience of the subgroup of households with odor lasting greater than or equal to 7 days was clearly different from that of both controls and other foam households which did not report persistent odor.

5. There is ambiguity though in how to interpret the data relating to the persistent odor subgroup. Uncertainty is raised because the persistent odor group reported an increased rate of symptom acquisition, physician visits, and medications taken, for those symptoms acquired prior to insulation as well as for those acquired later. The pre-foam rates for this group were higher for all three variables than other foam households, and slightly, although not significantly, higher than the overall control rates. Thus, the increase in symptoms and medical care in the persistent odor subgroup post-insulation must be fitted with the realization that this was an atypical group from the beginning.

At least three explanations are possible. It may be that the persistent odor subgroup represents a population with poor background health who experienced a real increase in morbidity due to increased formaldehyde exposure post-insulation. On the other hand these families may represent a subgroup of chronic overreporters, both for odor and for health symptoms. Finally, it may be that the families represent a subgroup of hypersusceptibles to formaldehyde who worsened following UF insulation of their homes. The methodology of this study does not permit resolution of this question.

Conclusions

The risk of acute, short-term problems resulting from UF foam insulations was studied. The most severe problem detected by this study was reported by one family which found part of the house unusable or unlivable until the foam was removed, an incidence of 0.25%. Structural problems specifically related to moisture release occurred in six (1.5%) houses, and damage due to pressure in two (0.5%). Odor of unusual duration, defined as ≥ 7 days in duration, occurred in 33 (8.4%) insulated homes. The evidence for acute health effects experienced by the UF foam-exposed population was suggestive rather than conclusive. No excess of increased morbidity overall was reported by the subject group, although for two specific symptoms "skin burning" and "wheezing or difficulty breathing," a statistically significant excess was reported. The strongest evidence of a health problem existed in the subgroup of insulated households reporting persistent odor. Residents of homes experiencing persistent odor reported an increased rate of symptom acquisition, physician visits, and medication usage, and may represent a subpopulation at special risk.

Table 1

Irritant Dose-Response Relationship for Airborne Formaldehyde Exposure
in Adult, Occupationally Exposed Populations (9)

<u>Sign or Symptom</u>	<u>Concentration</u>
Odor detection	0.05 ppm (10)
Eye irritation	0.01-0.05 ppm (11)
Upper respiratory irritation (eyes, nose, and pharynx)	0.3-3.0 ppm (12-14)
More severe upper respiratory irritation	4.0-5.0 ppm (14)
Severe respiratory irritation and difficulty in breathing	10.0 ppm (14)
Inflammatory changes in bronchi and lungs	10.0 ppm (x5-10 min.) (14)

Table 2

Reasons for Exclusion or Nonuse of Households on the
Three Manufacturers' Lists : New Jersey, 1979, UF Foam Study

Telephone unlisted	219
Telephone number illegible	16
Out-of-State location	106
Nonworking number	59
Business telephone	45
Telephone busy on six repeat calls (three separate days)	70
No answer on six repeat telephone calls	174
Refused interview	118
Ineligible respondents	170
No eligible respondent initially; sample size met before recontacted	75
Foam installed prior to one year earlier	22
Denial or uncertainty about UF foam	5
Used on pretest and excluded	15
Incomplete interview	52
Interview completed after the sample size obtained, not keypunched	11
Sample filled before family was contacted	<u>125</u>
Total	1,282
+Households Used	<u>395</u>
Total Households on Lists	1,677

Table 3

Reasons for Exclusion or Nonuse of Potential Control
Households : New Jersey, 1979, UF Foam Study

Nonfunctioning telephone number	58
No answer to six repeated telephone calls (three separate days)	159
Busy signal to six repeated telephone calls (three separate days)	59
Business telephone	12
Apartment - not house	1
Refusal to participate	180
No eligible respondent	81
Incomplete interview	36
Sample complete before call-back	86
Interview completed after the sample size obtained, not keypunched	11
	<hr/>
Total Ineligible or Not Used	683
Used	<u>400*</u>
Total	1,083

* 400 control homes were used, instead of 395, because initially the UF foam insulated sample included 400 homes. Five homes were subsequently excluded from the foam sample because of incomplete questionnaires or failure to meet the study requirements. However, because matched pair analysis was not used, the five corresponding control families were not also excluded.

Table 4

Demographic Characteristics of Foam and Control Populations :
New Jersey, 1979, UF Foam Study

	<u>Foam</u>	<u>Controls</u>
Number of Households	395	400
Number of Individuals	1,396	1,395
Mean Household Size	3.53	3.49
Mean Age in Years	32.0 (S.D.=20.19)	33.2 (S.D.=21.00)
Age Range in Years	<1-91	<1-94
Male:Female Ratio	1.013	1.006

Table 5

Age and Sex Characteristics of Respondents Answering
Questionnaire : New Jersey, 1979, UF Foam Study

	<u>Foam</u>	<u>Control</u>
Mean Age in Years	45.3 (S.D.=14.1)	47.0 (S.D.=14.7)
Male:Female Ratio	.340	.347

Table 6

Foam and Control Families by Duration of Residence :
New Jersey, 1979, UF Foam Study

	<u>Duration of Residence</u>			Total
	<u><10 years</u>	<u>≥10 years</u>	<u>Don't Know</u>	
Foam	205	187	3	395
Control	166	233	1	400
Total	371	420	4	795

$$\chi^2 = 8.6523$$

$$p < .005$$

Figure 2

Number of New Symptoms Per Month Reported By Controls :
New Jersey, 1979, UF Foam Study

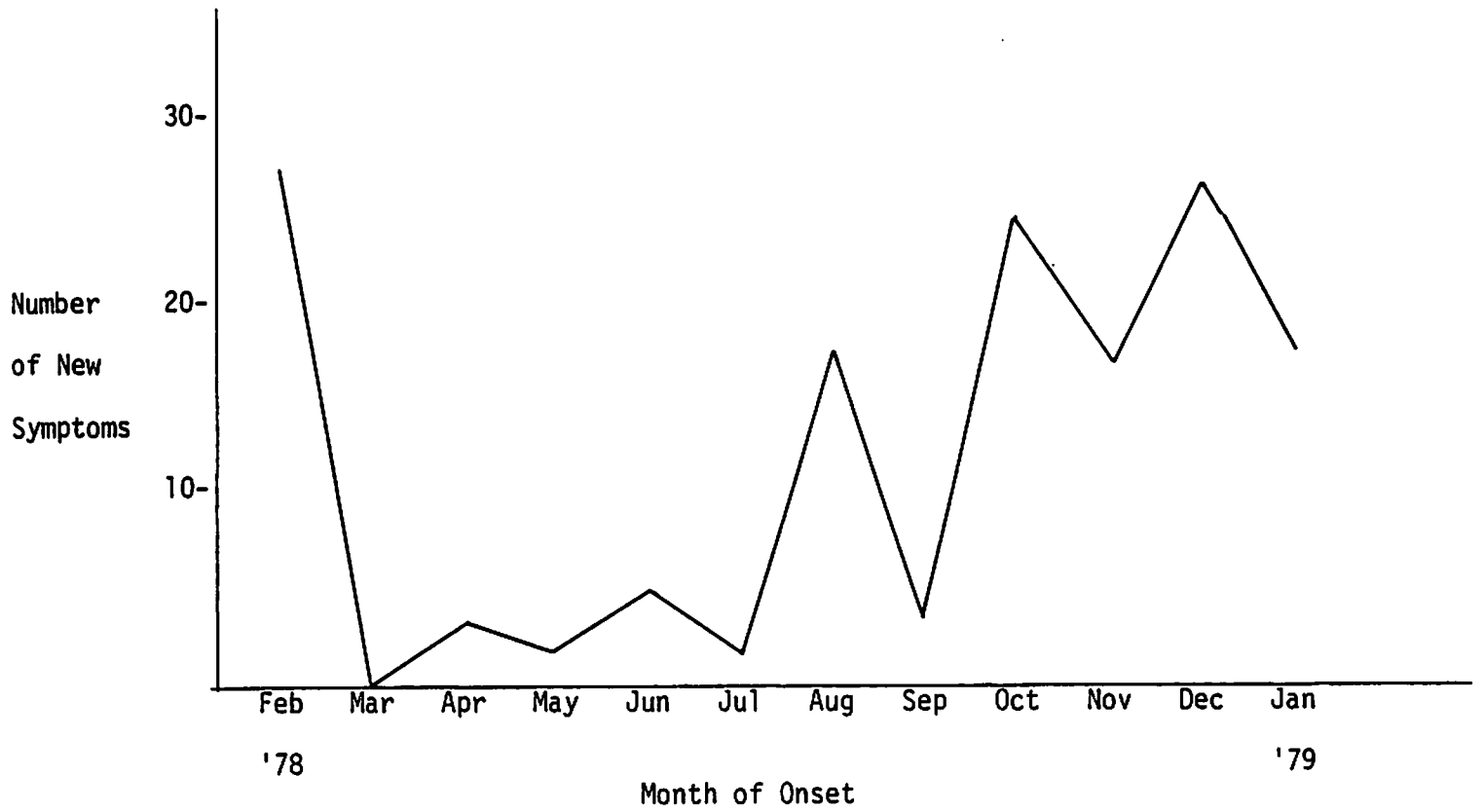


Table 7

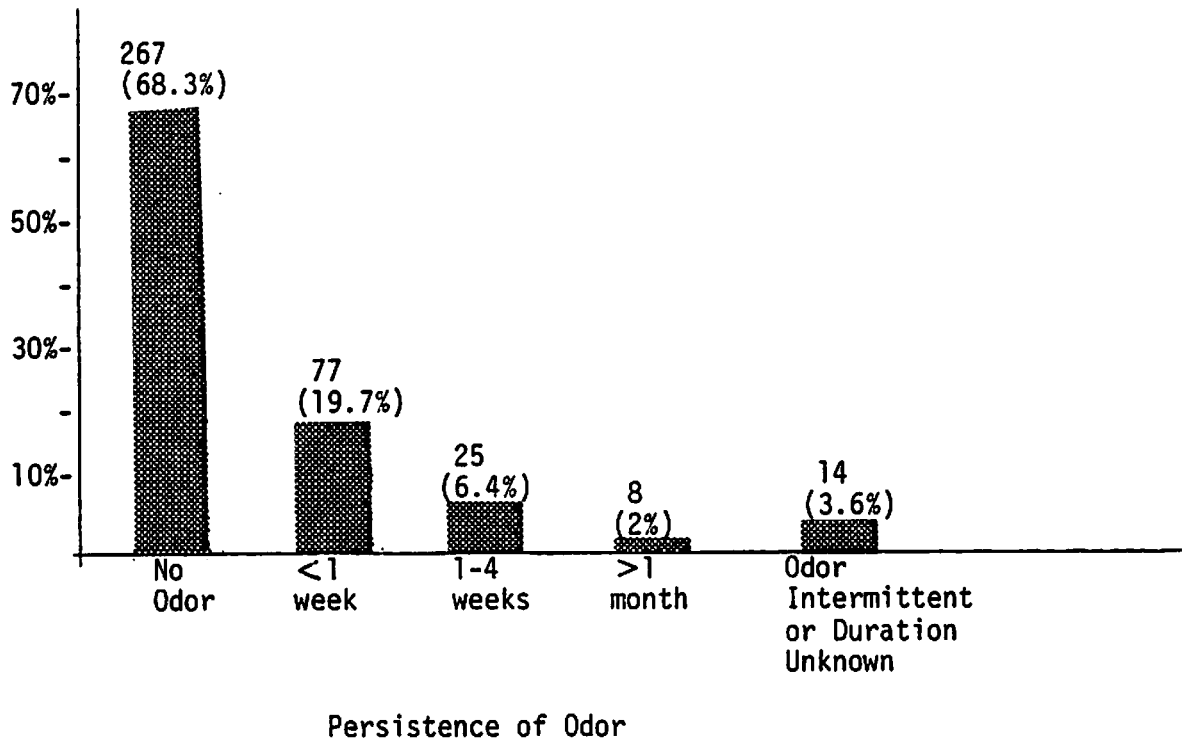
Smoking Histories of Foam and Control Populations :
New Jersey, 1979, UF Foam Study

	<u>Foam</u>		<u>Control</u>	
Cigarette				
Smoking Households	87		86	
Smoking Individuals	299		293	
<1 ppd*		129		136
1-2 ppd		158		146
>2 ppd		12		11
Never Smoked	1,055		1,064	
Don't Know	42		38	
Cigar				
Smoking Households	10		12	
Smoking Individuals	33		40	
<1 cigar		22		29
1-2		6		3
3-4		4		4
≥ 5		1		4
Never Smoked	1,331		1,334	
Don't Know	32		21	
Pipe				
Smoking Households	9		10	
Smoking Individuals	31		34	
<1 pipe		22		22
1-2		4		2
3-4		2		4
≥ 5		3		6
Never Smoked	1,329		1,337	
Don't Know	36		24	

*ppd signifies packs per day

Figure 1

Percentage of Households by Answer to Odor Duration
Question*: New Jersey, 1979, UF Foam Study



*Based on 391 households who answered the odor question.

Table 8

Duration of Odor vs. Whether Households Found It Irritating
or Bothersome : New Jersey, 1979, UF Foam Study

Odor Irritating or Bothersome	<7 Days	≥7 Days	Total
Yes	17	19	36
No	59	13	72
Don't Know	1	1	2
Total	77	33	110

$$\chi^2 = 12.26$$

$$p < .005$$

Table 9

Symptom Prevalence During the Period February 1978 Through January 1979
in the Foam and Control Populations : New Jersey, UF Foam Study

	<u>Foam (n=1,396)</u>		<u>Control (n=1,395)</u>		<u>χ²</u>	<u>p</u>
	<u>#*</u>	<u>%**</u>	<u>#*</u>	<u>%**</u>		
Asthma	16	1.1	12	.9	.32	n.s.
Wheezing or Difficulty Breathing	28	2.0	12	.9	5.70	0.017
Chest Pain	16	1.1	18	1.3	.03	n.s.
Burning Skin	11	.8	3	.2	3.51	n.s.
Burning Eyes	29	2.1	36	2.6	.57	n.s.
Sore Throat	38	2.7	56	4.0	3.2	n.s.
Running Nose	21	1.5	34	2.4	2.7	n.s.
Cough	38	2.7	42	3.0	.12	n.s.
Rash	18	1.3	29	2.1	2.17	n.s.
Headache	26	1.9	44	3.2	4.25	0.039
Insomnia	19	1.4	24	1.7	.38	n.s.
Dizziness	9	.6	17	1.2	1.91	n.s.
Vomiting	1	.1	3	.2		
<hr/>						
Total Symptoms	270		330		2.94	n.s.
Symptomatic Persons	205	14.7	239	17.1	2.94	n.s.
Symptomatic Households ⁺	131	33.2	140	35.0	.22	n.s.

* # signifies the number of reported symptoms. For individual symptoms, it also equals the number of symptomatic individuals. However, since any individual could experience more than one symptom, the total number of symptomatic persons is less than the total number of symptoms.

**% signifies the percentage of individuals experiencing any one symptom. Also, the percentage of symptomatic individuals and of symptomatic households is given.

+ % of symptomatic households based on 395 foam households and 400 controls.

Table 10

Incidence of New Symptoms Beginning in the Period
February 1978 Through January 1979 : New Jersey, UF Foam Study

	<u>Foam (n=1,396)</u>		<u>Control (n=1,395)</u>		<u>χ²</u>	<u>p</u>
	<u>#*</u>	<u>%**</u>	<u>#*</u>	<u>%**</u>		
Asthma	5	0.4	2	0.1		.16***
Wheezing or Difficulty Breathing	8	0.6	1	0.1		.01***
Chest Pain	11	0.8	10	0.7	.0000027	n.s.
Burning Skin	10	0.7	2	0.1	4.1	0.043
Burning Eyes	18	1.3	12	0.9	0.84	n.s.
Sore Throat	32	2.3	30	2.2	0.02	n.s.
Runny Nose	15	1.1	26	1.9	2.48	n.s.
Cough	30	2.2	30	2.2	.002	n.s.
Rash	9	0.6	18	1.3	2.40	n.s.
Headache	16	1.2	16	1.2	.03	n.s.
Insomnia	11	0.8	11	0.8	.04	n.s.
Dizziness	5	0.4	9	0.7	.65	n.s.
Vomiting	1	0.1	2	0.1		
<hr/>						
Total Symptoms	171		169		.0033	n.s.
Symptomatic Persons	138	9.9	138	9.9	.0033	n.s.
Symptomatic Households ⁺	91	23.0	95	23.8	.023	n.s.

*# signifies the number of new symptoms beginning during the study period. For individual symptoms it also equals the number of newly symptomatic individuals. However, since any individual could experience more than one symptom, the total number of symptomatic persons is less than the total number of symptoms.

**% signifies the percentage of individuals experiencing any one symptom. Also the percentage of symptomatic individuals and of symptomatic households is given.

***Fisher's Exact Test used to calculate statistical significance, because of small numbers of expected cases.

⁺Symptomatic household % based on 395 foam households and 400 controls.

Table 11

Rates of New Symptom Acquisition per Household Month of Exposure (n)[†]
for the Control Group and the Foam Population Pre- and Post Insulation :
New Jersey, 1979, UF Foam Study

	<u>Control</u> n=4,800		<u>Foam</u> <u>Pre-Insulation</u> n=2,549		<u>Foam</u> <u>Post-Insulation</u> n=2,179	
	<u>#*</u>	<u>Rate**</u>	<u>#*</u>	<u>Rate**</u>	<u>#*</u>	<u>Rate**</u>
Asthma	2	0.42	3	1.18	2	0.92
Wheezing or Difficulty Breathing	1	0.21	3	1.18	5	2.29
Chest Pains	10	2.1	1	0.39	10	4.59
Burning Skin	2	0.42	4	1.57	6	2.75
Burning Eyes	12	2.5	6	2.35	12	5.51
Sore Throat	30	6.25	9	3.53	23	10.56
Runny Nose	26	5.42	8	3.14	7	3.21
Cough	30	6.25	3	1.18	27	12.39
Rash	18	3.75	5	1.96	4	1.84
Headache	16	3.33	8	3.14	8	3.67
Insomnia	11	2.29	2	0.78	9	4.13
Dizziness	9	1.88	0	0	5	2.29
Vomiting	2	0.42	0	0	1	0.46
Total	169	35.21	52	20.4	119	54.6
Symptomatic Persons	138	28.75	39	15.3	99	45.4
Symptomatic Households	95		21		70	

*# signifies the number of new symptoms beginning during the study period. For individual symptoms, it also equals the number of newly symptomatic individuals. At the bottom of the table, the total number of symptoms, symptomatic persons, and symptomatic households is given.

**Rate per 1,000 household months. At the bottom of the table, the overall rates and rate of persons becoming newly symptomatic are given.

[†]Household months of exposure (n) are based on 400 control households and 394 foam households who knew the date of insulation. For this table the entire month of installation of the foam was considered to be a post-foam month.

Table 12

Rates of Individuals Developing A New Symptom Between
February 1978 and January 1979 By Month of Onset, Observed vs. Expected

Month	Controls			Pre-Foam			Post-Foam		
	Newly Symptomatic Persons	Person Months	Rate*	Observed**	Person Months	Expected ⁺	Observed**	Person Months	Expected ⁺
'78 Feb.	27	1,395	.0194	19	1,348	26.2	2	48	.9
Mar.	0	1,395	0	1	1,254	0	1	142	0
Apr.	3	1,395	.0022	1	1,152	2.5	3	244	.5
May	2	1,395	.0014	1	1,071.5	1.5	0	324.5	.5
Jun	5	1,395	.0036	7	1,024	3.7	6	372	1.3
July	2	1,395	.0014	2	945	1.3	1	451	.6
Aug.	17	1,395	.0122	6	829.5	10.1	9	566.5	6.9
Sept.	3	1,395	.0022	7	683.5	1.5	6	712.5	1.6
Oct.	25	1,395	.0179	2	464.5	8.3	14	931.5	16.7
Nov.	16	1,395	.0115	1	230	2.6	9	1,166	13.4
Dec.	26	1,395	.0186	0	87	1.6	24	1,309	24.3
'79 Jan.	17	1,395	.0122	0	30.5	0.4	33	1,365.5	16.7
Overall	143	16,740	.0085	47	9,119.5	59.7	108	7,632.5	83.4

*Rate per person month of exposure at which control persons become newly symptomatic. It should be noted that the denominator of person months is actually smaller than noted here, since once a person develops a symptom, he becomes ineligible to develop the same symptom again. However, the net change produced by this is negligible.

**Observed number of newly symptomatic persons.

+Expected number of newly symptomatic persons, calculated from the control rate for that month multiplied times the population at risk.

Table 13

Summary of Observed vs. Expected Rates* of Individuals Developing
A New Symptom Between February 1978 and January 1979 in the
Pre-Foam and Post-Foam Period

	<u>Observed Rate</u>	<u>Expected Rate</u>	<u>p**</u>
Pre-Foam	.0052	.0065	>.05
Post-Foam	.0142	.0109	<.025

*Rates per person month of exposure. Observed rates are the total number of individuals developing a new symptom divided by the total person months of exposure. Expected rates are calculated from the sum of expected number of newly symptomatic persons each month, divided by the total number of person months.

**Probability calculated from the one-tailed poisson distribution (23), using the actual totals from Table 12. Each observed or expected newly symptomatic person was assumed to represent one ill person month. Thus, pre-foam there were 47 ill person months and 9,072.5 well person months observed versus 59.7 ill and 9,059.8 well person months expected. The same method was used to analyze the post-foam data.

Table 14

Onset of Wheezing or Difficulty Breathing Between
February 1978 and January 1979
Pre- vs. Post-Foam Person Months*

	<u>Wheezing or Difficulty Breathing</u>		
	<u>Ill</u>	<u>Well</u>	<u>Total</u>
Pre-foam	3	9,116.5	9,119.5
Post-foam	5	7,627	7,632
Total	8	16,743.5	16,751.5

p = .177**

*Each new symptom is assumed to represent one ill person month.

**Probability calculated using Fisher's Exact Test.

Table 15

Onset of Burning Skin Between
February 1978 and January 1979,
Pre- vs. Post-Foam Person Months*

	Burning Skin		
	Ill	Well	Total
Pre-foam	4	9,115.5	9,119.5
Post-foam	6	7,626	7,632
Total	10	16,741.5	16,751.5

p = .165**

*Each new symptom is assumed to represent one ill person month.

**Probability calculated using Fisher's Exact Test.

Table 16

Households Reporting One Or More New Symptoms
Post-Insulation vs. Presence of Odor

		<u>New Health Symptom in Household</u>		
		<u>Yes</u>	<u>No</u>	<u>Total</u>
<u>Odor</u>	<u>Yes</u>	32	92	124
	<u>No</u>	36	231	267
<u>Total</u>		68	323	391

$$\chi^2 = 8.11$$

$$p < .005$$

Table 17

Reporting of Health Symptoms vs. Odor Category - Foam Population :
New Jersey, 1979, UF Foam Study

	≥ 7 days Persistent Odor		< 7 days Brief Odor		No Odor		<u>Total*</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	
Denominators							
# Houses	33		77		267		377
# Individuals	107		283		945		1,335
Prevalence Data							
Symptomatic Households	21 (63.6%)		32 (41.6%)		68 (25.5%)		121
Symptomatic Persons	61 (57.0%)		63 (22.3%)		125 (13.2%)		249
New Symptoms Within Last Year							
Symptomatic Households	15 (45.5%)		20 (26.0%)		48 (18.0%)		83
Symptomatic Persons	34 (31.8%)		31 (11.0%)		59 (6.2%)		124
New Symptoms Following Foam							
Symptomatic Households	13 (39.4%)		16 (20.8%)		36 (13.5%)		65
Symptomatic Persons	26 (24.3%)		22 (7.8%)		44 (4.7%)		92

*Excluded are 14 households with odor of unknown or intermittent duration as well as 4 households which did not answer the odor question.

Table 18

Persistence of Odor vs. Persons Developing New Health Symptoms
Post-Insulation : New Jersey, 1979, UF Foam Study

		≥ 7 days Persistent Odor	< 7 days Brief Odor	No Odor	Total*
Persons Developing New Symptoms Post-foam	Yes	26	22	44	92
	No	81	261	901	1,243
Total		107	283	945	1,335

$$\chi^2 = 57.9$$

$$p < .001$$

*Excluded are data on the occupants of 14 households with odor of unknown duration and of 4 households which did not answer the odor question, in all 61 persons.

Table 19

Rates At Which Individuals in Post-Foam Persistent Odor Households
Develop New Symptoms Between February 1978 and January 1979,
Observed vs. Expected

	<u>Month</u>	<u>Control</u>	<u>Persistent Odor Post-Foam</u>		
		<u>Rate*</u>	<u>Person Months</u>	<u>Expected+</u>	<u>Observed++</u>
<u>'78</u>	Feb.	.0194	9	.17	0
	Mar.	0	20	0	0
	Apr.	.0022	20	.04	0
	May	.0014	20	.03	0
	Jun.	.0036	30	.11	3
	Jul.	.0014	40	.06	0
	Aug.	.0122	47	.57	2
	Sept.	.0022	57	.13	2
	Oct.	.0179	77	1.38	5
	Nov.	.0115	92	1.06	1
	Dec.	.0186	107	1.99	2
	<u>'79</u>	<u>Jan.</u>	<u>.0122</u>	<u>107</u>	<u>1.31</u>
	Overall	.0085	626	6.85	24

*Rate per person month of exposure at which control persons became newly symptomatic (derived in Table 12). It should be noted that the denominator of person months is actually smaller than noted here, since once a person develops a symptom, he becomes ineligible to develop the same symptom again. However, the net change produced by this is negligible.

+Expected number of newly symptomatic persons, calculated from the control rate for that month multiplied times the population at risk.

++ Observed number of newly symptomatic persons.

Table 20

Comparison of Rates of Physician Visits (M.D.), Medications Taken (Rx) and Hospitalizations (Hosp.) per Person Month (n)* for Foam and Control Populations :
New Jersey, 1979, UF Foam Study

	<u>M.D.</u>		<u>Rx</u>		<u>Hosp.</u>	
	<u>#**</u>	<u>Rate</u>	<u>#**</u>	<u>Rate</u>	<u>#**</u>	<u>Rate</u>
For All Symptoms Beginning Within Study Year						
All Foam (n=16,752)	85	(.005)	91	(.005)	7	(.0004)
All Control (n=16,740)	90	(.005)	105	(.006)	8	(.0005)
Foam : Symptoms Beginning Pre-insulation						
All Odor Groups (n=8,569.5)	22	(.003)	23	(.003)	2	(.0002)
Persistent Odor (n=713.5)	5	(.007)	5	(.007)	0	(0)
Brief Odor (n=1,747.5)	6	(.003)	5	(.003)	0	(0)
No Odor (n=6,108.5)	11	(.002)	13	(.002)	2	(.0003)
Foam : Symptoms Beginning Post-insulation						
All Odor Groups (n=7,450.5)	53	(.007)	55	(.007)	3	(.0004)
Persistent Odor (n=570.5)	10	(.018)	13	(.023)	0	(0)
Brief Odor (n=1,648.5)	13	(.008)	14	(.008)	1	(.0006)
No Odor (n=5,231.5)	30	(.006)	28	(.005)	2	(.0004)

*(n) signifies person-months of exposure. For all foam and all control it includes entire population. For pre- and post-insulation it excludes 61 persons (732 person-months) for whom odor duration was unknown.

**# signifies number of symptoms.

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Appendix A - Foam Questionnaire

HEN
101-103

HEALTH-ENERGY SURVEY
February 1979

104-106 107 108
ID DECK SURVEY

SUBJECTS

TIME INTERVIEW BEGAN _____

Hello, my name is _____ (first and last). I'm (a student at/on the staff of) Rutgers University and I'm taking a public opinion survey for the Eagleton Institute at Rutgers. I'd like to ask you a few questions about housing and health. (Could I speak with/Are you) the female head of your household? If female head of household unavailable ask for male head of household. If neither available make call-back appointment for female head of household. Repeat introduction with new respondent.

1. To begin with, how long have you lived at your current residence, or have you lived there all your life?

- 109- / 1. ONE YEAR OR LESS / → / TERMINATE /
 / 2. UNDER 2 YEARS /
 / 3. UNDER 5 YEARS /
 / 4. UNDER 10 YEARS /
 / 5. OVER 10 YEARS /
 / 6. ALL LIFE /
 / 9. DON'T KNOW /

2. Do you live in a house, apartment, duplex or something else?

- 110- / 1. HOUSE /
 / 2. DUPLEX /
 / 3. TRAILER/MOBILE HOME (VOL.) /
 / 4. APARTMENT /
 / 5. OTHER (specify: _____) / → / TERMINATE /
 / 9. DON'T KNOW /

3. Are the outside walls of your home made of stone, wood, wood with aluminum siding, brick or cinder block; or something else?

- 111- 1. STONE
 2. WOOD
 3. WOOD WITH SIDING
 4. BRICK OR CINDER
 5. STUCCO
 6. ASBESTOS
 7. OTHER (specify: _____)
 9. DON'T KNOW

4. Have you added any insulation to your house within the last 12 months? IF YES: How many times in the last 12 months?

- 112- / 1. YES MORE THAN ONCE /
 / 2. YES ONCE /
 / 3. NO / → / TERMINATE INTERVIEW /
 / 9. DON'T KNOW /

GO TO Q.5, NEXT PAGE/

5. What type of insulation did you add? PROBE: Any other kind?
(IF NECESSARY, PROBE: Was it foam, boards, cellulose, fiberglass
or rockwool?)

Circle if mentioned

- A. Cellulose (shredded wood/newspapers) 113-1
- B. Rigid boards (styraphome) 114-1
- C. Rockwool (mineral wall, gypsum) 115-1
- D. Fiberglass 116-1
- E. Other (specify: _____) 117-1

F. Foam (urea-formaldehyde) 118-1

IF FOAM NOT MENTIONED, ASK G:

G. Did you add any foam insulation?

- 119- / 1. YES → SKIP TO Q.6
 / 2. NO → TERMINATE
 / 9. DON'T KNOW

H. Foam is commonly installed by drilling holes in the side
of the house and pumping or blowing in a substance known
as urea-formaldehyde. Can you recall if anything like this
was done?

- 120- / 1. YES → GO TO Q.6
 / 2. NO → TERMINATE
 / 9. DON'T KNOW

My next few questions are about the foam insulation you installed.

6. Can you recall what month you added the (foam) insulation?
IF DON'T KNOW, PROBE: Can you recall the season when you added
the insulation? PROBE: Was this in 1978?

- | | |
|---------------------|----------------------------------|
| 121-22-1. FEB. 1979 | 13. FEB. 1978 |
| 2. JAN. 1979 | 14. BEFORE FEB. 1978 - TERMINATE |
| 3. DEC. 1978 | 15. DON'T KNOW, FALL |
| 4. NOV. 1978 | 16. DON'T KNOW, WINTER |
| 5. OCT. 1978 | 17. DON'T KNOW, SPRING |
| 6. SEPT. 1978 | 18. DON'T KNOW, SUMMER |
| 7. AUG. 1978 | 99. DON'T KNOW |
| 8. JULY 1978 | |
| 9. JUNE 1978 | |
| 10. MAY 1978 | |
| 11. APRIL 1978 | |
| 12. MARCH 1978 | |

7. In what part of the house was the foam added--the attic, basement, and crawlspaces, walls or somewhere else?

- 123-
- 1. ATTIC ONLY
 - 2. BASEMENT/CRAWLSPACE ONLY
 - 3. WALL ONLY
 - 4. ATTIC & BASEMENT/CRAWLSPACE ONLY
 - 5. WALL & BASEMENT/CRAWLSPACE ONLY
 - 6. ATTIC & WALL ONLY
 - 7. ATTIC, BASEMENT/CRAWLSPACE & WALL
 - 8. OTHER (Specify: _____)
 - 9. DON'T KNOW

(IF ANY "ATTIC" RESPONSE IN Q.7, ASK:)

7A. Was the insulation put on the floor of the attic, or installed going up the sides of the wall of the attic?

- 124-
- 1. FLOOR
 - 2. SIDES
 - 3. BOTH
 - 9. DON'T KNOW

8. Do you happen to remember the name of the company that installed the foam insulation? IF YES: Who is that?

125 126

9. Do you think you have saved any money on home heating bills since you added insulation? IF YES, PROBE: Do you think you have saved a lot, some, or only a little?

- 127-
- 1. NO SAVINGS
 - 2. LOT
 - 3. SOME
 - 4. LITTLE
 - 8. YES - DON'T KNOW HOW MUCH
 - 9. DON'T KNOW

9B. How much do you expect to save on fuel bills in the next few years because of the insulation--a lot, some, a little or none at all?

- 128-
- 1. LOT
 - 2. SOME
 - 3. LITTLE
 - 4. NONE
 - 9. DON'T KNOW

Now thinking back to when the foam was added, let me ask you a few questions. If you can't remember, just say so.

10. During the day or days when the foam was put in were people living in your home, or did you live somewhere else during this period?

- 129-
- 1. NO
 - 2. YES
 - 9. DON'T KNOW
- SKIP TO Q. 12, P. 4

(IF "NO" TO Q. 10, ASK:)

11. How soon after the insulation was added did somebody return to the house?

- 130-
- 1. SAME DAY
 - 2. NEXT DAY
 - 3. 1 WEEK OR LESS
 - 4. MORE THAN 1 WEEK
 - 9. DON'T KNOW

12. Do you happen to recall the outside temperature at the time the insulation was added? Was it under 50, between 50 and 80, or over 80? IF CAN'T RECALL: Just in General, can you recall if it was cold, hot, or moderate outside?

- 131- 1. 49 OR UNDER
- 2. 50-80
- 3. 81 OR OVER
- 4. COLD
- 5. MODERATE
- 6. HOT
- 9. DON'T KNOW

13. Do you remember if it was raining at the time the insulation was added?

- 132- 1. YES (ALL OR PART OF THE TIME) → /SKIP TO Q.15/
- 2. NO
- 9. DON'T REMEMBER

(IF "NO" OR "DON'T REMEMBER" TO Q.13, ASK:)

14. Can you recall whether it was (damp/humid) or was it a dry day?

- 133- 1. DAMP/HUMID
- 2. DRY
- 3. "REGULAR" DAY (VOL. ONLY)
- 9. DON'T KNOW

15. At the time the foam was installed can you recall whether:

	Yes	No	Don't Know
A. the windows were open	134-1	2	9
B. the air conditioning was on	135-1	2	9
C. did you have an attic fan on	136-1	2	9

IF "NO" OR "DON'T KNOW" TO ALL

D. Was the house completely closed-sealed up when the insulation was installed? IF NO: What type of ventilation was there in the house?

- 137- 1. YES
- 2. NO (Specify: _____)
- 9. DON'T KNOW

16. Immediately after your house was insulated did you notice any unusual odors or smells?

- 138- 1. YES
- 2. YES--NOT THAT DAY, BUT A FEW DAYS LATER (VOL.)
- 3. NO
- 9. DON'T KNOW → /SKIP TO Q.17, P.5/

(IF "YES" TO Q.16, ASK:)

16a. How many days did this last, or was it an odor that came and went from time to time?

IF "TIME TO TIME", PROBE: Overall, how many days would you say the problem lasted for?

Days lasted / / code days 99=Don't know
 139 140 97=99 or more days

time-to-time / / code days 99=Don't know
 141 142 97=99 or more days

16b. Was this an odor you found irritating or were bothered by?

- 143- 1. YES
- 2. NO
- 9. DON'T KNOW

17. Have you had any serious problems with the house that are related to having the insulation installed?

- 144- 1. YES
 2. NO
 9. DON'T KNOW
- SKIP TO Q.18

(IF "YES" TO Q.17, ASK:)

17A. What was that?

145 146

147 148

17B. Has any part of the house been made unusable or unlivable?

- 149- 1. YES
 2. NO
 9. DON'T KNOW

17C. Have you or someone in your household had to live away from home temporarily because of this problem?

- 150- 1. YES
 2. NO
 9. DON'T KNOW

17D. Have you had to bring the insulation company back to correct this problem?

- 151- 1. YES
 2. NO
 9. DON'T KNOW

18. The New Jersey Department of Energy is interested in monitoring households who have recently installed insulation to see if it is effective or not.

	Yes	No	Don't Know
a. Would you be willing to let them take a thermographic picture of your house to look for spots where heat leaks out? This would be done free of charge.	152- 1	2	9
b. Would you be willing to let the Department of Energy look over your fuel bills, so that they can see the effects of insulation?	153- 1	2	9

Let me ask you a few questions about health and your family.

19. To begin with, not including yourself, how many people are now living in your household? Starting with the oldest, what are their ages and relationship to you. (Circle number of each person)

	RELATIONSHIP	AGE	RELATIONSHIP CODE	LIVES AWAY
154-	1. Respondent	155 156	157 158	159
160-	2.	161 162	163 164	165
166-	3.	167 168	169 170	171
172-	4.	173 174	175 176	177
209-	5.	210 211	212 213	214
215-	6.	216 217	218 219	220
221-	7.	222 223	224 225	226
227-	8.	228 229	230 231	232
233-	9.	234 235	236 237	238

KEYPUNCHER
 10UP
 01-06
 2
 07 2
 08

Have any of these people lived away from home for more than two months in the last 12 months? IF YES: Who is that? (WRITE "1" OVER LINE)

20. Have you or a member of your household had any of the following health problems in the last 12 months:
 IF YES: Which members of the household had this problem, or was this a problem you had?

	RESP.									
	NO	PERSON 1	2	3	4	5	6	7	8	9
1. asthmatic attacks										
2. wheezing or difficulty breathing										
3. chest pains										
4. stinging or burning skin										
5. burning eyes or tearing										

Now I'm going to read you a list of more common health problems. For each member of the household I ask about would you please think back over the past 12 months and tell me if the problem I mention has occurred more frequently than usual, or has been more severe than usual.

	RESP.									
	NO	PERSON 1	2	3	4	5	6	7	8	9
6. sore throats										
7. runny nose										
8. coughs										
9. rashes										
10. headaches										
11. problems sleeping										
12. dizziness										
13. vomiting										

INSTRUCTIONS: USING RESPONSES FROM Q.19 CHECK APPROPRIATE GRIDS IN ABOVE MATRIX. FOR EACH CHECK IN 1 TO 12 COMPLETE "HEALTH HISTORY FORM". IF 3 OR MORE CHECKS FOR ANY INDIVIDUAL SEE NOTE AT TOP OF HEALTH HISTORY FORM.

21. Does anybody in your household have:

- a. a history of rashes
- b. a history of allergies
- c. a history of asthma

22. A. Does anyone wear contact lenses

B. IF YES: Has (he/she) had any problem with these in the past 12 months?

	PERSON 1	2	3	4	5	6	7	8	9
a. a history of rashes									
b. a history of allergies									
c. a history of asthma									
A. Does anyone wear contact lenses									
B. IF YES: Has (he/she) had any problem with these in the past 12 months?									

THIS SPACE FOR CODERS

239 241 243 245 247 249 251 253 255
 240 242 244 246 248 250 252 254 256

IF NO HEALTH HISTORY FORMS FILLED OUT, SKIP Q.23

23. Has anyone in your household taken time off from school or work because of any of the health problems I mentioned. IF YES: "Who was that and what was the specific problem involved."

PERSON	PROBLEM
A. _____	_____
B. _____	_____
C. _____	_____
D. _____	_____
E. _____	_____
F. _____	_____

CODERS FILL IN PERSON, PROBLEM CODES

A	<u> </u> / <u> </u> / <u> </u>	B	<u> </u> / <u> </u> / <u> </u>	C	<u> </u> / <u> </u> / <u> </u>
	257 258 259		260 261 262		263 264 265
D	<u> </u> / <u> </u> / <u> </u>	E	<u> </u> / <u> </u> / <u> </u>	F	<u> </u> / <u> </u> / <u> </u>
	266 267 268		269 270 271		272 273 274

<u>DUP</u>	<u> 3 </u>	<u> 1 </u>
301-306	307	308

- 24A. Do you or any member of your household smoke cigarettes? IF YES: "Over the past 6 months about how many packs per day does (person) smoke?"
- B. Do you or anyone else smoke cigars? IF YES: "Over the past 6 months about how many a day does (person) smoke?"
- C. Does anyone in your household smoke a pipe? IF YES: "About how many pipes per day over the past 6 months?"

	RESP.	PERS. 2	3	4	5	6	7	8	9
cigarettes									
cigars									
pipes									

309-311	312-314	315-317	318-320	321-323	324-326	327-329	330-332	333-335
---------	---------	---------	---------	---------	---------	---------	---------	---------

FILL IN MATRIX WITH FOLLOWING CODES:

- | Cigarettes | Cigars and Pipes |
|---------------------------|-----------------------------|
| 1. DOESN'T SMOKE | 1. DOESN'T SMOKE |
| 2. YES, OCCASIONAL SMOKER | 2. YES, LESS THAN 1 PER DAY |
| 3. LESS THAN 1 PACK/DAY | 3. 1-2 |
| 4. 1-2 PACKS/DAY | 4. 3-4 |
| 5. OVER 2 PACKS/DAY | 5. 5 OR MORE |
| 9. DON'T KNOW | 9. DON'T KNOW |

That's all the questions I have. Thank you for giving me your time. Would you mind giving me your first name so that we can get in touch with you again if we have to

_____/_____/_____/_____/_____/_____/_____/_____/_____/_____/_____/_____/_____/_____/_____/_____/_____

336 337 338 339 340 341 342 343 FIRST NAME (PLEASE PRINT)

PHONE # (_____/_____/_____) _____

344 345 346 (area code) 347 348 349 350 351 352 353

ADDRESS: _____

THANK RESPONDENT AND HANG UP

- 25. Respondent's sex
- 354-1. MALE
- 2. FEMALE

TIME INTERVIEW ENDED _____

LENGTH OF INTERVIEW _____

355 356

INTERVIEWER'S NUMBER _____

357 358 359

EDITOR'S NUMBER _____

360 361

Appendix B - Control Questionnaire

REN
101-103

INDUSTRY SURVEY
February 1979

107-108
ID DECK SURVEY

CONTROL

TIME INTERVIEW BEGAN _____

Hello, my name is _____ (first and last). I'm
(a student at/on the staff of) Rutgers University and I'm taking a
public opinion survey for the Eagleton Institute at Rutgers. I'd
like to ask you a few questions about housing and health.
(Could I speak with/Are you) the female head of your household?
If female head of household unavailable ask for male head of
household. If neither available make call-back appointment for
female head of household. Repeat introduction with new respondent.

1. To begin with, how long have you lived at your current residence,
or have you lived there all your life?

109- / 1. ONE YEAR OR LESS / → / TERMINATE /
/ 2. UNDER 2 YEARS /
/ 3. UNDER 5 YEARS /
/ 4. UNDER 10 YEARS /
/ 5. OVER 10 YEARS /
/ 6. ALL LIFE /
/ 9. DON'T KNOW /

2. Do you live in a house, apartment, duplex or something else?

110- / 1. HOUSE /
/ 2. DUPLEX /
/ 3. TRAILER/MOBILE HOME (VOL..) /
/ 4. APARTMENT /
/ 5. OTHER (specify: _____) / → / TERMINATE /
/ 9. DON'T KNOW /

4. Have you added any insulation to your house within the last 12
months? IF YES: How many times in the last 12 months?

112- / 1. YES MORE THAN ONCE /
/ 2. YES ONCE /
/ 3. NO / → / SKIP TO Q. 19, P. 2 /
/ 9. DON'T KNOW /

- 4C1. What type of insulation did you add? PROBE: Any other kind?

178- / 1. DOESN'T MENTION FOAM / → / SKIP TO Q. 19, P. 2 /
/ 2. MENTIONS FOAM / → / TERMINATE INTERVIEW /
/ 9. DON'T KNOW /

(IF "DON'T KNOW TO Q. 4C1, ASK:)

- 4C2. Can you recall whether or not it was foam insulation?
Foam is often called urea-formaldehyde and pumped into
the sides of a house by drilling holes in the wall.

179- / 1. NOT FOAM / → / GO TO NEXT PAGE /
/ 2. FOAM / → / TERMINATE /
/ 9. DON'T KNOW /

19. To begin with, not including yourself, how many people are now living in your household? Starting with the oldest, what are their ages and relationship to you. (Circle number of each person)

After Family Set is done, PROCE: And what was your age on your last birthday?

	RELATIONSHIP	AGE	RELATIONSHIP CODE	LIVES AWAY
154-	1. Respondent	155 156	157 158	159
160-	2.	161 162	163 164	165
166-	3.	167 168	169 170	171
172-	4.	173 174	175 176	177
209-	5.	210 211	212 213	214
215-	6.	216 217	218 219	220
221-	7.	222 223	224 225	226
227-	8.	228 229	230 231	232
233-	9.	234 235	236 237	238

KEYPUNCHER
100P
01-66
2 2
07 08

Have any of these people lived away from home for more than two months in the last 12 months? IF YES: Who is that? (WRITE "1" OVER LINE)

20. Have you or a member of your household had any of the following health problems in the last 12 months:
IF YES: Which members of the household had this problem, or was this a problem you had?

	RESP.								
	NO	YES							
	PERSON 1	2	3	4	5	6	7	8	9
1. asthmatic attacks									
2. wheezing or difficulty breathing									
3. chest pains									
4. stinging or burning skin									
5. burning eyes or tearing									

Now I'm going to read you a list of more common health problems. For each member of the household I ask about would you please think back over the past 12 months and tell me if the problem I mention has occurred more frequently than usual, or has been more severe than usual.

	RESP.								
	NO	YES							
	PERSON 1	2	3	4	5	6	7	8	9
6. sore throats									
7. runny nose									
8. coughs									
9. rashes									
10. headaches									
11. problems sleeping									
12. dizziness									
13. vomiting									

INSTRUCTIONS: USING RESPONSES FROM Q.19 CHECK APPROPRIATE GRIDS IN ABOVE MATRIX. FOR EACH CHECK IN 1 TO 12 COMPLETE "HEALTH HISTORY FORM". IF 3 OR MORE CHECKS FOR ANY INDIVIDUAL SEE NOTE AT TOP OF HEALTH HISTORY FORM.

21. Does anybody in your household have:

	RESP.								
	PERSON 1	2	3	4	5	6	7	8	9
a. a history of rashes									
b. a history of allergies									
c. a history of asthma									
22. A. Does anyone wear contact lenses									
B. IF YES: Has (he/she) had any problem with these in the past 12 months?									

THIS SPACE FOR COVERS

239 241 243 245 247 249 251 253 255
240 242 244 246 248 250 252 254 256

IF NO HEALTH HISTORY FORMS FILLED OUT, SKIP Q.23

23. Has anyone in your household taken time off from school or work because of any of the health problems I mentioned. IF YES: "Who was that and what was the specific problem involved."

	<u>PERSON</u>	<u>PROBLEM</u>
A.	_____	_____
B.	_____	_____
C.	_____	_____
D.	_____	_____
E.	_____	_____
F.	_____	_____

CODERS FILL IN PERSON, PROBLEM CODES

A	<u> </u> / <u> </u> / <u> </u> 257 258 259	B	<u> </u> / <u> </u> / <u> </u> 260 261 262	C	<u> </u> / <u> </u> / <u> </u> 263 264 265
D	<u> </u> / <u> </u> / <u> </u> 266 267 268	E	<u> </u> / <u> </u> / <u> </u> 269 270 271	F	<u> </u> / <u> </u> / <u> </u> 272 273 274
DUP		3		2	
<u> </u> / <u> </u> / <u> </u> 301-306		<u> </u> / <u> </u> / <u> </u> 307		<u> </u> / <u> </u> / <u> </u> 308	

- 24A. Do you or any member of your household smoke cigarettes? IF YES: "Over the past 6 months about how many packs per day does (person) smoke?"
- B. Do you or anyone else smoke cigars? IF YES: "Over the past 6 months about how many a day does (person) smoke?"
- C. Does anyone in your household smoke a pipe? IF YES: "About how many pipes per day over the past 6 months?"

	<u>RESP.</u>	<u>PERS. 2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
cigarettes									
cigars									
pipes									
	309- 311	312- 314	315- 317	318- 320	321- 323	324- 326	327- 329	330- 332	333- 335

FILL IN MATRIX WITH FOLLOWING CODES:

- | | |
|---------------------------|-----------------------------|
| <u>Cigarettes</u> | <u>Cigars and Pipes</u> |
| 1. DOESN'T SMOKE | 1. DOESN'T SMOKE |
| 2. YES, OCCASIONAL SMOKER | 2. YES, LESS THAN 1 PER DAY |
| 3. LESS THAN 1 PACK/DAY | 3. 1-2 |
| 4. 1-2 PACKS/DAY | 4. 3-4 |
| 5. OVER 2 PACKS/DAY | 5. 5 OR MORE |
| 9. DON'T KNOW | 9. DON'T KNOW |

That's all the questions I have. Thank you for giving me your time. Would you mind giving me your first name so that we can get in touch with you again if we have to

 / / / / / / / FIRST NAME (PLEASE PRINT)

PHONE # (/ /) / / / / /

ADDRESS: _____

THANK RESPONDENT AND HANG UP

25. Respondent's sex
 1. MALE
 2. FEMALE

TIME INTERVIEW ENDED _____
 LENGTH OF INTERVIEW / /
 355 356

INTERVIEWER'S NUMBER / /
357 358 359

EDITOR'S NUMBER / /
360 361