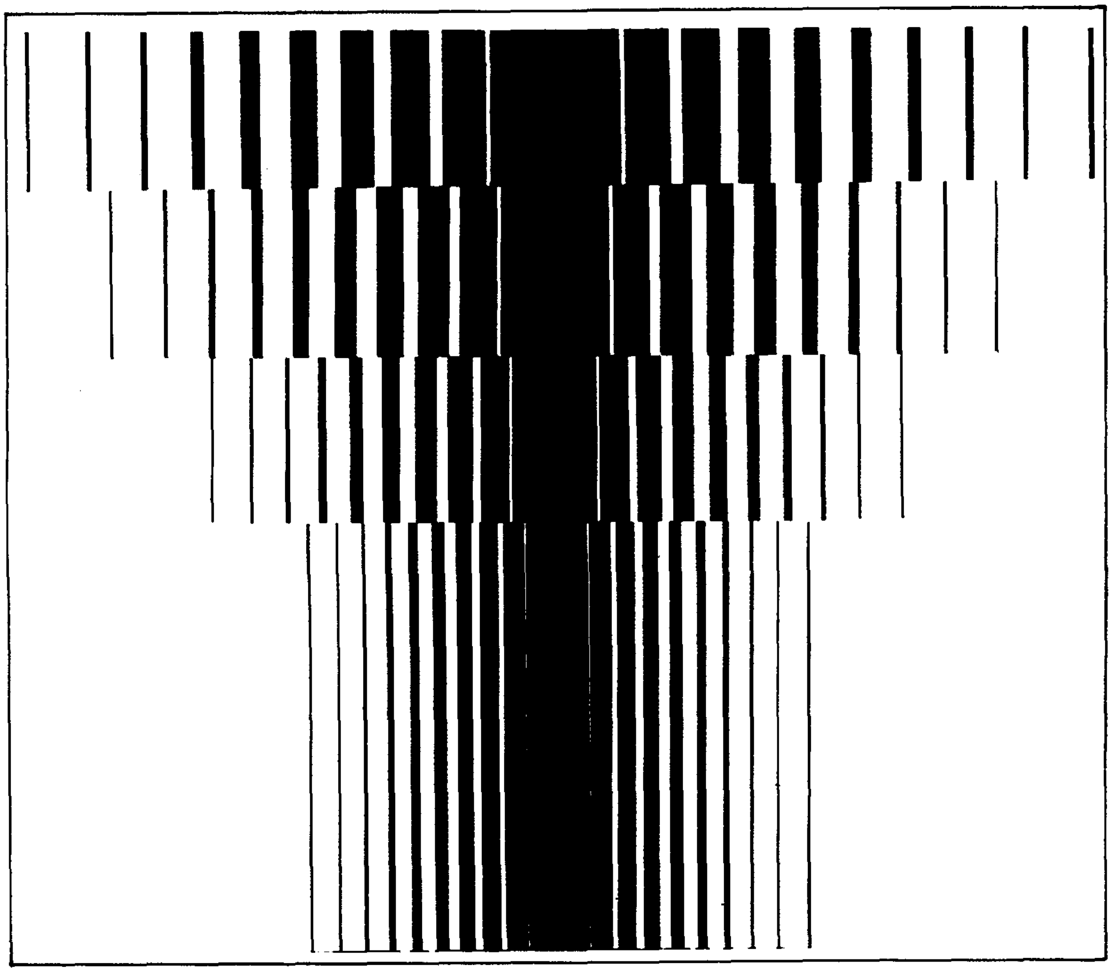
Incidence, Utilization, and Costs Associated With Acute Respiratory Conditions United States, 1980

Series C, Analytical Report No. 4



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National Medical Care Utilization and Expenditure Survey

The National Medical Care Utilization and Expenditure Survey (NMCUES) is a unique source of detailed national estimates on the utilization of and expenditures for various types of medical care. NMCUES is designed to be directly responsive to the continuing need for statistical information on health care expenditures associated with health services utilization for the entire U.S. population.

NMCUES will produce comparable estimates over time for evaluation of the impact of legislation and programs on health status, costs, utilization, and illness-related behavior in the medical care delivery system. In addition to national estimates for the civilian noninstitutionalized population, it will also provide separate estimates for the Medicaid-eligible populations in four States.

The first cycle of NMCUES, which covers calendar year 1980, was designed and conducted as a collaborative effort between the National Center for Health Statistics, Public Health Service, and the Office of Research and Demonstrations, Health Care Financing Administration. Data were obtained from three survey components. The first was a national household survey and the second was a survey of Medicaid enrollees in four States (California, Michigan, Texas, and New York). Both of these components involved five interviews over a period of 15 months to obtain information on medical care utilization and expenditures and other health-related information. The third component was an administrative records survey that verified the eligibility status of respondents for the Medicare and Medicaid programs and supplemented the household data with claims data for the Medicare and Medicaid populations.

Data collection was accomplished by Research Triangle Institute, Research Triangle Park, N.C., and its subcontractors, the National Opinion Research Center of the University of Chicago, Ill., and SysteMetrics, Inc., Berkeley, Calif., under Contract No. 233–79–2032.

Co-Project Officers for the Survey were Robert R. Fuchsberg of the National Center for Health Statistics (NCHS) and Allen Dobson of the Health Care Financing Administration (HCFA). Robert A. Wright of NCHS and Larry Corder of HCFA also had major responsibilities. Daniel G. Horvitz of Research Triangle Institute was the Project Director primarily responsible for data collection, along with Associate Project Directors Esther Fleishman of the National Opinion Research Center, Robert H. Thornton of Research Triangle Institute, and James S. Lubalin of SysteMetrics, Inc. Barbara Moser of Research Triangle Institute was the Project Director primarily responsible for data processing.

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Symbols

---	Data not available
...	Category not applicable
-	Quantity zero
0.0	Quantity more than zero but less than 0.05
†	Sample size is less than 50
‡	Sample size is less than 25

NOTE: Data estimates in tables may not add to totals because of rounding.

Incidence, Utilization, and Costs Associated With Acute Respiratory Conditions

By William R. Harlan, Hillary A. Murt, J. William Thomas, James M. Lepkowski, and Kenneth E. Guire, University of Michigan, P. Ellen Parsons, National Center for Health Statistics (formerly of the University of Michigan), and S. E. Berki and J. Richard Landis, University of Michigan

Executive Summary

Acute respiratory conditions are common causes of health disturbance in the general population. They are generally self-limiting, although occasionally recurrent, and seldom result in large health care costs for each episode of illness. The National Medical Care Utilization and Expenditure Survey (NMCUES), conducted during 1980, provided an opportunity to assess the effect of acute respiratory conditions on utilization of medical services and on functional capability as well as the cost of related medical care. Acute respiratory conditions were reported by survey respondents and separated into five subgroups: colds, influenza, nasopharyngitis, otitis media, and lower respiratory infections. Allergic conditions and chronic respiratory disorders (tuberculosis, chronic obstructive pulmonary disease, and pneumoconioses) were excluded. The subgroupings of acute respiratory conditions appear to separate the disorders in a manner consistent with the epidemiologic characteristics of each condition.

About one-half (50.4 percent) of the U.S. civilian noninstitutionalized population had one or more acute respiratory conditions during 1980. The highest rates for upper respiratory conditions (colds, influenza, nasopharyngitis, and otitis media) were reported for those under 18 years of age, and rates were lower in successively older groups. Lower respiratory infection rates were higher in the youngest and oldest groups.

Despite a high incidence in the general population, most symptomatic episodes of colds, influenza, and nasopharyngitis did not result in ambulatory care visits or hospital admissions. Otitis media and lower respiratory infections were more often associated with medical visits.

Acute respiratory conditions were associated with lower disability levels than the average for the U.S. civilian noninstitutionalized population during 1980 (5.9 restricted-activity days for acute respiratory conditions, compared with an overall average of 13.8 restricted-activity days). Persons with upper respiratory conditions (colds, influenza, otitis media, and nasopharyngitis) averaged 2.3 to 5.4 restricted-activity days, but persons with lower respiratory infections experienced an average of 8.2 restricted-activity days. Indirect costs attributed to acute respiratory conditions in 1980 were $7.7 billion for employed persons and $698 million for homemakers, for a total of $8.4 billion, about the same as total direct costs ($8.3 billion). These indirect costs were several times larger than the annual indirect costs estimated for either cardiovascular diseases or musculoskeletal diseases, two common chronic or recurrent condition groups. The high indirect costs reflect the high frequency of episodes in the general population during 1980 and the greater likelihood of associated bed-disability and work-loss days than for other conditions.

Despite the frequency of acute respiratory conditions, only a small proportion (15 percent) of the ambulatory visits made by people who had such episodes were specifically related to these conditions. Ambulatory visits for colds, influenza, and nasopharyngitis were infrequent, but lower respiratory infections and otitis media commonly resulted in ambulatory visits. Medical attention specifically attributable to acute respiratory conditions was more common for younger age groups and less common for successively older age groups. However, ambulatory visits for all causes were greater for the older groups; therefore, acute respiratory conditions comprised a lesser proportion of their total visits. Although women reported more episodes of acute respiratory conditions than men did, they less frequently sought medical care for these conditions. Acute respiratory conditions were infrequently reported as a cause for hospitalization. Lower respiratory infections were an exception and led to hospital care for 12 percent of persons reporting this condition. The most common surgical procedure reported by persons with acute respiratory conditions was tonsillectomy and/or adenoidectomy, and this procedure was almost exclusively performed on persons under 19 years of age.

Total charges for acute respiratory conditions in 1980 amounted to $8.3 billion, or about 5 percent of the total charges for all health services to the U.S. civilian noninstitutionalized population. Charges for physician services and prescribed medications made up a greater proportion of charges for acute respiratory conditions than for all conditions in the general population. This reflects the predominance of ambulatory care for these conditions. Surgical procedures related to acute respiratory conditions were performed relatively infrequently (5.0 per 1,000 population), and about one-half of these procedures were tonsillectomy and/or adenoidectomy (2.7 per 1,000 population). The total charges for relevant surgical procedures were $2.1 billion. Charges associated with lower respiratory infections comprised 42 percent of the total charges for all acute respiratory conditions.

Per capita charges for acute respiratory conditions averaged $74 for those reporting one or more episodes, but the condition charges varied greatly, ranging from $20 for influenza to $408 for lower respiratory infections. Approximately 30 percent of per capita charges were paid out of pocket. Charges specifically related to upper respiratory conditions comprised a greater proportion of per capita charges for all care among young people (15 percent) than among persons 65 years of age and over (2 percent). Lower respiratory infections differed from this pattern, having the highest per capita charges and total charges and only a minimal age differential.

Despite the low costs per person, acute respiratory diseases have considerable impact on total health costs because they are common and frequently result in bed disability and work loss. These disorders are responsible for a major proportion of health expenditures for children and young adults. From middle age through retirement, the proportion of health expenditures related to acute respiratory conditions declines, and chronic disorders assume greater economic and health importance.

NOTES: The authors are grateful for the support received during all stages of the preparation of this document, both from colleagues at the University of Michigan and from the staff of the National Center for Health Statistics. At the University of Michigan, Sharon Stehouwer contributed greatly to initial analyses of the NMCUES data and to identification and correction of several problems encountered in the data base. Drs. Catherine McLaughlin, Richard Lichtenstein, and Leon Wyszewianski provided valuable conceptual help. Quality secretarial support in the preparation of the many tables included in the report came from Jan Feldman, Carolyn Parker, and Johanna Haaxma-Jurek. At the Institute for Social Research, University of Michigan, Nan Collier developed software for calculating sampling errors, and Judy Connors performed many of the analyses for generating sampling errors for national estimates.

Continual support was received from the National Center for Health Statistics. The project officer, Dr. Mary Grace Kovar, Special Assistant for Data Policy and Analysis, was instrumental in providing focus to the project. The authors are indebted to Robert J. Casady, Chief of the Statistical Methods Staff, for writing the major section in Appendix I in which the NMCUES survey design and estimation methodology are described. When potential errors in the data were identified during our analyses, Robert Wright and Michelle Chyba quickly solved the problems. Editors in the Publications Branch provided valuable assistance during all stages of the report, especially preparation of the detailed tables.

Introduction

Acute respiratory conditions are common causes of visits for health services and are often associated with work-loss and disability days. The economic importance of these medical problems is generally underestimated because they are an accepted part of life, they are usually self-limiting and of short duration, and the unit costs for care, whether self administered or medically dispensed, are relatively small. However, in the aggregate, this group of diseases represents an important and sizable cause of morbidity and results in considerable economic loss. The impact of these diseases has been difficult to document because of variable patterns of seeking care, paucity of residual morbidity, and the orientation of most economic studies toward the high-cost aspects of medical care, such as hospitalization and surgery. Lack of information has also obscured potential age, race, and sex differences in care-seeking patterns and expenditures, which remain poorly defined within the general population. Data regarding the incidence of and service utilization patterns for respiratory conditions could have implications for setting prevention and treatment priorities and for health care financing. The National Medical Care Utilization and Expenditure Survey (NMCUES) of 1980 provides a unique opportunity to quantify the health and economic impact of acute respiratory conditions.

The impact of acute, primarily infectious, respiratory conditions on health service utilization and economic costs is examined in this report. Chronic respiratory diseases (e.g., chronic obstructive pulmonary disease, pneumoconioses, and tuberculosis) and allergic diseases (e.g., bronchial asthma) have health implications and service patterns that differ considerably from those of acute conditions and are not analyzed in this report.

Acute respiratory conditions are usually grouped into a single category in health service utilization studies, but this may obscure important differences among disease subgroups with respect to care patterns and cost. No validated standardized criteria exist for separating these conditions by etiologic agent or symptom complex. Therefore, physician and patient discrimination of disease entities based on symptomatology has been considered imprecise, and the differences among conditions in morbidity and costs have been thought to be too trivial to justify more discrete differentiation. However, preventive medical and cost-containment strategies might differ among the entities, and data specific to diseases would be useful. In this report, the costs of care for the general category of acute respiratory conditions are compared with other health costs, and this broad category is differentiated into five symptomatic subgroups: colds, nasopharyngitis, influenza, otitis media, and lower respiratory infections. The incidence, disability, service utilization, and direct and indirect costs for each subgroup are compared.

Acute respiratory conditions and the subgroups were defined using modified codes of the Ninth Revision of the International Classification of Diseases (World Health Organization, 1977).

Acute respiratory conditions (general category)—This includes all of the specific subgroups listed below. A person may have reported more than one of the diagnoses listed below. Specific exclusions are tuberculosis, International Classification of Diseases (ICD) code 9011; chronic obstructive pulmonary disease, 492, 496; chronic bronchitis, 491; bronchial asthma, 493; allergic rhinitis, 477; and pneumoconioses related to external agents, 500–505.

- *Colds and nonspecific upper respiratory conditions*—This is the subgroup of diagnoses coded as ICD numbers 079, 460–465, 475, 478.2, and 478.6.
- *Nasopharyngitis*—This subgroup comprises diagnoses coded as ICD numbers 472, 473, 474, and 475. The category of chronic nasopharyngitis, 472, was included, because it was interpreted as recurrent or prolonged acute infection of the upper respiratory passages. This diagnosis, reported mostly in younger persons and in those having tonsillectomy and/or adenoidectomy, was felt to be closely related to acute infectious processes.
- *Influenza*—This is reported as ICD code 487. The success in differentiating this condition from colds and other nonspecific respiratory symptom complexes is documented below.
- *Otitis media and related complications*—This subgroup comprises ICD codes 381–386.
- *Lower respiratory infections*—Included in this category are ICD codes 466, 480–486, 490, and 510–515. Chronic infectious processes are specifically excluded.

The diagnoses in the NMCUES data file were provided by the survey respondents, recorded by the interviewer, and reduced to numeric codes by trained coders. Respondent-provided diagnoses could represent self-diagnosis (if the condition was not attended by a health provider) or the diagnosis reported by a health provider and subsequently interpreted by the respondent, interviewer, and coder. To clarify the imprecision attending this course of reporting and to determine whether the general category could be separated into subgroups, the five subgroups were examined by various features known to characterize the disease entities.

The acute respiratory subgroups have different seasonal variations. Seasonal incidence rates for each acute respiratory subgroup as reported by NMCUES respondents are plotted in Figures 1 and 2. According to NMCUES data, the occurrence of influenza during 1980 peaked in January and February, with a secondary peak in December. Influenza incidence was also monitored by the Centers for Disease Control (CDC). Calendar year 1980 comprises the latter half of CDC's 1980 respiratory disease reporting period and the first half of the 1981 period. The pattern of influenza found in NMCUES corresponds with culture-confirmed peak periods reported by CDC. A significant number of excess deaths (43,800) were attributed to pneumonia and influenza during the first 16 weeks of 1980, January to April (Centers for Disease Control, 1984), and this level exceeded the epidemic threshold. The epidemic threshold was also exceeded for a 13-week period beginning December 13, 1980, but only 2 weeks of this period (weeks 51 and 52) are included in NMCUES. The trough during weeks 16–40 (late April through September) are also in line with CDC-reported influenza incidence.

The seasonal pattern for colds was quite different, particularly for weeks 12–46 (March through November), although this diagnostic category, like influenza, had a peak in weeks 1–8 (January and February). Nasopharyngitis had a different seasonal pattern from those of influenza and colds, with high levels in week 1, a peak in weeks 4–16, and a secondary increase in weeks 40–51. Otitis media reported in NMCUES had little seasonal variation, although it was somewhat higher in weeks 5–9. Lower respiratory infections (Figure 1) had higher rates during periods corresponding to higher influenza rates but also had high rates from March through May and no trough during the summer. The correspondence between peaks of influenza and pneumonia is well recognized and is assumed to reflect secondary bacterial complication in persons experiencing influenza infection. Seasonal incidence patterns are evidence that these acute respiratory disease subgroups were differentiated along patterns corresponding with the known behavior of the diseases.

An additional check on the accuracy of reported diagnoses is the distribution of demographic characteristics of those reporting disease. The age, sex, and race distributions for these diseases, included in Table 1, are similar to those reported for acute respiratory conditions (Gwaltney, 1985). Otitis media is characteristically a disease of children (birth to 12 years of age), with no striking sex or racial differences; this is concordant with the data from NMCUES. Lower respiratory infections are more common in children and older adults, and this was found in NMCUES. Influenza affects both adults and children, but colds are more common in children.

Nasopharyngitis is a category that combines several codes for infections of the pharynx and nasal and sinus areas. Although all of these infections are assumed to be acute and self-limiting or recurrent acute diseases, a significant portion were coded under the rubric "chronic nasopharyngitis." When the characteristics of persons assigned this code were compared with those of persons having acute diagnoses within the category, no significant differences were found. Thus, it is assumed that the "chronic nasopharyngitis" codes represent either recurrent acute manifestations of infectious disease or continuing manifestations of an acute episode, as commonly occurs with sinusitis. No direct evidence can be provided to verify this assumption. However, to avoid excluding the large number of persons with this code, their records were merged with others that have diagnoses involving the same anatomical area.

Despite these internal and external validations of the ability to specify diagnostic subgroups within the general category of acute respiratory conditions, one should keep in mind that the diagnoses are reported by household informants. Some imprecision in specification should be expected because standard diagnostic criteria were not applied by the physician or by the survey respondent.

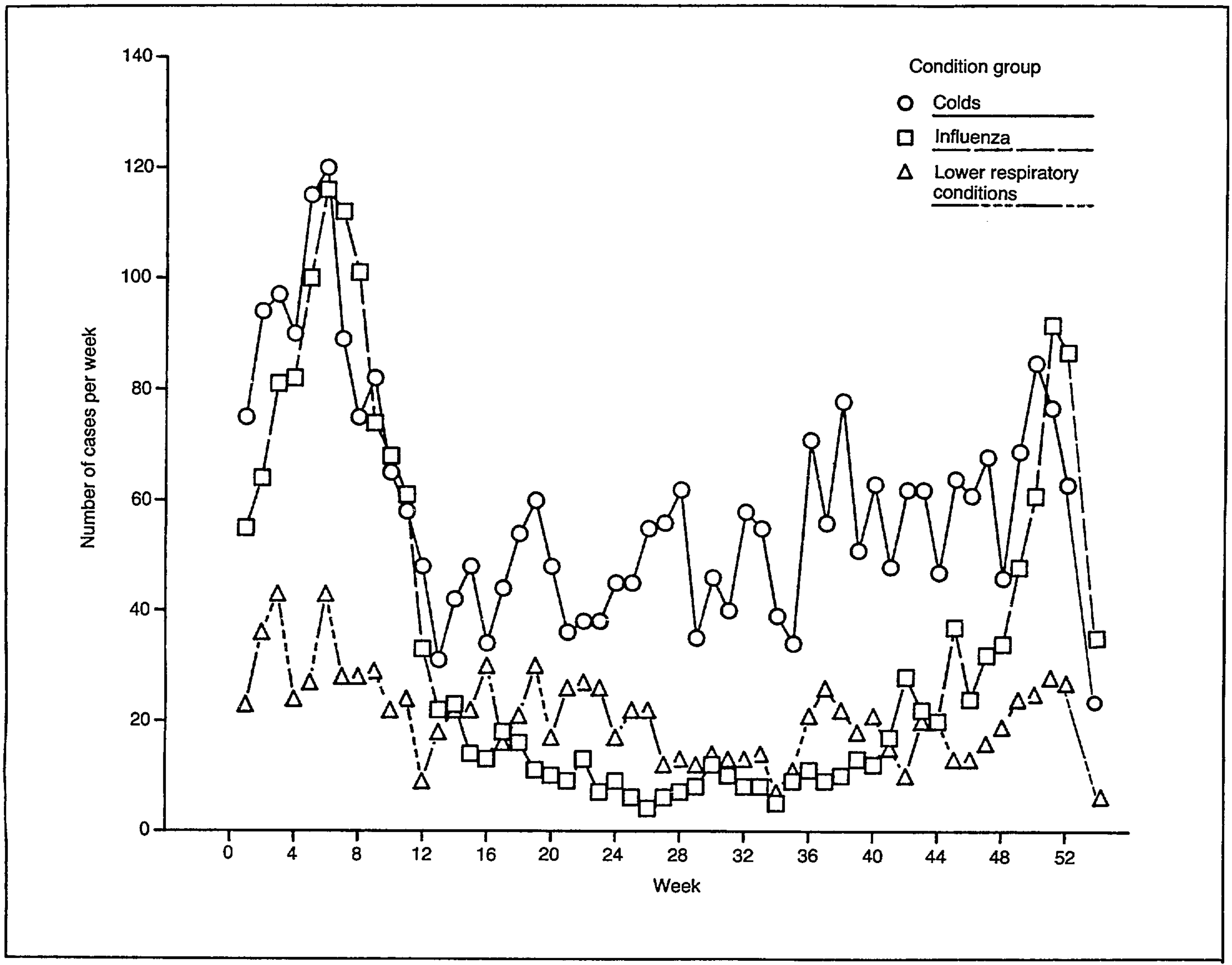

Figure 1

Incidence of colds, influenza, and lower respiratory conditions, by week: National Medical Care Utilization and Expenditure Survey, 1980

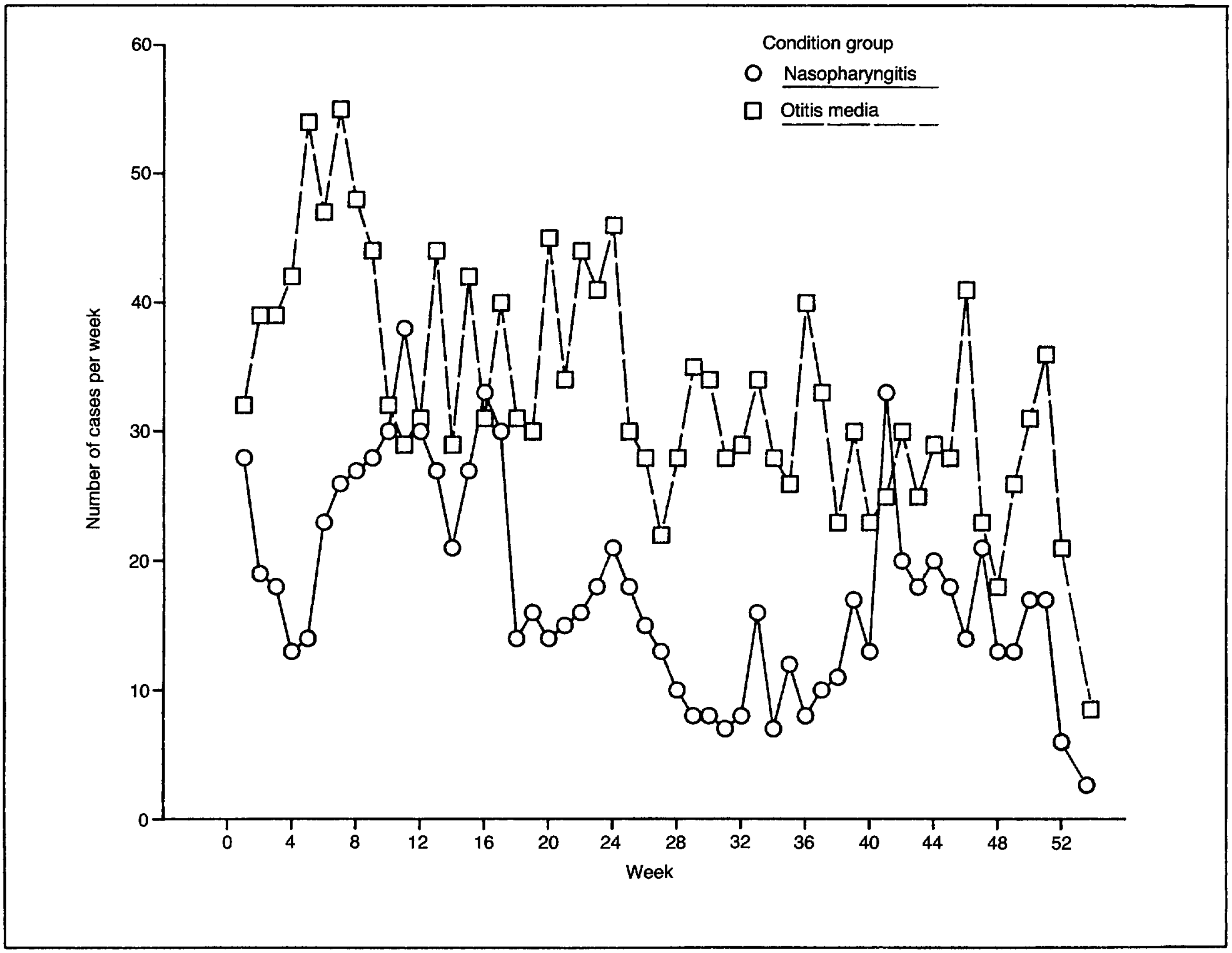

Figure 2

Incidence of nasopharyngitis and otitis media, by week: National Medical Care Utilization and Expenditure Survey, 1980

Sources and Limitations of Data

The National Medical Care Utilization and Expenditure Survey

Data for this study come from the public use files of the National Medical Care Utilization and Expenditure Survey (NMCUES), a national household survey conducted from early 1980 through early 1981. Specific details concerning the sample design and data collection are outlined in Appendix I.

From February 1980 through April 1981, data on 17,123 persons in 6,798 families were collected at approximately 3-month intervals. A total of five interviews, two personal interviews followed by two telephone interviews and a final personal interview, were conducted. At the conclusion of the first interview, survey participants were provided with a specially designed calendar diary for recording data about medical events and costs in preparation for subsequent rounds of interviewing. Prior to each interview but the first, respondents were sent a summary sheet showing all medical events and costs reported in previous interviews.

Public Use Tapes

NMCUES public use tapes consist of six files: the person, medical visit, dental visit, hospital stay, prescribed medicines and other medical expenses, and condition files. The person file has one record for each of the 17,123 responding eligible persons with data describing the person's demographic characteristics, health care coverage, employment, income, and usual source of care; numbers of visits, hospital admissions, and other medical events reported for 1980; total charges for each category of care; and limitations and disabilities, including identification of conditions. Data from the other five files, which have more detailed information about events summarized in the person file, can be linked to records in the person file through a unique identification number assigned to each person.

The medical visit file contains one record for every visit reported by people in the person file. A total of 86,594 visits are in the file, which includes visits to providers' offices, hospital outpatient departments, and emergency rooms. Each record contains the identifying number of the person making the visit, the place of visit, type of physician or nonphysician seen, type of services provided, conditions causing or associated with the visit, procedures performed during the visit, associated charges, and sources of payment. Similar data on dental visits and hospital admissions are provided in the dental visit and hospital stay files, respectively.

The prescribed medicines and other medical expenses file contains one record for each purchase of prescribed medications or other medical expense incurred by survey participants during 1980. Data include the identifying number of the person for whom the purchase was made, date of purchase, prescribed medicine codes, codes for conditions leading to the purchase or other expense, and associated charges and sources of payment.

If a medical condition caused any limitation in a person's activities (e.g., staying in bed, staying home from work) or caused the person to seek medical care, then a condition record appears in the condition file. For each condition, the condition file record contains the identifying number of the person, codes from the International Classification of Diseases (World Health Organization, 1977), dates of onset of illness, counts of visit types, prescribed medicines and other medical expenses, associated charges, and, if applicable, the reasons for not seeing a physician.

Modifications to the public use files that were made by the University of Michigan in the course of this analysis are presented in Appendix II. Analytical strategies appropriate for NMCUES are presented in Appendix III. Sampling errors for estimators used throughout this report can be estimated using procedures outlined in Appendix IV. Definitions of terms used in this report are listed in Appendix V.

Limitations of the Data

Estimates of incidence—In NMCUES, a particular medical condition was noted only when it caused some type of disability or resulted in an ambulatory visit, hospital admission, purchase of a prescribed medication, or other encounter with the health care system. Hence, conditions that usually require treatment or which cause some sort of disability will be better reported. In the context of respiratory conditions, mildly symptomatic colds are less likely to be reported than lower respiratory diseases, which are often associated with significant morbidity and physician consultation.

The diagnostic accuracy of reported problems depends on both information that the respondent obtained from the health care provider and the respondent's ability to convey this information accurately to the interviewer. In the absence of medical care, the respondent's previous experience or education may affect the diagnostic accuracy of reporting. In cases where the condition resulted in limitation of activity but was never medically attended, the diagnostic accuracy of the condition may be suspect, particularly for new conditions. The diagnostic specificity of subgroups of acute respiratory conditions, described in the Introduction, is particularly sensitive to this issue.

Estimates of disability—Obtaining detailed information about the number of disability days associated with each medical condition is complicated by the manner in which the public use files were constructed. For each condition group discussed in this report, the number of associated disability days (restricted-activity days, bed-disability days, and work-loss days) is of interest. Respondents could list more than one underlying condition for a disability day. It is possible to compute the number of disability days listed for each condition in the condition file, but duplication exists for days reported as caused by two or more conditions. Also, the structure of the public use files does not permit linkage of a specific disability day with all the associated illnesses. The person file contains an unduplicated count of disability days for each respondent, but no information on conditions causing disability. This problem is particularly important with regard to respiratory conditions because they are so common and frequently aggravate or complicate other medical problems, particularly coexistent chronic diseases. Therefore, a procedure was devised that would allow estimation of condition-related disability days for persons reporting more than one condition.

Estimation of disability days attributable to a given condition was accomplished by a two-step process. First, for each person, the ratio of the number of disability days in the person file (an unduplicated count) to the total number of disability days in the condition file (a duplicated count) was computed. Second, this ratio was multiplied by the number of disability days listed in the condition file for each medical condition. The result is an estimate of disability days attributable to each condition. The major criticism of this method is that it uniformly reduces the proportion of duplicated days for all conditions. Therefore, variability in actual illness behavior across medical conditions is minimized.

Utilization of health services—For each medical encounter recorded in the survey, respondents could report up to four medical conditions. The public use files show that approximately 10 percent of medical visits have two conditions recorded; multiple conditions are listed for about 12 percent of all hospital stays; and 4 percent of the prescribed medication records have two conditions recorded.

On one hand, listing multiple conditions on the event record permits analysis of patterns of care-seeking behavior associated with different illnesses. Such data can reveal, for example, whether certain illnesses are generally treated by themselves or are treated along with other conditions during a medical visit or hospitalization.

On the other hand, the NMCUES survey instrument does not designate "principal diagnosis" or primary reason for each medical encounter. Therefore, when multiple conditions are reported, it is difficult to attribute health service use to a specific diagnosis. For this report, a condition-related medical service is defined as one for which the respondent identified an acute respiratory condition as the only or as one of several reasons for seeking medical care. Services that are not condition related are defined as those for which none of the acute respiratory conditions was listed.

Cost of health services—The NMCUES data contain a number of improbably low values of total charges for ambulatory visits, prescribed medications, and hospital stays. In many cases, the reported data may not correspond with total charges for the service received but instead represent out-of-pocket expenses incurred by patients. To the extent that some respondents reported out-of-pocket expenses as total charges for services, estimates of total charges are biased downward.

As noted above, people are often treated for more than one condition when they seek medical care. As a result, it is difficult to isolate those charges that are specific to a given illness. Thus, for these analyses, condition-related charges are defined as charges for health services for which acute respiratory conditions were listed as the only or as one of several reasons for seeking care. Because these charges may also reflect the treatment of other conditions, they may overestimate the economic impact of acute respiratory conditions, both for the population as a whole and for individuals suffering from these conditions.

Indirect costs—The indirect cost of illness and injury is the loss of resources resulting from them. Resource loss is generally calculated as lost productive capacity: the loss of potential economic output because of morbidity and mortality. Indirect costs are usually estimated on the basis of the amount of time by which the individual's productivity is diminished or lost and the monetary value of that lost productive time.

In calculating the indirect costs of morbidity for 1980, the first necessary calculation is the number of years of productive activity lost by individuals with illness or injury. This measure deals with lost productivity, so the convention is to count only persons 17 years of age and over who were either working or keeping house at the time of their illness or who were unable to engage in these activities because of illness or injury. However, persons who were unable to work for health reasons for the entire year are excluded from calculations in this report because in NMCUES no condition was associated with such long-term disability. Individuals who were not in the work force for other reasons, e.g., students or retirees, are also not part of the population "at risk" in these calculations.

The unit for calculation of lost productive time is productive person years. Productive years lost, a nonmonetary measure of morbidity costs, is defined as the number of productive days lost because of illness in a year divided by the number of productive days in a year. For this report, lost productive time is calculated for all employed persons and homemakers. Persons who were employed at any time in 1980 were classified as employed in the NMCUES data files. Homemakers are defined as persons who were not employed or disabled in 1980 and who claimed "keeping house" as their primary activity in 1979. For employed persons, reported work-loss days are divided by 245, the average number of workdays in a year, to determine productive time lost. In this study, calculations of lost output for homemakers were performed for both bed-disability days and restricted-activity days because the former underestimates lost productivity and the latter overestimates lost productivity. The appropriate denominator to analyze days lost for either of these calculations is 365 because homemakers can perform their work every day of the year. By performing both sets of calculations, a range of lost productivity with upper and lower bounds can be constructed for homemakers. Estimates in this report are given for the more restrictive unit of measure, bed-disability days, and for restricted-activity days, which yield somewhat higher estimates of lost productivity. Measures of lost productive time for employed individuals and homemakers have been weighted and aggregated to produce national estimates of productive person years for these two population groups.

Estimates of the indirect costs of morbidity are calculated by multiplying an individual's reported work-loss time by his or her reported earnings, when available. Reported earnings do not include employee benefits, so earnings are adjusted by a factor of 1.172 to account for the additional value represented by fringe benefits. The adjustment factor is based on the mean percent of earnings represented by employee benefits (17.2 percent) in 1980 (*Survey of Current Business,* 1981). Lost earnings for employed persons whose earnings were not reported are estimated using U.S. Department of Labor 1980 data for mean annual earnings and are specific to the individual's age, sex, race, and employment status (full or part time). Again, figures are adjusted to include the value of employee benefits. Lost productivity for homemakers, whose labor is not reimbursed, is estimated using the market-value approach. The value of lost homemaker services is approximated by estimating the cost of replacing those services with services purchased in the market. The values employed are derived from time-use studies and relevant wage rates (Hodgson and Rice, 1984; Walker and Gauger, 1973). Details of the estimation procedures, including tables of values used to estimate these costs, are presented in "The costs of illness, United States, 1980," Appendix V (Parsons et al., 1986).

Findings

Incidence

Over one-half of the U.S. civilian noninstitutionalized population (504 per 1,000 persons, or 112.3 million persons) had one or more episodes of acute respiratory disease during 1980 (Table A). Colds (259 per 1,000) and influenza (260 per 1,000) were the most frequently reported conditions. Acute lower respiratory infections were least frequently reported in the survey (39 per 1,000) and were reported approximately one-sixth as frequently as either colds or influenza. When the population is limited to those who reported any condition during 1980, the rates are slightly but consistently higher for all respiratory conditions and for each specific respiratory subgroup. One or more acute respiratory conditions were reported by 589 per 1,000 persons reporting any condition and 504 per 1,000 persons in the general population. The higher incidence rate in those reporting any other health-related condition indicates that there is a slightly greater rate of respiratory conditions among persons who report other medical conditions.

These findings represent estimates of only severe or troublesome episodes of acute respiratory conditions. Only episodes resulting in a medical visit or disability were reported by respondents. Moreover, respondents reported conditions occurring in the last 3 months, making it less likely that a brief episode or mildly symptomatic illness would be recalled. NMCUES rates do not necessarily agree with those from the National Household Interview Survey (NHIS), in which information is obtained on all symptomatic episodes, regardless of morbidity, and which has a shorter recall period. NHIS data indicate 253,175,000 incidents of acute respiratory conditions in 1980, and 52.3 percent of respondents reported one or more episodes during 1980 (Jack, 1981). NMCUES and NHIS estimates of rates are similar, but NMCUES estimates of persons affected are lower, probably because a higher threshold for reporting is used.

Underreporting may differ among the specific subgroups within this broad category because of different levels of disability. Lower respiratory conditions are generally associated with more prominent symptomatology and disability and are more likely to result in utilization of health services. Therefore, lower respiratory conditions would be less likely to be underreported than colds, which can be mild and not result in disability or work loss. The condition subgroups within the respiratory condition category are not mutually exclusive, so the same surveyed individual might report episodes in more than one disease group or multiple episodes of one category but would be counted only once in a person-specific analysis.

Although acute respiratory conditions are usually self-limiting and resolve with little or no residual morbidity, some individuals may have multiple episodes. About 29 percent of the population had one episode, and 21.6 percent had two or more episodes during the calendar year (Table B). Children under 12 years of age had the most recurrent episodes, with 9.6 percent having four or more episodes during the year, compared with 3.2 percent of the total population (Table 1). The proportion of persons experiencing one or more episodes decreased with age. Of children under 12 years of age, 68.1 percent had one or more episodes, and 9.6 percent had four or more. Of people 65 years of age and over, 32.6 percent reported one or more episodes, and less than 1 percent had four or more episodes. Females reported significantly more multiple occurrences of respiratory disease than did males, but there was no significant gender difference in single occurrences. More single and multiple occurrences were reported by white and other persons than by black persons.

Table A

Incidence rate of acute respiratory conditions for all persons and persons with any health condition, by condition group: United States, 1980

Condition group	Estimated population in thousands	All persons	Persons with any health condition
		Rate per 1,000 population	
Persons with acute respiratory conditions	112,302	504.0	588.8
Colds	57,638	258.7	302.2
Nasopharyngitis	16,150	72.5	84.7
Influenza	57,866	259.7	303.4
Otisis media	11,424	51.3	59.9
Lower respiratory infections	8,592	38.6	45.1

NOTE: An estimated 222,824,000 persons were in the civilian nonistitutionalized population in 1980.

Table B

Percent distribution of persons by number of episodes of acute respiratory conditions, according to selected characteristics: United States, 1980

Characteristic	Total	Number of episodes: None	1	2	3	4 or more
		Percent				
All persons	100.0	49.6	28.7	13.1	5.3	3.2
Age						
Under 12 years	100.0	32.0	29.0	19.3	10.2	9.6
12–18 years	100.0	48.2	29.9	14.0	5.8	2.1
19–44 years	100.0	49.8	30.3	12.9	4.7	2.2
45–64 years	100.0	57.5	27.9	10.3	3.2	1.1
65 years and over	100.0	67.4	22.5	7.1	2.3	0.7
Sex						
Male	100.0	53.0	27.5	12.1	4.7	2.7
Female	100.0	46.5	29.9	14.1	5.9	3.7
Race						
Black	100.0	60.6	26.2	8.9	3.0	1.1
White and other	100.0	48.1	29.1	13.7	5.6	3.5
Perceived health status						
Excellent	100.0	49.9	28.8	12.7	5.1	3.5
Good	100.0	48.4	28.9	13.9	5.9	3.0
Fair	100.0	49.9	28.3	13.6	5.3	2.9
Poor	100.0	56.8	26.6	10.4	3.0	3.2

It is not clear whether age, sex, and race differences represent true differences in incidence or, alternatively, variability in recall or perceived morbidity. The age gradient of decreased episodes, either single or multiple, supports the idea of decreased incidence with increasing age rather than possible differential reporting by those in school, the work force, or retirement. The male-female differences are small but consistent. The differences by race are also consistent. However, the possibility that differences in reporting or in perceived severity of illness consistently bias the results cannot be excluded.

The perceived health status of persons was not related to the occurrence of single or multiple episodes of acute respiratory conditions, and persons rating their health as "poor" tended to report fewer respiratory episodes (Table B). A person's subjective assessment of health status is generally determined by the presence of chronic or debilitating diseases. Acute respiratory conditions either occur no more frequently than chronic conditions or are given relatively little attention compared with coexisting chronic conditions. Therefore, persons rating their health status as "poor" may not feel that acute respiratory conditions merit reporting.

The distributions by age, sex, race, education, and family income of persons reporting the specific conditions comprising acute respiratory diseases are given in Table 1. Colds, nasopharyngitis, influenza, and otitis media were more commonly reported in children (under 12 years of age) and in younger adults (12–44 years of age) than in older adults. The inverse relationship of these rates to age was consistent and significant. The rates for influenza were relatively high throughout childhood and the middle adult ages, with the lowest rates being found in those 65 years of age and over. Otitis media, including complications, was predominantly reported for children. Lower respiratory infections were more common at the two ends of the age range, in those under 12 years of age and 65 years of age and over.

The lower rates of acute respiratory conditions for people 65 years of age and over may reflect several factors: differential reporting, decreased exposure to infectious agents from lessened social and work interactions, and effect of immunization programs, or natural development of relative immunity over a lifetime of exposure. Whatever the explanation, rates for acute respiratory conditions exclusive of lower respiratory disease were relatively low in the elderly population even during a year of high influenza rates.

Females reported higher rates of disease for every acute respiratory condition except otitis media, which had similar rates for males and females. White and other persons reported higher rates for all acute respiratory conditions than did black persons, with the most striking differences being found for influenza, otitis media, and lower respiratory disease. There was a positive relationship between rates of reported disease and education for every condition except lower respiratory disease, for which no difference was found. There was no evident pattern by income for lower respiratory conditions, but the lowest rates were found for those at the highest income level ($35,000 or more). In other condition groups, the rates generally were directly related to income, with the lowest rates being reported in the lowest family income group (less than $10,000) and the highest rates in the higher family income groups ($20,000–$34,999 or $35,000 and more). Demographic differences in rates could represent differential reporting because of varying perceptions of acute illness and different financial ability to pay for health care.

These incidence data correspond with demographic patterns of respiratory conditions found in NHIS data. (As explained earlier, NMCUES estimates are expected to be somewhat lower than those from NHIS.) According to both NHIS and NMCUES data, rates for acute upper respiratory conditions are highest in youth and decline with age. For lower respiratory infections, there is no consistent age gradient, and the highest rates are in the young and in the old. Females, white and other persons, and persons with more education and higher incomes have higher rates of acute respiratory conditions.

Disability

Acute respiratory conditions were associated with means of 5.9 restricted-activity days, 3.2 bed-disability days, and 2.1 work-loss days (Table C). Colds, nasopharyngitis, and otitis media resulted in the fewest days of disability. Influenza was associated with significantly more disability than other upper respiratory conditions. Lower respiratory infections accounted for the greatest mean number of restricted-activity, bed-disability, and work-loss days.

The civilian noninstitutionalized population had 13.8 restricted-activity days, 5.3 bed-disability days, and 5.8 work-loss days per capita (Parsons et al., 1986). Therefore, in each disability category, the mean level of disability attributed to acute respiratory conditions was less than that reported for all conditions in the general population. Lower respiratory infections were associated with two to four times as many restricted-activity and bed-disability days as were colds, nasopharyngitis, or otitis media. The bed-disability and work-loss days associated with influenza were at least twice as great as those for other upper respiratory conditions, but 1980 was characterized as an influenza epidemic year.

Table C

Mean days of condition-related disability for persons with acute respiratory conditions, by type of disability and condition group: United States, 1980

Condition group	Type of disability		
	Restricted activity	Bed disability	Work loss
	Mean days		
Total	5.9	3.2	2.1
Colds	3.7	1.7	1.1
Nasopharyngitis	2.3	1.2	0.8
Influenza	5.4	3.2	2.2
Otitis media	3.4	1.3	0.6
Lower respiratory infections	8.2	4.7	2.9

Indirect Costs

Indirect medical costs represent the loss to society of productivity foregone because of illness. These costs were considerable for acute respiratory conditions (Table D). For the total category of acute respiratory conditions, $8.4 billion was calculated as the indirect cost when bed-disability days were used as the measure of lost productivity for homemakers in the estimates, and $9.1 billion was estimated when restricted-activity days were used. Employed persons incurred $7.7 billion in indirect costs; homemakers incurred $698 million and $1.4 billion when bed-disability days and restriced-activity days, respectively, were used in the calculation.

Among the specific subgroups, influenza had the greatest associated indirect costs for employed persons and for homemakers when restricted-activity days were used as the measure. Somewhat lower, but nevertheless important in relation to other disorders, were the indirect costs associated with colds. Indirect costs from colds were approximately one-half of those attributed to influenza, although the incidence of the two disorders in 1980 was similar (Table A). However, the indirect costs attributed to colds were several times greater than those for the other specific acute respiratory conditions. Otitis media was associated with the lowest attributable indirect costs. This disorder affects primarily younger persons, who are not in the work force, so one would not expect an appreciable indirect cost impact. On the other hand, these calculations do not capture the indirect costs to the responsible adult who must provide dependent care during the illness of a child. The estimates in Table D are not discrete for each of the subgroups, as persons might have had more than one respiratory condition or multiple episodes of conditions. The data files in NMCUES do not permit separation of these costs by specific episodes.

The indirect costs associated with acute respiratory conditions were considerably greater than those calculated for hypertension and cardiovascular diseases (Harlan et al., to be published) or for musculoskeletal conditions (Murt et al., 1986). The contrast with cardiovascular diseases is especially striking. The indirect costs of illness attributed to acute respiratory conditions were approximately fourfold to fivefold greater than those for cardiovascular conditions. The differences for mus-

Table D

Estimated value of productivity lost as a result of morbidity for persons with acute respiratory conditions, by employment and condition group: United States, 1980

Condition group	Total			Homemakers	
	Bed disability[1]	Restricted activity[2]	Employed	Bed disability[1]	Restricted activity[2]
	Amount in millions				
Persons with acute respiratory conditions	$8,355	$9,068	$7,657	$698	$1,412
Colds	2,309	2,533	2,177	133	356
Nasopharyngitis	366	407	341	24	65
Influenza	4,786	5,135	4,341	45	794
Otitis media	135	143	119	16	24
Lower respiratory infections	772	867	688	84	180

[1]Calculated using bed-disability days as measure of lost productivity for homemakers.
[2]Calculated using restricted-activity days as measure of lost productivity for homemakers.

NOTE: "Employed" refers to persons employed at any time in 1980; "homemakers" refers to persons who did not work for all of 1980 but were not disabled and claimed homemaking as their major activity in 1979.

Table E

Mean ambulatory care visits for persons with acute respiratory conditions and percent distribution by reason for visit, according to condition group: United States, 1980

Condition group	All visits	Reason for visit		
		Indexed condition only	Indexed condition and unrelated morbidity	Unrelated morbidity only
	Mean visits			
Persons with acute respiratory conditions	5.9	0.9	0.1	4.9
Colds	5.9	0.6	0.1	5.2
Nasopharyngitis	7.3	0.6	0.2	6.5
Influenza	5.7	0.4	0.0	5.3
Otitis media	7.4	1.6	0.4	5.3
Lower respiratory infections	8.7	1.3	0.4	7.0
	Percent distribution			
Persons with acute respiratory conditions	100.0	15.0	1.7	83.3
Colds	100.0	10.4	1.6	88.0
Nasopharyngitis	100.0	8.4	2.1	89.5
Influenza	100.0	6.3	0.8	92.9
Otitis media	100.0	22.1	5.7	72.3
Lower respiratory infections	100.0	15.2	4.1	80.6

NOTE: An estimated 5.2 mean ambulatory care visits were made by the total civilian noninstitutionalized population.

culoskeletal disorders were less marked; nevertheless, respiratory conditions had 1-1/2 to 3 times greater indirect costs. The considerably greater indirect costs for acute respiratory conditions than for two common categories of chronic disease may be attributable to the greater incidence of respiratory conditions and their propensity to result in work-loss, bed-disability, or restricted-activity days. In contrast, cardiovascular and musculoskeletal conditions may result in chronic functional limitation or elimination from the work force but less work absence or bed disability.

Ambulatory Visits and Treatment

Ambulatory visits by the U.S. population for acute respiratory conditions are shown in Table E. An estimated 112.3 million persons had one or more episodes of acute respiratory conditions (Table A). These persons averaged 5.9 visits to health care providers, but only a fraction (0.9) of a visit was specifically attributable to acute respiratory conditions (15 percent), and 0.1 of a visit (1.7 percent) was for a respiratory condition plus another unrelated condition. The majority of ambulatory visits made by persons reporting a respiratory condition (4.9 visits) were for unrelated morbidity. Although acute respiratory conditions were common in the general population and were frequently responsible for disability days and relatively great indirect costs, they were not commonly the main reason for an ambulatory visit.

This pattern of infrequent visits for the indexed condition was found for colds, nasopharyngitis, and influenza. A greater proportion of visits for otitis media and lower respiratory infections (22.1 percent and 15.2 percent, respectively) were made for the indexed condition only. Otitis media and lower respiratory infections may have considerable morbidity and often require prescribed medications, especially antibiotics. A greater proportion of ambulatory visits were for treatment of these conditions alone or in conjunction with a related condition. Although ambulatory care visits include visits to nonphysician providers such as chiropractors and podiatrists, it is assumed that most visits specifically attributable to acute respiratory conditions were made to physicians or to nonphysicians working under a physician's supervision.

The distributions of ambulatory visits by age, sex, and race are given for each condition in Tables 2–6. For all subgroups reporting one or more upper respiratory conditions, total visits increased for successively older groups, but the number of visits specifically attributed to acute respiratory conditions were lower for older adults. Therefore, younger persons had a greater proportion of ambulatory visits for the indexed respiratory condition, and older people made a greater proportion of visits for problems unrelated to acute respiratory conditions.

Hospital Admissions and Surgical Procedures

Acute respiratory conditions infrequently require hospital admissions for treatment, but they may lead to hospitalization by complicating a chronic disease or by causing development of permanent structural changes from persistent or recurrent infections. For persons reporting acute respiratory conditions, Table F shows rates of hospital admissions specifically attributable to acute respiratory conditions (indexed condition) and attributable to unrelated conditions. Less than 3 percent of persons reporting upper respiratory conditions required hospitalization specifically for the condition. Hospital admissions were more frequently for an unrelated condition, and 10.4 percent reported such an admission. Persons reporting lower respiratory infections represent a different subgroup. These individuals were at least six times as likely to be hospitalized for the condition as people reporting upper respiratory conditions were. They were also significantly more likely to be hospitalized for an unrelated condition. These findings indicate the severity of lower respiratory infections and suggest that they occur more frequently in persons with other serious conditions requiring hospitalization.

Table F

Percent of persons with acute respiratory conditions who had a hospital admission, by reason for admission and condition group: United States, 1980

Condition group	Reason for admission		
	All admissions	Indexed condition	Unrelated condition
		Percent	
All acute respiratory conditions	12.5	2.1	10.4
Colds	11.9	1.1	10.8
Nasopharyngitis	15.5	2.7	12.8
Influenza	11.0	0.5	10.5
Otitis media	12.7	1.8	10.9
Lower respiratory infections	29.6	12.2	17.4

The rate for surgical procedures related to acute respiratory conditions was 5 per 1,000 population (Table G), and more than one-half of the relevant procedures were tonsillectomy and/or adenoidectomy (2.7 per 1,000). (Thoracotomy was specifically excluded from these analyses.) The rates for all respiratory surgical procedures, and specifically for tonsillectomy and/or adenoidectomy, were highest when nasopharyngitis (31.5 per 1,000) or otitis media (17.9 per 1,000) was the associated acute disease. Surgical procedures were least frequently reported in association with influenza (5.7 per 1,000). Tonsillectomy and/or adenoidectomy represented 78.7 percent of surgical procedures for nasopharyngitis and 62.6 percent for otitis media. These proportions are slightly greater than the proportion for all persons with or without respiratory conditions (54.0 percent).

The rates for all surgical procedures were highest in those under 18 years of age, and tonsillectomy and/or adenoidectomy accounted for the preponderance of procedures. Rates for related surgical procedures were lowest in those 45–64 years of age and rose again among persons 65 years of age and over. The rates for tonsillectomy and/or adenoidectomy were essentially zero for those 45 years of age and over. Surgical procedures for these older persons were probably related to diagnostic procedures, such as bronchoscopy and biopsy. Respiratory surgical procedures were significantly more common in males than females, and tonsillectomy and/or adenoidectomy rates were also significantly greater for males than females. Surgical rates were significantly greater for white and other persons than for black persons, but the tonsillectomy and/or adenoidectomy rates did not differ significantly between the racial groups.

Table G

Rate of condition-related surgical procedures for persons with acute respiratory conditions, rate of tonsillectomy and/or adenoidectomy procedures, and charges for procedures, by condition group and selected characteristics: United States, 1980

	Relevant respiratory surgical procedures[1]		Tonsillectomy and/or adenoidectomy	
Condition group and characteristic	Rate per 1,000 population	Charges in millions	Rate per 1,000 population	Charges in millions
All persons	5.0	$2,082	2.7	$651
Persons with acute respiratory conditions	8.5	1,429	5.3	640
Condition group				
Colds	11.0	865	7.4	442
Nasopharyngitis	31.5	581	24.8	429
Influenza	5.7	483	3.0	184
Otitis media	17.9	236	11.2	143
Lower respiratory infections	12.3	342	6.3	60
Age				
Under 12 years	10.7	452	9.0	371
12–18 years	7.8	357	5.5	192
19–44 years	3.0	392	0.9	88
45–64 years	1.8	217	-	-
65 years and over	4.6	664	-	-
Sex				
Male	5.8	1,207	3.2	379
Female	4.1	875	2.3	272
Race				
Black	4.0	137	2.9	99
White and other	5.1	1,946	2.7	552

[1]Excludes thoracotomies.

Direct Costs

Total charges—The total charges for acute respiratory conditions and for each subgroup are presented in Table H. Charges for inpatient hospital care accounted for $4.1 billion, or 48.6 percent of the total direct costs specifically related to acute respiratory conditions. Physician services represented 39.5 percent of total charges, and smaller proportions of the charges were attributed to prescribed medications (9.5 percent), other professional services (2.0 percent), and dental and other services (0.4 percent). In comparison with direct costs for all health problems in the U.S. civilian noninstitutionalized population (Table J), acute respiratory conditions had significantly greater proportions of physician charges and prescribed medication charges. For lower respiratory infections, charges for inpatient hospital care were proportionately greater and charges for physician services less, a pattern concordant with the greater utilization of hospital services for lower respiratory infections (Table F).

The total direct costs of acute respiratory conditions were $8.3 billion, which represented 5.4 percent of the reported health care costs for the total population (Tables H and J). Acute respiratory diseases were responsible for 5.6 percent of total direct costs for hospital care and 7.6 percent of charges for physician services. Lower respiratory infections represented the greatest charges ($3.5 billion) among the subgroups of acute respiratory conditions, comprising 42.0 percent of the total. Physician charges for lower respiratory infections comprised $750 million, or 22.7 percent of the total physician charges for all persons with acute respiratory conditions, although persons having this condition represented only 7.7 percent of the total reporting an acute respiratory condition. Upper respiratory conditions differed from lower respiratory infections with respect to charges. Upper respiratory conditions had a larger proportion of total direct costs attributed to physician services (44.1–57.3 percent) and to prescribed medications (13.7–14.5 percent) than did lower respiratory infections (21.4 percent for physician services and 2.7 percent for prescribed medications). On the other hand, hospital charges were proportionately smaller for upper respiratory conditions (26.1–37.7 percent) than for lower respiratory infections (74.1 percent).

Per capita charges and out-of-pocket expenditures—The per capita condition-related charges attributable to medical care for acute respiratory conditions during 1980 are given in Table K. Per capita charges ranged from

Table H

Condition-related charges for persons with acute respiratory conditions and percent distribution by type of service, according to condition group: United States, 1980

Condition group	All condition-related health services	Type of service: Hospital inpatient care[1]	Physician services[2]	Other professional services[3]	Prescribed medications	Other health services[4]
		Amount in millions				
Persons with acute respiratory conditions	$8,345	$4,052	$3,299	$165	$795	$35
Colds	2,030	661	1,034	48	283	4
Nasopharyngitis	915	345	403	34	133	-
Influenza	1,164	349	635	14	160	6
Otitis media	1,048	273	600	23	143	8
Lower respiratory infections	3,508	2,600	750	48	93	18
		Percent distribution				
Persons with acute respiratory conditions	100.0	48.6	39.5	2.0	9.5	0.4
Colds	100.0	32.6	51.0	2.3	13.9	0.2
Nasopharyngitis	100.0	37.7	44.1	3.7	14.5	-
Influenza	100.0	30.0	54.5	1.2	13.7	0.5
Otitis media	100.0	26.1	57.3	2.2	13.7	0.8
Lower respiratory infections	100.0	74.1	21.4	1.4	2.7	0.5

[1]Excludes physician services provided to patients admitted to the hospital.
[2]Includes both inpatient and outpatient physician services.
[3]Includes chiropractors, podiatrists, optometrists, psychologists, social workers, nurses, physical therapists, and others.
[4]Includes dental services, eyeglasses, orthopedic appliances, hearing aids, diabetic supplies, and ambulance services.

Table J

Total charges for all persons and for persons with acute respiratory conditions and percent distribution by type of health service, according to condition group: United States, 1980

Condition group	All health services	Type of service: Hospital inpatient care[1]	Physician services[2]	Other professional services[3]	Prescribed medications	Other health services[4]
		Amount in millions				
All persons	$153,878	$71,955	$43,490	$9,197	$7,831	$21,405
Persons with acute respiratory conditions	73,899	30,684	22,403	4,974	4,403	11,435
Colds	35,450	13,680	11,113	2,506	2,203	5,948
Nasopharyngitis	12,052	4,723	3,867	849	880	1,733
Influenza	35,282	14,153	10,770	2,382	2,049	5,929
Otitis media	6,993	2,675	2,533	438	491	856
Lower respiratory infections	11,541	6,545	2,990	476	564	967
		Percent distribution				
All persons	100.0	46.8	28.3	6.0	5.1	13.9
Persons with acute respiratory conditions	100.0	41.5	30.3	6.7	6.0	15.5
Colds	100.0	38.6	31.3	7.1	6.2	16.8
Nasopharyngitis	100.0	39.2	32.1	7.0	7.3	14.4
Influenza	100.0	40.1	30.5	6.8	5.8	16.8
Otitis media	100.0	38.2	36.2	6.3	7.0	12.2
Lower respiratory infections	100.0	56.7	25.9	4.1	4.9	8.4

[1]Excludes charges for physician services provided to patients admitted to the hospital.
[2]Includes both inpatient and outpatient physician services.
[3]Includes chiropractors, podiatrists, optometrists, psychologists, social workers, nurses, physical therapists, and others.
[4]Includes dental services, eyeglasses, orthopedic appliances, hearing aids, diabetic supplies, and ambulance services.

Table K

Per capita condition-related charges for persons with acute respiratory conditions and percent of charges paid out of pocket, by type of health service and condition group: United States, 1980

Condition group	All condition-related health services		Hospital admissions[1]		Ambulatory visits[2]		Prescribed medications		Other health services[3]	
	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket
Total	$74	29.8	$42	13.1	$25	46.5	$7	70.1	$0.3	31.3
Colds	35	37.8	14	8.9	17	52.0	5	69.2	0.0	47.0
Nasopharyngitis	57	25.8	30	4.9	18	43.6	8	63.1	-	-
Influenza	20	36.7	7	6.2	10	46.9	3	74.9	0.0	24.2
Otitis media	92	36.8	28	13.0	50	41.5	13	72.0	1	26.7
Lower respiratory infections	408	21.5	343	16.7	53	42.2	11	71.0	2	29.5

[1]Includes inpatient physician services.
[2]Includes outpatient visits to physicians and to other health professionals.
[3]Includes dental and other health services.

$20 to $92 for upper respiratory conditions. The high per capita charge for lower respiratory conditions, $408, reflects greater charges for hospital care ($343). Of upper respiratory conditions, otitis media was associated with the greatest charges ($92), primarily because of high charges for ambulatory visits ($50) and prescribed medications ($13).

Per capita charges for colds ($35) were higher than those for influenza ($20), though not significantly so. The similarity was unanticipated because influenza is generally a more severe illness, and 1980 was characterized as an epidemic year for influenza with a significant increase in fatalities. The population reporting one or more episodes of either condition was similar (57,638,000 for colds and 57,866,000 for influenza), and only slightly more ambulatory visits were reported for colds. Multiple episodes of colds do not account for the difference, as multiple episodes were reported with equal frequency for both conditions. However, influenza was reported more frequently in the working-age population than colds were and was associated with greater indirect costs. These findings suggest that adults may have identified their illness as influenza, knowing that it was epidemic, and remained home from work but did not seek medical care. On the other hand, medical care may have been sought for younger persons with colds because of parental uncertainty about the diagnosis, severe symptoms, or complications. The problem of complications might also indicate why per capita hospital charges are higher for colds than for influenza.

The proportion of charges paid out of pocket averaged 29.8 percent and varied from 21.5 percent to 37.8 percent (Table K). The smallest proportion of out-of-pocket expenditures was for lower respiratory disease, reflecting the greater number of hospital admissions and subsequent third-party health care coverage for this condition. Prescribed medications were generally paid out of pocket (70 percent). Charges paid out of pocket for ambulatory visits (46.5 percent) also represented important sources of these expenses.

Per capita hospital charges—Per capita inpatient hospital charges were greater than per capita charges for ambulatory visits, although the proportion of out-of-pocket expenses was less than one-third (Table K). Hospital charges for upper respiratory conditions were modest, ranging from $7 to $30 per capita, but per capita hospital charges for lower respiratory infections were more than 10 times greater at $343. Per capita hospital charges for nasopharyngitis and otitis media were somewhat higher than charges for colds and influenza were. This reflects the higher surgical rates, specifically for tonsillectomy and/or adenoidectomy, for these conditions (Table G).

Per capita charges by demographic characteristics—The patterns of costs for specific respiratory subgroups by demographic characteristics (Tables 7–11) indicate considerable differences in charges. The tables have been constructed so the charges for all conditions can be contrasted with charges specifically for respiratory conditions. The tables show per capita charges as well as the percent of total charges that were out of pocket.

For persons reporting colds (Table 7), the average charges specifically for colds were $35, but charges for all conditions were $615. The proportion of out-of-pocket expenses for the indexed condition was 37.8 percent, and for all conditions 33.0 percent. By age group, the charges attributable to colds were greatest in those under 12 years of age and least in those 12–17 years of age. By contrast, per capita charges for all conditions were lowest in the youngest group and increased progressively for each age group. Therefore, the proportion of total per capita charges attributable to colds decreased in successively older groups. The proportion was 15.3 percent ($46/$300) for those under 12 years of age but decreased to 2.3 percent ($37/$1,601) for those 65 years of age and over.

Although more females than males reported colds (Table 1), females reported lower per capita charges for care of colds. The charges for all conditions were similar for both sexes. The proportion of cold-related out-of-pocket expenses was slightly greater for females (40.8 percent) than males (35.1 percent), and females also had a greater proportion of out-of-pocket expenses for all illnesses.

There were no major racial differences in charges for all conditions or specifically for colds. The proportion of total out-of-pocket expenditures was significantly greater for white and other persons than for black persons. Charges for colds were greatest for those with the lowest family income and the least education of the head of family. However, for all conditions, the distribution of per capita charges across education or income tended to have a U-shaped relationship.

Similar patterns were found for pharyngitis and influenza (Tables 8 and 9). The proportion of total charges accounted for by these respiratory disease categories was lower in successively older age groups. Relatively small differences were found by sex and race in per capita charges specifically related to these conditions. The pattern of greater charges for males and black persons was generally present. An inverse relationship between per capita charges and education and income was found. Otitis media involved charges primarily for those under 12 years of age, but little variation among per capita charges was apparent by other sociodemographic characteristics (Table 10).

The per capita charge pattern for lower respiratory infections differed markedly from that for the other conditions (Table 11). Per capita charges specifically for lower respiratory infections increased fivefold from the youngest to the oldest age group ($151 for under 12 years of age to $842 for 65 years of age and over). Per capita charges for all conditions also increased proportionately with age, from $543 to $2,882. The proportion of total charges attributed to lower respiratory disease was similar at all ages, varying from 27 to 37 percent. The proportion attributable to acute respiratory conditions did not decrease with increasing age, as was the case for upper respiratory infections. The proportion of lower respiratory charges that were paid out of pocket was lowest for persons 65 years of age and over, accounting for only 10.6 percent of total per capita charges.

There were differences by sex and race in per capita charges for lower respiratory infections. Males had 2.4 times greater charges than females had for lower respiratory infections, but the difference was not statistically significant. On the other hand, charges for all conditions for males were 1.5 times greater than charges for females, a statistically significant difference. Black persons had almost twofold greater charges for lower respiratory disease than white and other persons had, although the differential charges between the two groups for all medical conditions was small and the differences were not significant. The proportion of total out-of-pocket expenses was significantly greater for black persons, being 2.6 times more than the proportion for white and other persons. This represents a reversal of the pattern observed for upper respiratory infections.

Per capita charges were greatest for the lowest educational level and were only about one-half as great among those who reported some college education. Charges for this condition differed considerably by income level. Persons with family incomes less than $20,000 per year had six times greater per capita charges for lower respiratory disease than persons with incomes of $35,000 per year or more had, but the variances were great and the differences were not significant.

Per capita charges for acute respiratory conditions confirm the pattern for visits. For younger persons, particularly those under 12 years of age, respiratory infections accounted for a major proportion of total health care charges, and these charges were primarily attributable to ambulatory visits and prescribed medications (Tables 12–16). Hospital and surgical charges resulted primarily from tonsillectomy and/or adenoidectomy. For young adults (18–44 years of age), the per capita charge for respiratory conditions constituted a lesser proportion of per capita charges for all conditions than at younger ages. Over 45 years of age, a relatively small proportion of health care charges were related to respiratory infections; this was particularly striking for persons 65 years of age and over. However, the total per capita charges for all conditions were greater with increasing age. This pattern was found for each subgroup of acute respiratory conditions except lower respiratory disease. Persons with lower respiratory infections had markedly higher per capita charges, and charges were greatest in the older age groups. Moreover, total charges for all conditions were greater in persons with lower respiratory infections, indicating that their general health was not as good as that of persons with upper respiratory infections.

Discussion

Acute respiratory conditions are common and frequent in the general population and represent an important source of direct and indirect medical costs. NMCUES data permit estimates of incidence and costs for these conditions, but caveats should be noted regarding these estimates. The actual incidence rates for acute respiratory conditions cannot be accurately estimated from this survey because episodes were reported only if they were sufficiently troublesome to require a visit to a health provider or caused disability. An important strength of NMCUES as regards acute respiratory conditions was the quarterly sampling during the survey year. This frequent sampling and the use of a calendar diary improved the likelihood that relatively minor acute episodes would be recorded. The repeated surveys of the same cohort provided estimates of seasonal incidence, patterns of recurrence, and more reliable estimates of economic effects of illness, particularly when compared across sociodemographic groups. Another issue is the accuracy of respondent-reported diagnoses for the subgroups of acute respiratory conditions. The accuracy is suspect, particularly when many episodes were not medically attended. However, the seasonal rates for subgroups, documented in Figures 1 and 2, were remarkably consistent with the expected seasonal patterns and the reported influenza trends for 1980. Moreover, the agreement between the observed demographic correlates of acute respiratory subgroups in this survey and those reported in the literature support the separation of the general category into subgroups for analysis (Gwaltney, 1985; Trevino and Moss, 1984; Jack, 1981).

During 1980, more than one-half of the civilian noninstitutionalized population had one or more episodes of acute respiratory conditions. Colds and influenza accounted for the major proportion of occurrences, and their rates were approximately equal. However, calendar year 1980 exceeded the epidemic threshold for influenza and pneumonia deaths during the first 2 months of the year (Centers for Disease Control, 1984). Therefore, one would expect the rates for influenza, and perhaps for lower respiratory infections, to be unusually high. This probably accounts for the roughly equal rates, because colds are generally more common than influenza (Gwaltney, 1985). Therefore, the results of this survey might not be representative of the "usual" year, and health care use patterns and costs may be affected as well.

The effect of acute respiratory conditions on medical costs was impressive, although 1980 may not be a typical year. Direct medical charges attributed to respiratory disease accounted for 5 percent of the total direct charges for all medical care. This relatively high proportion of care costs resulted from the high incidence rate of acute respiratory conditions despite a relatively low cost per occurrence. The finding is even more impressive considering that a large proportion of episodes were not medically attended, the per capita costs for ambulatory visits were relatively low, and hospital admissions were infrequent. Lower respiratory infections constituted the only subgroup with an important proportion of hospital charges. Therefore, the direct costs attributable to acute respiratory conditions resulted from high incidence despite low unit costs.

Indirect costs associated with acute respiratory conditions were equivalent with the direct costs of these disorders. Indirect costs reflect the economic or societal loss of productivity resulting from the condition or its treatment (Cooper and Rice, 1976). Disability costs are included if there was a loss of productivity even if medical consultation was not obtained. Conservative estimates based on bed-disability days yielded $7.7 billion for employed persons and $698 million for homemakers. Estimates based on bed disability are conservative because lesser disability not requiring bed care is not included. These estimates are even more remarkable because persons under 17 years, who had the highest incidence of acute respiratory conditions, were not included in the calculation of indirect costs. Moreover, indirect costs do not include the cost of attendance by a caretaker who might remain away from work although not experiencing the condition.

The disability costs attributed to respiratory conditions were greater than those for either cardiovascular disease or musculoskeletal conditions, which are prevalent chronic or recurrent disorders. The relatively great morbidity costs of acute, generally self-limiting conditions can be attributed to the frequency of the respiratory conditions and their predisposition to affect younger, working-age persons and to cause frequent brief periods of bed disability followed by recovery. Chronic disorders tend to result in removal from the work force through prolonged disability or a lower functional status. Thus, their impact might not be reflected in disability days lost from work.

Service use patterns and per capita charges differed among the subgroups of respiratory conditions. Colds and influenza were characterized by predominantly ambulatory care with relatively low per capita charges. Otitis media and nasopharyngitis were more commonly associated with surgical procedures, primarily tonsillectomy and/or adenoidectomy, than were the other acute respiratory conditions (Kozak and McCarthy, 1984). Despite more frequent surgical procedures, per capita charges remained relatively low for otitis media and nasopharyngitis. All of these subgroups were more common in younger persons, for whom they comprised a major source of health costs. However, lower respiratory infections contrasted sharply with the upper respiratory conditions and had considerably higher per capita charges. Lower respiratory infections were common in older persons and were more often associated with hospital admissions. The considerable costs associated with lower respiratory disease make preventive strategies for this group of conditions a high priority from the perspective of cost containment and health improvement.

The availability of vaccines capable of preventing pneumococcal pneumonia and influenza provides a potentially cost-effective strategy to prevent acute lower respiratory disease. The polyvalent pneumococcal vaccine effectively prevents lower respiratory infection from the most common etiologic agent. The influenza vaccine is produced annually and contains the viruses most likely to be encountered during the year. Both immunizations have proved effective. The pneumococcal vaccine need be given only once to each individual; the influenza vaccine should be administered annually. Immunization has been recommended for older persons and for those with chronic or debilitating conditions. Immunization costs are small compared with the direct and indirect costs of acute lower respiratory illness, particularly for older persons. Untoward effects of the vaccines are minimal. However, the response by physicians and the public has been disappointingly small. Consideration should be given to a detailed formal assessment to determine whether this form of prevention is as cost effective as it appears to be. If so, incentives for immunization of persons covered by Medicare might be considered as a means of increasing compliance with the recommendation for immunization.

The distributions of utilization and charges for acute respiratory conditions by sociodemographic characteristics provide an interesting portrayal of service use. Overall, acute respiratory conditions had the highest incidence and greatest per capita charges in children and adolescents and were lower in older persons. This pattern was most prominent for upper respiratory conditions (colds, influenza, nasopharyngitis, and otitis media). Lower respiratory infections were major reasons for service use and medical charges at the two extremes of the age distribution, in children and in those 65 years of age and over. Per capita charges for lower respiratory infections were four times greater than those for any other subgroup. Males and white and other persons had greater per capita charges for acute upper respiratory conditions, although the reported incidence was not remarkably different than that for females and black persons. This suggests that incidence of acute upper respiratory conditions is roughly similar by sex and race, but careseeking behaviors differ. Black persons and those with lower income levels had greater charges for lower respiratory diseases. Because most persons with lower respiratory infections seek medical care, the increased charges for black persons may relate to more severe illness, delay in seeking care, or complications that increase morbidity.

When ambulatory visits for all acute respiratory conditions were compared with ambulatory visits for unrelated conditions, an interesting pattern was found. Acute respiratory conditions represented a greater proportion of all visits and of all per capita charges for younger persons. For older persons, the number of acute respiratory conditions was somewhat less, and these conditions accounted for a relatively small proportion of all ambulatory care visits. The incidence of acute respiratory conditions decreases in older persons, but the prevalence of chronic disorders increases. For example, older persons make more ambulatory visits and have more hospital admissions for cardiovascular and musculoskeletal conditions. There is no indication from these survey data that acute respiratory conditions are more common in persons with chronic conditions. Therefore, the financial impact of acute respiratory conditions is greater on younger persons (and their caretakers) than on older persons. The financial impact of lower respiratory infections is somewhat greater than the impact of upper respiratory conditions among older persons, who have greater incidence and unit charges for lower respiratory infections.

Acute respiratory conditions have been considered relatively unimportant from the economic perspective because of the self-limiting nature and relatively low costs of care for each episode. However, data from NMCUES indicate that the aggregate direct costs attributable to these conditions are relatively great, and the indirect costs from lost or decreased productivity are remarkably high, equivalent to the direct costs. Although the cost impact on individuals is low, the total cost to society is high because of the frequency of these conditions and the higher incidence in younger employed individuals. The economic impact of these conditions relates primarily to indirect costs. The direct costs of illness would be greater if all persons experiencing morbidity from acute respiratory conditions were to seek medical care. Acute lower respiratory infections differ in their economic impact. They more often result in ambulatory care visits and hospital admissions, and the direct charges for care are proportionately higher than for upper respiratory conditions.

The economic burden of acute respiratory conditions is largely related to the indirect costs of illness. Therefore, strategies to prevent work loss and functional disability would have the greatest economic impact.

The desirability of immunization for the elderly has been discussed. Planners should also consider the possible benefits from immunizing persons under 65 years of age. For example, military recruits are immunized against influenza, and this successfully prevents interruption of training because of infections from these viruses. The cost savings of maintaining the training sequence is substantial, so immunization is cost effective in this situation. However, it is not clear that immunization would be similarly cost effective in a civilian population or that compliance with immunization would be as great.

A second strategy to decrease illness costs is to make drugs for symptomatic treatment available without prescription. Symptomatic relief could thus be obtained without a physician visit. This strategy becomes increasingly feasible as greater numbers of drugs formerly available by prescription only become available "over the counter." The fact that a majority of colds reported in this survey did not result in an ambulatory care visit indicates that self care is important. On the other hand, bacterial infections, such as otitis media and lower respiratory disease, require antibiotics that remain prescription drugs in the United States because of the potential for serious side effects.

It will be of interest to follow trends in the costs of care for acute respiratory conditions if immunization programs are expanded and more effective over-the-counter treatment for viral infections is introduced. Economic evaluation of trends in nonprescription therapy and immunization should be directed at indirect costs, which constitute the cost component most responsive to these strategies.

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List of Detailed Tables

Table 1

Number of persons with acute respiratory conditions and rate per 1,000 population, by condition and selected characteristics: United States, 1980

Characteristic	Estimated population in thousands	All acute respiratory conditions	Colds	Naso-pharyngitis	Influenza	Otitis media	Lower respiratory infections
		Number of persons in thousands					
Age							
Under 12 years	42,019	28,582	17,314	4,189	13,412	6,513	2,237
12–17 years	24,045	12,628	6,518	1,712	6,905	892	612
18–44 years	89,713	44,918	22,307	6,161	24,733	2,517	3,113
45–64 years	43,578	18,528	7,921	2,837	9,459	1,062	1,641
65 years and over	23,469	7,646	3,579	1,250	3,357	440	988
Sex							
Male	107,481	50,547	25,588	6,596	25,831	5,576	3,607
Female	115,344	61,755	32,050	9,553	32,035	5,848	4,985
Race							
Black	26,046	10,252	6,119	1,411	3,736	872	709
White and other	196,779	102,049	51,519	14,738	54,130	10,552	7,883
Education of head of family							
Not a high school graduate	72,128	31,004	15,319	4,339	15,031	2,441	2,564
High school graduate	78,063	39,954	20,472	5,614	20,225	4,093	3,113
Some college	72,633	41,345	21,847	6,196	22,610	4,891	2,914
Family income							
Less than $10,000	42,766	19,334	9,626	2,765	9,474	2,080	1,594
$10,000–$19,999	60,176	30,074	15,775	4,227	15,224	2,834	2,770
$20,000–$34,999	74,839	39,429	19,874	5,745	21,154	4,146	2,763
$35,000 or more	45,043	23,464	12,363	3,413	12,014	2,365	1,464
		Rate per 1,000 population					
Age							
Under 12 years	42,019	680.2	412.0	99.8	319.2	155.0	53.2
12–17 years	24,045	525.2	271.1	71.2	287.2	37.1	25.4
18–44 years	89,713	500.7	248.7	68.7	275.7	28.1	34.7
45–64 years	43,578	425.2	181.8	65.1	217.1	24.4	37.7
65 years and over	23,469	325.8	152.5	53.3	143.0	18.8	42.1
Sex							
Male	107,481	470.3	238.1	61.4	240.3	51.9	33.6
Female	115,344	535.4	277.9	82.8	277.7	50.7	43.2
Race							
Black	26,046	393.6	234.9	54.2	143.4	33.5	27.2
White and other	196,779	518.6	261.8	74.9	275.1	53.6	40.1
Education of head of family							
Not a high school graduate	72,128	429.8	212.4	60.2	208.4	33.8	35.6
High school graduate	78,063	511.8	262.3	71.9	259.1	52.4	39.9
Some college	72,633	569.2	300.8	85.3	311.3	67.3	40.1
Family income							
Less than $10,000	42,766	452.1	225.1	64.6	221.5	48.6	37.3
$10,000–$19,999	60,176	499.8	262.1	70.2	253.0	47.1	46.0
$20,000–$34,999	74,839	526.9	265.6	76.8	282.7	55.4	36.9
$35,000 or more	45,043	520.9	274.5	75.8	266.7	52.5	32.5

Table 2

Mean ambulatory care visits for persons with colds and percent distributions by reason for visit and age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All visits	Reason for visit: Indexed condition only	Reason for visit: Indexed condition and unrelated morbidity	Reason for visit: Unrelated morbidity only
			Mean visits		
Total	57,633	5.9	0.6	0.1	5.2
Age					
Under 12 years	17,314	4.8	0.8	0.1	3.9
12–17 years	7,546	4.6	0.5	0.0	4.1
18–44 years	21,279	6.0	0.5	0.1	5.4
45–64 years	7,921	6.9	0.5	0.1	6.3
65 years and over	3,579	11.0	0.6	0.2	10.2
Sex					
Male	25,588	5.2	0.6	0.1	4.5
Female	32,050	6.4	0.6	0.1	5.7
Race					
Black	6,119	4.4	0.6	0.1	3.7
White and other	51,519	6.1	0.6	0.1	5.4
			Percent distributions		
Total	100.0	100.0	10.4	1.6	88.0
Age					
Under 12 years	30.0	100.0	17.1	2.8	80.1
12–17 years	13.1	100.0	11.3	1.0	87.6
18–44 years	36.9	100.0	8.6	1.0	90.4
45–64 years	13.7	100.0	7.3	1.4	91.3
65 years and over	6.2	100.0	5.6	1.9	92.5
Sex					
Male	44.4	100.0	12.0	1.6	86.4
Female	55.6	100.0	9.4	1.6	89.0
Race					
Black	10.6	100.0	13.9	2.2	83.8
White and other	89.4	100.0	10.1	1.5	88.3

Table 3

Mean ambulatory care visits for persons with nasopharyngitis and percent distributions by reason for visit and age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All visits	Reason for visit: Indexed condition only	Reason for visit: Indexed condition and unrelated morbidity	Reason for visit: Unrelated morbidity only
			Mean visits		
Total	16,150	7.3	0.6	0.2	6.5
Age					
Under 12 years	4,189	6.0	0.7	0.1	5.2
12–17 years	1,957	4.7	0.7	0.1	4.0
18–44 years	5,916	7.2	0.5	0.1	6.6
45–64 years	2,837	10.0	0.6	0.3	9.1
65 years and over	1,250	10.0	0.7	0.3	9.0
Sex					
Male	6,596	6.5	0.7	0.1	5.7
Female	9,553	7.8	0.6	0.2	7.1
Race					
Black	1,411	9.5	0.7	0.3	8.5
White and other	14,738	7.1	0.6	0.1	6.4
			Percent distributions		
Total	100.0	100.0	8.4	2.1	89.5
Age					
Under 12 years	25.9	100.0	11.3	2.3	86.5
12–17 years	12.1	100.0	14.0	1.3	84.7
18–44 years	36.6	100.0	7.5	1.4	91.1
45–64 years	17.6	100.0	5.9	3.0	91.2
65 years and over	7.7	100.0	7.2	2.7	90.0
Sex					
Male	40.8	100.0	10.5	2.1	87.4
Female	59.2	100.0	7.2	2.1	90.7
Race					
Black	8.7	100.0	7.6	3.0	89.4
White and other	91.3	100.0	8.5	2.0	89.5

Table 4

Mean ambulatory care visits for persons with influenza and percent distributions by reason for visit and age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All visits	Reason for visit: Indexed condition only	Reason for visit: Indexed condition and unrelated morbidity	Reason for visit: Unrelated morbidity only
			Mean visits		
Total	57,866	5.7	0.4	0.0	5.3
Age					
Under 12 years	13,412	4.2	0.4	0.1	3.7
12–17 years	7,582	4.8	0.3	0.0	4.4
18–44 years	24,056	5.8	0.3	0.0	5.5
45–64 years	9,459	6.7	0.3	0.1	6.3
65 years and over	3,357	9.7	0.5	0.1	9.1
Sex					
Male	25,831	4.7	0.4	0.0	4.3
Female	32,035	6.4	0.3	0.1	6.0
Race					
Black	3,736	5.4	0.5	0.1	4.7
White and other	54,130	5.7	0.3	0.0	5.3
			Percent distributions		
Total	100.0	100.0	6.3	0.8	92.9
Age					
Under 12 years	23.2	100.0	10.7	1.3	88.1
12–17 years	13.1	100.0	6.2	0.5	93.3
18–44 years	41.6	100.0	5.2	0.6	94.2
45–64 years	16.3	100.0	5.1	0.9	94.0
65 years and over	5.8	100.0	5.4	1.3	93.4
Sex					
Male	44.6	100.0	7.8	0.8	91.4
Female	55.4	100.0	5.4	0.8	93.8
Race					
Black	6.5	100.0	10.2	1.5	88.2
White and other	93.5	100.0	6.0	0.8	93.2

Table 5

Ambulatory care visits for persons with otitis media and percent distributions by reason for visit and age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All visits	Reason for visit: Indexed condition only	Indexed condition and unrelated morbidity	Unrelated morbidity only
			Mean visits		
Total	11,424	7.4	1.6	0.4	5.3
Age					
Under 12 years	6,513	6.3	1.7	0.4	4.2
12–17 years	998	7.6	1.3	0.3	5.9
18–44 years	2,411	8.1	1.6	0.3	6.2
45–64 years	1,062	9.8	1.5	0.5	7.8
65 years and over	440	12.9	1.4	0.8	10.7
Sex					
Male	5,576	6.7	1.6	0.4	4.7
Female	5,848	8.0	1.7	0.4	5.9
Race					
Black	872	7.4	1.7	0.2	5.5
White and other	10,552	7.4	1.6	0.4	5.3
			Percent distributions		
Total	100.0	100.0	22.1	5.7	72.3
Age					
Under 12 years	57.0	100.0	27.5	6.6	65.9
12–17 years	8.7	100.0	17.5	4.4	78.0
18–44 years	21.1	100.0	19.6	4.2	76.3
45–64 years	9.3	100.0	14.9	4.9	80.2
65 years and over	3.9	100.0	10.7	6.6	82.8
Sex					
Male	48.8	100.0	23.4	6.4	70.2
Female	51.2	100.0	21.0	5.0	74.0
Race					
Black	7.6	100.0	22.7	3.2	74.1
White and other	92.4	100.0	22.0	5.9	72.1

Table 6

Mean ambulatory care visits for persons with lower respiratory infections and percent distributions by reason for visit and age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All visits	Reason for visit: Indexed condition only	Reason for visit: Indexed condition and unrelated morbidity	Reason for visit: Unrelated morbidity only
			Mean visits		
Total	8,592	8.7	1.3	0.4	7.0
Age					
Under 12 years	2,237	8.2	1.3	0.3	6.7
12–18 years	779	7.4	2.0	0.3	5.0
19–44 years	2,946	7.7	1.1	0.2	6.4
45–64 years	1,641	10.4	1.6	0.6	8.2
65 years and over	988	10.6	1.0	0.6	9.1
Sex					
Male	3,607	8.4	1.4	0.3	6.7
Female	4,985	8.9	1.3	0.4	7.2
Race					
Black	709	7.0	1.4	0.3	5.3
White and other	7,883	8.8	1.3	0.4	7.1
			Percent distributions		
Total	100.0	100.0	15.2	4.1	80.6
Age					
Under 12 years	26.0	100.0	15.7	3.4	80.9
12–18 years	9.1	100.0	27.5	4.7	67.8
19–44 years	34.3	100.0	14.4	2.7	82.8
45–64 years	19.1	100.0	15.6	5.5	78.9
65 years and over	11.5	100.0	9.0	5.8	85.2
Sex					
Male	42.0	100.0	16.7	3.5	79.9
Female	58.0	100.0	14.3	4.6	81.2
Race					
Black	8.3	100.0	19.9	4.3	75.9
White and other	91.7	100.0	14.9	4.1	81.0

Table 7

Per capita charges for all conditions and for colds among persons with colds and percent of charges paid out of pocket, by selected characteristics: United States, 1980

Characteristic	Estimated population in thousands	All conditions		Colds	
		Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket
Total	57,638	$615	33.0	$35	37.8
Age					
Under 12 years	17,314	300	33.3	46	35.5
12–17 years	7,546	444	48.0	25	38.9
18–44 years	21,279	661	35.2	30	38.5
45–64 years	7,921	900	31.5	34	40.8
65 years and over	3,579	1,601	20.2	37	41.1
Sex					
Male	25,588	613	30.5	42	35.1
Female	32,050	617	34.9	30	40.8
Race					
Black	6,119	605	24.0	37	27.6
White and other	51,519	616	34.0	35	39.1
Education of head of family					
Not a high school graduate	15,319	675	27.6	40	34.5
High school graduate	20,472	544	36.7	35	38.5
Some college	21,847	640	33.9	32	40.1
Family income					
Less than $10,000	9,626	814	25.0	46	25.9
$10,000–$19,000	15,775	599	31.1	27	47.6
$20,000–$34,999	19,874	498	38.5	36	38.5
$35,000 or more	12,363	669	36.0	36	39.3

Table 8

Per capita charges for all conditions and for nasopharyngitis among persons with nasopharyngitis and percent of charges paid out of pocket, by selected characteristics: United States, 1980

Characteristic	Estimated population in thousands	All conditions: Per capita charge	All conditions: Percent out of pocket	Nasopharyngitis: Per capita charge	Nasopharyngitis: Percent out of pocket
Total	16,150	$746	31.3	$57	25.8
Age					
Under 12 years	4,189	472	24.1	59	21.8
12–17 years	1,957	626	37.4	102	15.9
18–44 years	5,916	657	35.0	35	33.4
45–64 years	2,837	1,092	30.8	56	35.0
65 years and over	1,250	1,493	27.8	80	24.8
Sex					
Male	6,596	756	25.8	61	24.3
Female	9,553	726	35.3	54	27.0
Race					
Black	1,411	654	30.1	68	12.4
White and other	14,738	755	31.4	56	27.3
Education of head of family					
Not a high school graduate	4,339	787	28.9	78	18.9
High school graduate	5,614	786	28.2	54	26.1
Some college	6,196	682	36.4	44	33.9
Family income					
Less than $10,000	2,765	890	24.3	75	15.4
$10,000–$19,000	4,227	676	32.8	50	29.4
$20,000–$34,999	5,745	730	32.0	60	25.8
$35,000 or more	3,413	745	35.1	44	35.0

Table 9

Per capita charges for all conditions and for influenza among persons with influenza and percent of charges paid out of pocket, by selected characteristics: United States, 1980

Characteristic	Estimated population in thousands	All conditions		Influenza	
		Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket
Total	57,866	$610	31.1	$20	36.7
Age					
Under 12 years	13,412	278	33.5	22	33.5
12–17 years	7,582	511	36.9	12	41.3
18–44 years	24,056	587	32.9	13	51.7
45–64 years	9,459	792	33.7	22	39.6
65 years and over	3,357	1,808	18.8	75	17.5
Sex					
Male	25,831	549	27.7	20	36.2
Female	32,035	359	33.4	20	37.1
Race					
Black	3,736	555	35.6	27	38.6
White and other	54,130	614	30.9	20	36.5
Education of head of family					
Not a high school graduate	15,031	791	24.3	27	30.6
High school graduate	20,225	549	31.1	23	33.2
Some college	22,610	544	37.8	13	51.0
Family income					
Less than $10,000	9,474	1,021	20.4	41	17.7
$10,000–$19,000	15,224	554	33.8	20	37.9
$20,000–$34,999	21,154	504	33.9	16	48.4
$35,000 or more	12,014	542	39.2	11	60.5

Table 10

Per capita charges for all conditions and for otitis media among persons with otitis media and percent of charges paid out of pocket, by selected characteristics: United States, 1980

Characteristic	Estimated population in thousands	All conditions: Per capita charge	All conditions: Percent out of pocket	Otitis media: Per capita charge	Otitis media: Percent out of pocket
Total	11,424	$312	33.0	$92	36.8
Age					
Under 12 years	6,513	436	27.4	91	37.6
12–17 years	998	701	62.0	55	65.3
18–44 years	2,411	527	36.8	61	51.3
45–64 years	1,062	1,011	37.4	125	22.3
65 years and over	†440	†2,517	†20.4	†269	†17.8
Sex					
Male	5,576	543	32.4	107	32.4
Female	5,848	679	33.4	77	42.6
Race					
Black	872	699	28.3	110	34.0
White and other	10,552	605	33.4	90	37.1
Education of head of family					
Not a high school graduate	2,441	643	26.8	85	30.2
High school graduate	4,093	642	34.5	109	31.0
Some college	4,891	472	36.8	81	46.8
Family income					
Less than $10,000	2,080	996	20.9	157	18.0
$10,000–$19,000	2,834	476	34.8	59	51.8
$20,000–$34,999	4,146	497	43.6	95	40.2
$35,000 or more	2,365	640	33.4	67	51.0

Table 11

Per capita charges for all conditions and for lower respiratory infections among persons with lower respiratory infections and percent of charges paid out of pocket, by selected characteristics: United States, 1980

Characteristic	Estimated population in thousands	All conditions		Lower respiratory infections	
		Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket
Total	8,592	$1,343	23.2	$408	21.5
Age					
Under 12 years	2,237	543	24.1	151	20.5
12-17 years	779	955	40.3	354	41.5
18-44 years	2,946	1,083	31.5	370	27.8
45-64 years	1,641	2,158	20.2	593	18.5
65 years and over	988	2,882	12.9	842	10.6
Sex					
Male	3,607	1,665	20.2	621	20.4
Female	4,985	1,110	26.6	255	23.4
Race					
Black	709	1,483	31.6	712	45.7
White and other	7,883	1,331	22.4	381	17.5
Education of head of family					
Not a high school graduate	2,564	1,886	17.1	519	13.5
High school graduate	3,113	1,240	23.2	480	26.7
Some college	2,914	976	33.7	234	26.0
Family income					
Less than $10,000	1,594	1,970	16.7	561	19.5
$10,000-$19,000	2,770	1,752	21.1	595	20.4
$20,000-$34,999	2,763	900	29.5	300	23.7
$35,000 or more	1,464	725	37.7	95	35.0

Table 12

Per capita condition-related charges and percent of charges paid out of pocket for persons with colds, by type of health service, age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All health services[1]		Hospital admissions		Ambulatory visits		Prescribed medications	
		Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket
Total	57,633	$35	37.8	$14	8.9	$17	52.0	$5	69.2
Age									
Under 12 years	17,308	46	35.5	17	12.3	23	44.2	6	66.9
12-17 years	7,546	25	38.9	10	4.5	11	60.0	4	69.7
18-44 years	21,279	30	38.5	12	9.6	14	55.0	4	69.4
45-64 years	7,921	34	40.8	14	2.4	15	65.2	6	67.9
65 years and over	3,579	37	41.1	12	6.8	18	51.6	6	81.8
Sex									
Male	25,583	41	35.1	19	9.6	17	53.4	5	69.0
Female	32,050	30	40.8	9	7.9	16	50.7	5	69.0
Race									
Black	6,116	37	27.6	16	10.2	17	38.4	5	48.6
White and other	51,517	35	39.1	13	8.8	17	53.6	5	71.5

[1] Includes dental and other services, such as eyeglasses, orthopedic appliances, hearing aids, diabetic supplies, and ambulance services.

Table 13

Per capita condition-related charges and percent of charges paid out of pocket for persons with nasopharyngitis, by type of health service, age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All health services[1]		Hospital admissions		Ambulatory visits		Prescribed medications	
		Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket
Total	16,150	$57	25.8	$30	4.9	$18	43.6	$8	63.1
Age									
Under 12 years	4,189	59	21.8	36	6.2	18	41.6	5	62.2
12-17 years	1,957	102	15.9	82	7.0	16	45.3	5	70.7
18-44 years	5,916	35	33.4	10	–	16	38.7	8	64.9
45-64 years	2,837	56	35.0	24	5.0	18	59.3	14	54.2
65 years and over	1,250	80	24.8	39	–	29	37.8	11	77.5
Sex									
Male	6,596	61	24.3	35	6.8	18	43.6	8	57.4
Female	9,553	53	27.0	27	3.2	18	43.7	8	66.9
Race									
Black	1,411	68	12.4	39	0.0	22	23.8	7	43.7
White and other	14,738	56	27.3	29	5.5	18	45.9	8	64.7

[1]Includes dental and other services, such as eyeglasses, orthopedic appliances, hearing aids, diabetic supplies, and ambulance services.

Table 14

Per capita condition-related charges and percent of charges paid out of pocket for persons with influenza, by type of health service, age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All health services[1]		Hospital admissions		Ambulatory visits		Prescribed medications	
		Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket
Total	57,864	$20	36.7	$7	6.2	$10	46.9	$3	74.9
Age									
Under 12 years	13,409	22	33.5	7	8.7	13	39.7	3	71.8
12–17 years	7,582	12	41.3	3	5.0	6	51.6	2	73.6
18–44 years	24,056	13	51.7	2	1.0	9	56.1	3	77.4
45–64 years	9,469	22	39.6	5	5.4	13	43.2	4	74.7
65 years and over	3,357	75	17.5	53	6.8	17	38.1	4	73.0
Sex									
Male	25,828	20	36.2	7	6.1	11	45.8	3	74.0
Female	32,035	20	37.1	7	6.3	10	47.9	3	75.5
Race									
Black	3,734	27	38.6	6	11.9	18	41.6	3	69.9
White and other	54,130	20	36.5	7	5.9	10	47.6	3	75.3

[1] Includes dental and other services, such as eyeglasses, orthopedic appliances, hearing aids, diabetic supplies, and ambulance services.

Table 15

Per capita condition-related charges and percent of charges paid out of pocket for persons with otitis media, by type of health service, age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All health services[1]		Hospital admissions		Ambulatory visits		Prescribed medications	
		Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket	Per capita charge	Percent out of pocket
Total	11,424	$92	36.8	$28	13.0	$50	41.5	$13	72.0
Age									
Under 12 years	6,513	91	37.6	28	13.7	51	42.6	13	69.9
12–17 years	998	55	65.3	13	10.0	32	47.4	11	76.6
18–44 years	2,411	61	51.3	–	–	48	43.4	13	81.8
45–64 years	1,062	125	22.3	41	–	64	30.2	14	60.2
65 years and over	†440	†269	†17.8	†188	†4.7	†66	†41.3	†10	†72.8
Sex									
Male	5,576	107	32.4	45	10.2	49	43.2	12	69.9
Female	5,848	77	42.6	12	23.1	51	40.0	13	73.9
Race									
Black	872	110	34.0	36	20.0	60	31.7	13	82.0
White and other	10,552	90	37.1	27	12.2	50	42.5	12	71.1

[1] Includes dental and other services, such as eyeglasses, orthopedic appliances, hearing aids, diabetic supplies, and ambulance services.

Table 16

Per capita condition-related charges and percent of charges paid out of pocket for persons with lower respiratory infections, by type of health service, age, sex, and race: United States, 1980

Age, sex, and race	Estimated population in thousands	All health services[1] Per capita charge	All health services[1] Percent out of pocket	Hospital admissions Per capita charge	Hospital admissions Percent out of pocket	Ambulatory visits Per capita charge	Ambulatory visits Percent out of pocket	Prescribed medications Per capita charge	Prescribed medications Percent out of pocket
Total	8,592	$408	21.5	$343	16.7	$53	42.2	$11	71.0
Age									
Under 12 years	2,237	151	20.5	101	6.9	40	43.2	10	68.9
12-17 years	779	354	41.5	275	43.2	70	30.2	9	75.8
18-44 years	2,946	370	27.8	319	23.3	40	52.1	11	71.8
45-64 years	1,641	593	18.5	504	13.5	73	44.0	12	71.6
65 years and over	988	842	10.6	748	7.4	71	30.5	13	69.2
Sex									
Male	3,607	621	20.4	553	17.4	56	41.5	10	69.2
Female	4,985	255	23.4	191	15.3	50	42.8	11	72.2
Race									
Black	709	712	45.7	646	45.7	46	37.1	13	77.5
White and other	7,883	381	17.5	316	11.4	53	42.6	11	70.3

[1] Includes dental and other services such as eyeglasses, orthopedic appliances, diabetic supplies, hearing aids, and ambulance services.

Appendixes

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Appendix I. Sample Design, Data Collection, and Processing

Introduction

The National Medical Care Utilization and Expenditure Survey (NMCUES) was designed to collect data about the U.S. civilian noninstitutionalized population during 1980. Because of the complexity of the survey, the analyst must be familiar with a range of design features, both to determine appropriate analytic methods and to investigate the impact that the design may have on a particular analysis. Several topics are addressed in this appendix: The overall design of NMCUES, the survey background, sampling methods, data collection methods, weighting, and compensation procedures for missing data. In these descriptions, the NMCUES data are presented essentially as they are available to the user of the public use data tape. This appendix draws heavily from a paper in the Proceedings of the 19th National Meeting of the Public Health Conference on Records and Statistics (Casady, 1983).

Survey Background

During the course of NMCUES, information was obtained on health, access to and use of medical services, associated charges and sources of payment, and health care coverage. The survey was cosponsored by the National Center for Health Statistics (NCHS) and the Health Care Financing Administration (HCFA). Data collection was provided under contract by the Research Triangle Institute (RTI) and its subcontractors, National Opinion Research Center (NORC) and SysteMetrics, Inc.

The basic survey plan for NMCUES drew heavily on two previous national surveys: The National Health Interview Survey (NHIS), which is conducted by NCHS, and the National Medical Care Expenditure Survey (NMCES), which was cosponsored by the National Center for Health Services Research and NCHS.

NHIS is a continuing multipurpose health survey first conducted in 1957. The primary purpose of NHIS is to collect information on illness, disability, and the use of medical care. Although some information on medical charges and insurance payments has been collected in NHIS, the cross-sectional nature of the NHIS survey design is not well suited for providing annual data on charges and payments.

NMCES was a panel survey in which sample households were interviewed six times over an 18-month period in 1977 and 1978. NMCES was designed specifically to provide comprehensive data on how health services were used and paid for in the United States in 1977.

NMCUES is similar to NMCES in survey design and question wording, so that analysis of change during the years between 1977 and 1980 is possible. Both NMCUES and NMCES are similar to NHIS in terms of question wording in areas common to the three surveys. Together they provide extensive information on illness, disability, use of medical care, costs of medical care, sources of payment for medical care, and health care coverage at two points in time.

Sample Design

General plan—The NMCUES sample of housing units and group quarters, hereafter jointly referred to as dwelling units, is a concatenation of two independently selected national samples, one provided by RTI and the other by NORC. The sample designs used by RTI and NORC are quite similar with respect to principal design features: Both can be characterized as stratified, multistage area probability designs. The principal differences between the two designs are the type of stratification variables and the specific definitions of sampling units at each stage.

Target population—All persons living in a sample dwelling unit at the time of the first interview became part of the national sample. Unmarried students 17–22 years of age who lived away from home were included in the sample if their parent or guardian was included in the sample. In addition, persons who died or were institutionalized between January 1 and the date of first interview were included in the sample if they were related to persons living in the sampled dwelling units and were living in the sample dwelling before their death or institutionalization. All of these persons were considered "key" persons, and data were collected for them for the full 12 months of 1980 or for the portion of time that they were part of the U.S. civilian noninstitutionalized population. In addition, children born to key persons during 1980 were considered key persons, and data were collected for them from the time of birth.

Relatives from outside the original population (i.e., institutionalized, in the Armed Forces, or outside the United States from January 1 up to the first interview) who moved in with key persons after the first interview were also considered key persons, and data were collected for them from the time they joined the key person. Relatives who moved in with key persons after the first interview but were part of the civilian noninstitutionalized population on January 1, 1980, were classified as "nonkey" persons. Data were collected for nonkey persons for the time that they lived with a key person; but because they had a chance of selection in the initial sample, their data are not used for general analysis of persons. However, data for nonkey persons are used in an analysis of families because they contribute to the family's utilization of and charges for health care during the time they are part of the family. Family analysis is not part of this investigation, though, and will not be discussed further.

Persons included in the sample were grouped into "reporting units" for data collection purposes. Reporting units were defined as all persons related to each other by blood, marriage, adoption, or foster care status who lived in the same dwelling unit. The combined NMCUES sample consisted of approximately 7,200 reporting units, of which nearly 6,600 agreed to participate in the survey. In total, complete data were obtained on 17,123 key persons. The RTI sample yielded approximately 8,300 respondents and the NORC sample 8,800.

Research Triangle Institute Sample Design

Primary sampling units (PSU's)—A PSU was defined as a county, a group of contiguous counties, or parts of counties with a combined minimum 1970 population size of 20,000. A total of 1,686 nonoverlapping RTI PSU's cover the entire land area of the 50 States and Washington, D.C. The PSU's were classified as one of two types. The 16 largest standard metropolitan statistical areas (SMSA's) were designated as self-representing PSU's, and the remaining 1,670 PSU's in the primary sampling frame were designated as non-self-representing PSU's.

Stratification of PSU's—PSU's were grouped into strata whose members tend to be relatively alike within strata and relatively unlike between strata. PSU's derived from the 16 largest SMSA's were of sufficient 1970 population size to be treated as primary strata. The 1,659 non-self-representing PSU's from the continental United States were stratified into 42 approximately equal-sized primary strata. Each primary stratum had a 1970 population size of about 3.3 million. One supplementary primary stratum of 11 PSU's, with a 1970 population size of about 1 million, was added to the RTI primary frame to include Alaska and Hawaii.

First-stage selection of PSU's—The total RTI primary sample consisted of 59 PSU's, of which 16 were self-representing. The non-self-representing PSU's were obtained by selecting 1 PSU from each of the 43 non-self-representing primary strata. These PSU's were selected with probability proportional to 1970 population size.

Secondary stratification—In each of 59 sample PSU's, the entire PSU was divided into nonoverlapping smaller area units called secondary sampling units (SSU's). Each SSU consisted of one or more 1970 census-defined enumeration districts (ED's) or block groups (BG's). Within each PSU the SSU's were ordered and then partitioned to form approximately equal-sized secondary strata. Two secondary strata were formed in the non-self-representing PSU drawn from Alaska and Hawaii, and four secondary strata were formed in each of the remaining 42 non-self-representing PSU's. Thus, the non-self-representing PSU's were partitioned into a total of 170 secondary strata. In a similar manner the 16 self-representing PSU's were partitioned into 144 secondary strata.

Second-stage selection of SSU's—One SSU was selected from each of the 144 secondary strata covering the self-representing PSU's, and two SSU's were selected from each of the remaining secondary strata. All second-stage sampling was with replacement and with probability proportional to the SSU's total noninstitutionalized population in 1970. The total number of sample SSU's was $2 \times 170 + 144 = 484$.

Third-stage selection of areas and segments—Each SSU was divided into smaller nonoverlapping geographic areas, and one area within the SSU was selected with probability proportional to the 1970 total number of housing units. Next, one or more nonoverlapping segments of at least 60 housing units (HU's) were formed in the selected area. One segment was selected from each SSU with probability proportional to the segment HU count. In response to the sponsoring agencies' request that the expected household sample size be reduced, a systematic sample of one-sixth of the segments was deleted from the household sample. Thus, the total third-stage sample was reduced to 404 segments.

Fourth-stage selection of housing units—All dwelling units within the segment were listed, and a systematic sample of dwelling units was selected. The procedures used to determine the sampling rate for segments guaranteed that all dwelling units had an approximately equal probability of selection. All reporting units within the selected dwelling units were included in the sample.

National Opinion Research Center Sample Design

Primary sampling units (PSU's)—The land area of the 50 States and Washington, D.C., was divided into nonoverlapping PSU's. A PSU consisted of SMSA's, parts of SMSA's, counties, parts of counties, or independent cities. Grouping of counties into a single PSU occurred when individual counties had a 1970 population of less than 10,000.

Zoning of PSU's—The PSU's were classified into two groups according to metropolitan status (SMSA or not SMSA). These two groups were individually ordered and then partitioned into zones with a 1970 census population size of 1 million persons.

First-stage zone selection of PSU's—A single PSU was selected within each zone with a probability proportional to its 1970 population. It should be noted that this procedure allows a PSU to be selected more than one time. For instance, an SMSA PSU with a population of 3 million may be selected at least twice and possibly as many as four times. The full general-purpose sample contained 204 PSU's, which were systematically allocated to 4 subsamples of 51 PSU's. The final set of 76 sample PSU's was chosen by randomly selecting 2 complete subsamples of 51 PSU's; 1 subsample was included in its entirety, and 25 PSU's in the other subsample were selected systematically for inclusion in NMCUES.

Second-stage zone selection of SSU's—Each PSU selected in the first stage was partitioned into a nonoverlapping set of SSU's defined by BG's, ED's, or a combination of the two types of census units. SSU's were selected from the ordered list of these SSU's. The cumulative number of households in the second-stage frame for each PSU was divided into 18 zones of equal width. An SSU could be selected more than once, as was the case in the PSU selection. If a PSU had been hit more than once in the first stage, then the second-stage selection process was repeated as many times as there were first-stage hits. Some 405 SSU's were identified by selecting 5 SSU's from each of the 51 PSU's in the subsample that was included in its entirety and 6 SSU's from each of the 25 PSU's in the subsample for which one-half of the PSU's were included.

Third-stage selection of segments—The selected SSU's were subdivided into area segments with a minimum size of 100 housing units. One segment was then selected with probability proportional to the estimated number of housing units.

Fourth-stage selection of housing units—Sample selection at this level was essentially the same as for the RTI design.

Data Collection

Field operations for NMCUES were performed by RTI and NORC under specifications established by the cosponsoring agencies. Persons in the sample dwelling units were interviewed at approximately 3-month intervals beginning in February 1980 and ending in March 1981. The core questionnaire was administered during each of the five interview rounds to collect data on health, health care, health care charges, sources of payment, and health care coverage. A summary of responses was used to update information reported in previous rounds. Supplements to the core questionnaire were used during the first, third, and fifth interview rounds to collect data that did not change during the year or that were needed only once. Approximately 80 percent of the third- and fourth-round interviews were conducted by telephone; all remaining interviews were conducted in person. The respondent for the interview was required to be a household member 17 years of age and over. A nonhousehold proxy respondent was permitted only if all eligible household members were unable to respond because of health, language, or mental condition.

Weighting

For the analysis of NMCUES data, sample weights are required to compensate for unequal probabilities of selection, to adjust for the potentially biasing effects of failure to obtain data from some persons or reporting units (RU's) (i.e., nonresponse), and failure to cover some portions of the population because the sampling frame did not include them (i.e., undercoverage).

Basic sample design weights—Development of weights reflecting the sample design of NMCUES was the first step in the development of weights for each person in the survey. The basic sample design weight for a dwelling unit is the product of four components that correspond to the four stages of sample selection. Each of the four weight components is the inverse of the probability of selection at that stage when sampling was without replacement, or the inverse of the expected number of selections when sampling was with replacement, and multiple selection of the sample unit was possible.

Two-sample adjustment factor—As previously discussed, the NMCUES sample is composed of two independently selected samples. Each sample, together with its basic sample design weights, yields independent unbiased estimates of population parameters. Because the two NMCUES samples were of approximately equal size, a simple average of the two independent estimators was used for the combined sample estimator. This is equivalent to computing an adjusted basic sample design weight by dividing each basic sample design weight by 2. In the subsequent discussion, only the combined sample design weights are considered.

Total nonresponse and undercoverage adjustment—A weight adjustment factor was computed at the RU level to compensate for RU-level nonresponse and undercoverage. Because every RU within a dwelling unit is included in the sample, the adjusted basic sample design weight assigned to an RU is simply the adjusted basic sample design weight for the dwelling unit in which the RU is located. An RU was classified as responding if members of the RU initially agreed to participate in NMCUES and as nonresponding otherwise.

Initially, 96 RU weight-adjustment cells were formed by cross-classifying the following variables: Race of RU head (white or all other), type of RU head (female,

male, or husband-wife), age of RU head (four levels), and size of RU (four levels). These cells were then collapsed to 63 cells so that each cell contained at least 20 responding RU's. Within each cell an adjustment factor was computed so that the sum of adjusted basic sample design weights would equal the March 1980 Current Population Survey estimate for the same population. The weight for nonresponse and undercoverage was computed for each RU as the product of the adjusted basic sample design weight and the nonresponse-undercoverage adjustment factor for the cell containing the RU.

Poststratification adjustment—Once the nonresponse–undercoverage adjusted RU weights were computed, a poststratification adjusted weight was computed at the person level. Because each person within an RU is included in the sample, the nonresponse and undercoverage adjusted weight for a sample person is the nonresponse–undercoverage adjusted weight for the RU in which the person resides. Each person was classified as responding or nonresponding, as discussed subsequently in the section on attrition imputation.

Sixty poststrata were formed by cross-classifying age (15 levels), race (2 levels), and sex (2 levels). One poststratum (black males 75 years of age and over) had fewer than 20 respondents, so it was combined with an adjacent poststratum (black males 65–74 years of age), resulting in 59 poststrata.

Estimates based on population projections from the 1980 census were obtained from the Bureau of the Census for the U.S. civilian noninstitutionalized population by age, race, and sex poststrata for February 1, May 1, August 1, and November 1, 1980. The mean of these midquarter population estimates for each of the poststrata was computed and used as the 1980 average target population for calculating the poststrata adjustment factors.

Survey-based estimates of the average poststrata population were developed using the nonresponse and undercoverage adjusted weights. First, a survey-based estimate of the target population of each poststratum for each quarter was computed by summing the nonresponse and undercoverage adjusted weights for respondents eligible for the survey on the midquarter date. Then the survey-based estimate of the 1980 average population was computed as the mean of the four midquarter estimates. Finally, the poststratification adjustment factor in each poststratum was computed as the ratio of the 1980 average target population (obtained from Bureau of the Census data) to the NMCUES 1980 average population. The poststratified weight for each respondent was then computed as the product of the nonresponse and undercoverage adjusted weight and the poststratification adjustment factor for the poststratum containing the respondent.

Thus, the weighting procedure is composed of three steps: Development of base sample design weights for each RU, adjustment for RU-level nonresponse and undercoverage, and adjustment for person-level nonresponse and undercoverage. A further adjustment for the number of days a person was an eligible member of the U.S. civilian noninstitutionalized population was made, but this adjustment affects only certain types of estimates from NMCUES and is discussed in Appendix III.

Survey Nonresponse

Nonresponse in panel surveys such as NMCUES occurs when sample individuals refuse to participate in the survey (total nonresponse), when initially participating individuals drop out of the survey (attrition nonresponse), or when data for specific items on the questionnaire are not collected (item nonresponse). Response rates for RU's and persons in NMCUES were high, with approximately 90 percent of the sample RU's agreeing to participate in the survey and approximately 94 percent of the individuals in the participating RU's supplying complete information. Even though the overall response rates are high, survey-based estimates of means and proportions may be biased if nonrespondents tend to have different health care experiences than respondents or if there is a substantial response rate differential across subgroups of the target population. Furthermore, annual totals tend to be underestimated unless allowance is made for the loss of data attributable to nonresponse.

Two methods commonly used to compensate for survey nonresponse are data imputation and adjustment of sampling weights. For NMCUES, data imputation was used to compensate for attrition and item nonresponse, and weight adjustment was used to compensate for total nonresponse. The calculation of the weight adjustment factors was discussed in the previous section.

Attrition Imputation

A special form of the sequential hot-deck imputation method (Cox, 1980) was used for attrition imputation. First, each sample person with incomplete annual data (referred to as a "recipient") was linked to a sample person with similar demographic and socioeconomic characteristics who had complete annual data (referred to as a "donor"). Second, the time periods for which the recipient had missing data were divided into two categories: Imputed eligible days and imputed ineligible days. Imputed eligible days were those days for which the donor was eligible (i.e., in scope), and imputed ineligible days were those days for which the donor was ineligible (i.e., out of scope). The donor's medical care experiences, such as medical provider visits, dental visits, and hospital stays, during the imputed eligible days were imputed into the recipient's record for eligible days. Finally, the results of the attrition imputation were used to make the final determination of a person's respondent status. If more than two-thirds of the person's total eligible days (both reported and imputed) were imputed eligible days, then the person was considered a total nonrespondent, and the data for the person were removed from the data file.

Item Nonresponse and Imputation

Persons classified as respondents may fail to provide information for some or many items in the questionnaire. In NMCUES, item nonresponse was particularly a problem for health care charges, income, and other sensitive topics. The extent of missing data varied by question, and imputation for all items in the data file would have been expensive. Imputations were made for missing data on key demographic, economic, and charge items across five of the six data files in the public use data tape (all except the condition file). Table I illustrates the extent of the item nonresponse problem for selected survey measures that received imputations in four data files used in this report.

Demographic items tend to require the least amount of imputation. Some, such as age, sex, and education, had insignificant levels of imputation. Income items had higher levels of nonresponse. Nearly one-third of the persons required imputation for at least one component of total personal income, which is a cumulation of earned income and 11 sources of unearned income. The bed-disability days, work-loss days, and cut-down days have levels of imputation between those for the demographic and income items.

Table I

Percent of data imputed for selected survey items in 4 of the NMCUES public use data files: United States, 1980

Tape location	Description	Percent imputed
	Person file (n = 17,123)	
P54	Age	0.1
P57	Race	[1]20.0
P59	Sex	0.1
P62	Highest grade attended	0.1
P67	Perceived health status	0.8
P592	Functional limitation score	3.2
P125	Number of bed-disability days	7.9
P128	Number of work-loss days	8.9
P135	Number of cut-down days	8.2
P399	Wages, salary, business income	9.7
P434	Pension income	3.5
P445	Interest income	21.6
P462	Total personal income	[2]30.4
	Medical visit file (n = 86,594)	
M117	Total charge	25.9
M123	First source of payment	1.8
M125	First source of payment amount	11.6
	Hospital stay file (n = 2,946)	
H252	Nights hospitalized	3.1
H124	Total charge	36.3
H130	First source of payment	2.2
H132	First source of payment amount	17.6
	Medical expenses file (n = 58,544)	
E117	Total charge	19.4
E123	First source of payment	2.8
E125	First source of payment amount	10.0

[1]Race for children under 17 years of age imputed from race of head of reporting unit.
[2]Cumulative across 12 types of income.

The highest levels of imputation occurred for the important charge items on the various visit, hospital stay, and medical expenses files. Total charges for medical visits, hospital stays, and prescribed medicines and other medical expenses were imputed for 25.9 percent, 36.3 percent, and 19.4 percent of the events, respectively. Among the source-of-payment data, the imputation rates for the source of payment were small, but the rates for the amount paid by the first source of payment were generally subject to high rates of imputation. The number of nights hospitalized on the hospital stay file was imputed at a rate comparable to that for first source of payment.

The methods used to impute for missing items were diverse and tailored to the measure requiring imputation. Three types of imputation predominate: Edit or logical imputations, a sequential hot deck, and a weighted sequential hot deck. The edit or logical imputations were used to eliminate missing data that could reasonably be determined from other data items that provided overlapping information for the given item. The sequential hot deck was used primarily for small numbers of imputations for the demographic items; the weighted sequential hot deck was used more extensively and for virtually all other items for which imputations were made.

The edit or logical imputation is a process in which the value of a missing item is deduced from other available information in the data file. For example, race was not recorded for children under 17 years of age during the survey. Instead, a logical imputation was made during data processing that assigned the race of the head of the reporting unit to the child. Similarly, extensive editing was performed for the charge data before any imputations were made. If first source of payment was available, only one source of payment was given; and if total charge was missing, the value of the first source of payment amount was assigned to the total charge item.

In the sequential hot-deck procedure, the data are grouped within imputation classes formed by variables thought to be correlated with the item to be imputed. An additional sorting within imputation classes by variables also thought to be correlated with the imputed item is typically used. An initial value, such as the mean of the nonmissing cases for the item, is assigned as a "cold-deck" value. The first record in the file is then examined. If it is missing, the "cold-deck" value replaces the missing data code; if it is real (not missing), the real value replaces the "cold-deck" value and becomes a "hot-deck" value. Then the next record is examined. Again, the "hot-deck" value is used to replace missing data; if the value is real, it becomes the "hot-deck" value. The process continues sequentially through the sorted file. The weighted hot deck, a modification of the sequential hot deck, uses weights to determine which real values are used to impute for a particular record needing imputation.

The imputation process will be described for two items to illustrate the nature of imputation for NMCUES. For Hispanic origin, two different imputation procedures were used: Logical and sequential hot deck. Because Hispanic origin was not recorded during the interview for children under 17 years of age, a logical imputation was made by assigning to the child the Hispanic origin of the wife of the head of the reporting unit, if present, and the origin of the head of the reporting unit otherwise. For the remaining cases that were not assigned a value by this procedure, the data were grouped into classes by observed race of the head of the reporting unit; within classes, the data were sorted by reporting unit identification number, primary sampling unit, and segment. An unweighted sequential hot deck was used to impute values of Hispanic origin for the remaining cases with missing values.

The imputations for medical visit total charge were made after extensive editing had been done to eliminate as many inconsistencies as possible between sources of payment and total charges. The medical visit records were then separated into three types: emergency room, hospital outpatient department, and doctor visits. Within each type, the records were classed and sorted by several measures, which differed across visit types, prior to a weighted hot-deck imputation. For example, the records for doctor visits were classified by reason for visit, type of doctor seen, whether work was done by a physician, and age of the individual. Within the groups formed by these classification variables, the records were then sorted by type of health care coverage and month of visit. Finally, the weighted hot-deck procedure was used to impute for missing total charge, sources of payment, and source-of-payment amounts for the classified and sorted data file.

Because imputations were made for missing items for a large number of the important items in NMCUES, they can be expected to influence the results of the survey in several ways. In general, the weighted hot deck is expected to preserve the means of the nonmissing observations when those means are for the total sample or classes within which imputations were made. However, means for other subgroups, particularly small subgroups, may be changed substantially by imputation. In addition, sampling variances can be substantially underestimated when imputed values are used in the estimation process. For a variable with one-quarter of its values imputed, for instance, sampling variances based on all cases will be based on one-third more values than were actually collected in the survey for the given item. That is, the variance would be too small by a factor of at least one-third. Finally, the strength of relationships between measures that received imputations can be substantially attenuated by the imputation. A more complete discussion of these issues can be found in Lepkowski, Stehouwer, and Landis (1984).

Appendix II. Data Modifications to Public Use Files

During the preparation of this report, a number of problems were discovered in the NMCUES public use files that required modification of the data. Eight sets of problems were identified:

(1) Sampling weights for 68 newborns (i.e., persons born in 1980) were in error.

(2) Six respondents had extremely high hospital stay charges.

(3) Forty-seven respondents had health care coverage categories inconsistent with source of payment for some medical events.

(4) For 173 respondents, fewer bed-disability days than hospital nights were reported. (Length-of-stay data were recorded in terms of the number of nights—as opposed to days—spent in the hospital.)

(5) Four respondents had extremely long lengths of stay in the hospital as a result of incorrect hospital admission dates.

(6) Four respondents had poverty status categories that were inconsistent with their poverty status level.

(7) Nine respondents were coded as deliveries in the hospital file but had inconsistent values for other hospital stay data.

(8) One respondent had duplicate hospital stay records.

Details of the changes made to correct these problems may be obtained from NCHS. Detailed descriptions of the specific changes are provided in the NMCUES series report by Lepkowski et al. (to be published). General information on the problems and changes is outlined below.

(1) Records for 68 newborns were incorrectly coded as eligible for the entire survey period (all 366 days) although born after January 1, 1980. These errors were corrected by changing the eligible time-adjustment factor and the person time-adjusted weight for each of the 68 records.

(2) After careful examination, the University of Michigan and NCHS determined that six hospital stay records, each with charges of at least $90,000, were incorrect and should be changed. These six records and related information in the person file (e.g., hospital stay charges, total charges) were changed to conform with records in the Medicare best estimate file or with other information about each of the six respondents' hospitalizations contained in the hospital stay file.

(3) Discrepancies between source of payment and health care coverage were noted in the course of analysis. All of the discrepancies involved Medicare coverage. Forty-seven respondents reporting Medicare as a source of payment in the medical visit, hospital stay, or prescribed medicine file were not properly coded as covered by Medicare. Health care coverage for these respondents was reclassified strictly according to source-of-payment data. Respondents originally coded as covered by private insurance but whose records did not show private insurance as a source of payment for any services were coded as having Medicare and private insurance coverage. When reassignment based on imputed data for source of payment would conflict with real data for health care coverage, the real data were used in preference to the imputed data.

(4) For 173 cases, the value for hospital nights was greater than the value for bed-disability days. According to interviewer instructions for the NMCUES questionnaire, hospital nights should be included in bed-disability days, except for newborns. Therefore, the value of bed-disability days was adjusted to equal hospital nights for these 173 cases, a procedure used in Health Interview Survey processing. However, this adjustment does not fully compensate for the errors in recording or computing bed-disability days. It is likely that bed-disability days are still underestimated for these 173 cases after the edit. The edit was performed without regard to the imputation status of either bed-disability days or hospital nights.

(5) Four cases with discrepancies between bed-disability days and hospital nights also had improperly coded hospital admission dates, which led to the recording of excessively long lengths of stay. In these cases, the admission dates and hospital nights were corrected, and the bed-disability days edit was not necessary.

(6) Comparison of the continuous and the categorical poverty status variables on the public use file identified four respondents whose categorical poverty status was inconsistent with their continuous poverty status value. The categorical variable was changed to correspond to their poverty status on the continuous variable.

(7) A variety of problems were discovered on nine records coded as deliveries in the hospital stay file.

(a) Two deliveries were attributed to male respondents. Examination of the data files suggested that the sex variable was incorrectly coded in these two cases; the sex was therefore recoded to female. A third delivery attributed to a male was actually that of the respondent's spouse. In this case, the hospital record was reassigned and appropriate changes made in the person file for both respondents.

(b) Four hospitalizations for newborns were incorrectly coded as deliveries. These were recoded in the hospital stay file. A fifth newborn's hospital record was attributed to its mother. In this case, the hospital record was transferred to the newborn, and appropriate changes were made in the person file for both respondents.

(c) One delivery was attributed to a 74-year-old woman. Following an NCHS recommendation, the response was recoded to reflect signs, symptoms, and ill-defined conditions as the admitting condition.

(8) Two sets of duplicate records (four records in total) in the hospital stay file were discovered for one respondent. The two duplicates were deleted in the hospital stay file, and necessary changes were made in the person file. Three of the four records had been imputed to another respondent for reasons of attrition. No changes were made in the records for the respondent receiving the attrition-imputed records.

Appendix III. Analytical Strategies

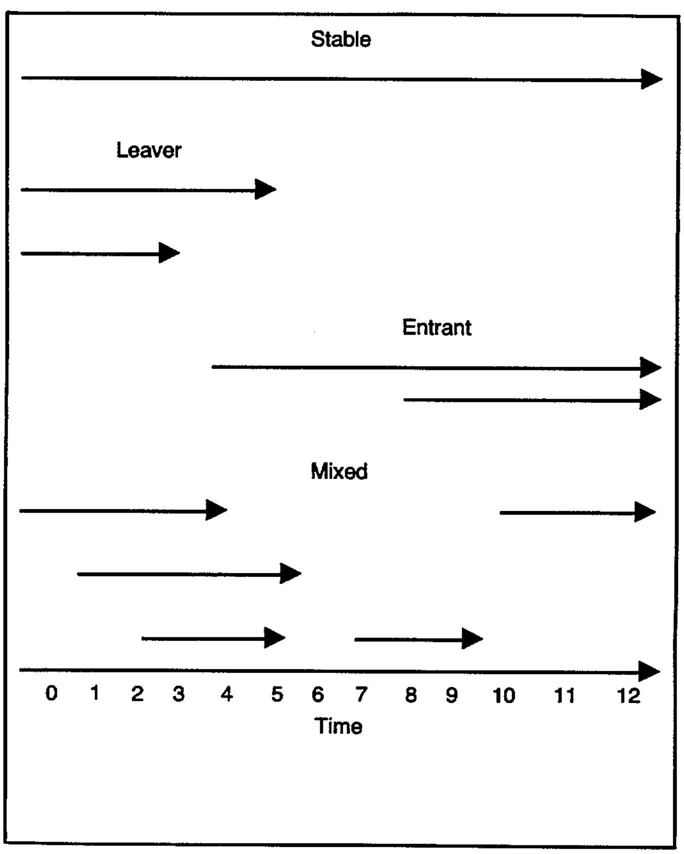
Notion of an Average Population

NMCUES was a panel survey in which members of the population were followed during the panel period (calendar year 1980). The nature of a dynamic population over time influences the rules used to determine who should be followed and for how long. It also has significant implications for the form of estimators for characteristics of the population during the panel period. Before discussing estimation strategies for NMCUES data, it is useful to review the nature of a dynamic population over time.

The nature of a longitudinal population as members move in and out of eligibility is illustrated in Figure I. Stable members of the population appear at the beginning and at every time point during the life of the longitudinal time period. Even though these persons are termed "stable," they may, of course, change residence during the panel period and may be quite difficult to trace. Leavers are persons who are eligible at the beginning of a time period but become ineligible at some later time. Leaving may occur through events such as death, institutionalization, or moving outside the geographic boundary of the population. At the same time, new members (entrants) may enter the population through births or through returns from institutions or from outside the geographic boundary of the population. Finally, there also will be mixed population elements that are both entrants and leavers from the population during different time periods. The majority of the population typically will be stable in nature, but it is the entrants and leavers, persons who may be experiencing major changes in their lives, who are often of particular interest to analysts of panel survey data. In order to assure adequate coverage of all elements in the dynamic population considered over the entire time period, NMCUES followup rules were carefully specified to include entrants, leavers, and mixed population elements properly.

Figure I

Dynamic population for 12 time period panel survey



As an illustration, consider a person who was in the Armed Forces on January 1, 1980, and was discharged on June 1, 1980, thus becoming a key person (i.e., one to be followed for the rest of the year while eligible) in the NMCUES panel. Because NMCUES was designed to provide information about the civilian population, medical care use and charges during the first 5 months of 1980 for this person are outside the scope of the survey. Data about health care use and charges were not collected unless they occurred after June 1. At the same time, this person was eligible for only 7 months of the year, and he was also "at risk" of incurring health care use or charges for only 7 of the 12 months. This person thus contributes only $7/12$ or 0.58 of a year of eligibility (person year) to the study. This quantity is referred to as the "time-adjustment factor" in the documentation and throughout these appendixes.

For readers not familiar with the concept of "person years of risk," it may be useful to consider briefly the rules that were used to determine eligibility for a given person at a given moment during 1980. There were essentially two ways of becoming eligible for or entering the NMCUES eligible population. One way was to be a member of the U.S. civilian noninstitutionalized population on January 1, 1980, and hence a member of the original or base cohort about which inferences were to be made. The second way was to enter after January 1 through birth or through rejoining the civilian noninstitutionalized population during the year by returning from an institution, from the Armed Forces, or from outside the United States. There were also several ways by which persons who were eligible members of the population could become ineligible. Death obviously removes a person from further followup, as does institutionalization, joining the Armed Forces, or moving to a residence outside the United States. Information was collected to monitor the exact number of days that each person selected for NMCUES was eligible during the year. These eligibility periods are summarized by the time-adjustment factor on each record.

The use of "person years" to form sample estimates requires careful assessment of the characteristic to be estimated. Estimates that use only data collected from persons during periods of eligibility (e.g., total number of doctor visits, total charges for health care) do not need to account for time adjustments. Estimates for person characteristics (e.g., total population, proportion of the population in a given subgroup) must be based on person years to obtain estimates that correspond to those for health care estimates. Some estimates require the use of the time-adjustment factor in the denominator but not in the numerator. For example, an estimate of the mean total charge for health care during 1980 must use the total charges for health care as a numerator without time adjustment, but the denominator must be the number of person years that the U.S. population was exposed to the risk of such charges during 1980, a time-adjusted measure. The mean in this case is actually a rate of health care charges per person year of exposure for the eligible population in 1980.

When making estimates in which person years are important, the effect of the time-adjustment factor will vary depending on the subpopulation of interest (Table II). A cross-sectional cohort of N persons selected from the U.S. population on January 1, 1980, and followed for the entire year will contribute a total number of person years for 1980 that is smaller than N because of removals (i.e., deaths, institutionalization, and so on). If entrants are added to the initial cohort during the year, the person years contributed by the initial cohort and the entrants may well exceed N, but it will still be less than the number of original cohort members plus the number of entrants.

The difference between persons and person years will vary by subgroups as well. Females 25–29 years of age on January 1 constitute a cohort for which few additions are expected because of entrants from institutions, the Armed Forces, or living abroad. Few removals are expected because of death, institutionalization, joining the Armed Forces, or moving abroad. On the other hand, males 80 years of age and over on January 1 will contribute a much smaller number of person years to the population than the total number of persons in the cohort at the beginning of the year, because a large number of the cohort will die during the year.

Role of Weights and Imputation

Estimated means and sampling errors from NMCUES for bed-disability days, work-loss days, work-loss days in bed, cut-down days, and restricted-activity days are presented in Table III. For each survey measure, separate estimates were computed using all data (i.e., both real and imputed) and using only the real data. The unweighted and weighted mean, unweighted and weighted simple random sampling standard error of the mean, and the weighted complex standard error, which accounts for the stratified, multistage nature of the design, are presented.

For each measure, the weighted means computed using all the data and using only the real data are quite similar. This similarity is not unexpected given that the weighted hot deck imputation procedure is designed to preserve the weighted mean for overall sample estimates. The simple random sampling standard errors, however, are smaller when all data are used simply because the simple random sampling variance is inversely related to the sample size. For the complex standard error, three of the five measures have smaller standard errors when all data are used, and the other two measures show the opposite relationship. Weighting and imputation for the disability measures have little or no effect on estimated means or their standard errors for the total

Table II

Effect of person-year adjustment on counts and sampling weights, by 4 population groups: United States, 1980

Population group	Sample size	Person years	Sum of sampling weights: Basic weight in thousands	Sum of sampling weights: Adjusted weight in thousands
Total population	17,123	16,862.84	226,368	222,824
Females, 25–29 years of age	702	699.39	9,529	9,494
Males, 80 years of age and over	113	104.05	1,384	1,274
All persons born during 1980	251	121.02	3,560	1,713

Table III

Sample size, means, and standard errors for 5 disability measures, by all and real data subgroups: United States, 1980

Estimates in this table are presented for illustrative purposes. Calculations were made prior to data modifications described in Appendix II.

Disability measure and data type	Sample size	Unweighted estimates: Mean	Unweighted estimates: Simple random sampling standard error	Weighted estimates: Mean	Weighted estimates: Simple random sampling standard error	Weighted estimates: Complex standard error
Bed-disability days						
All data	17,123	5.303	0.1279	5.268	0.1269	0.1540
Real data	15,777	5.253	0.1326	5.228	0.1319	0.1599
Work-loss days						
All data	13,069	3.614	0.1221	3.696	0.1220	0.1629
Real data	11,537	3.510	0.1284	3.574	0.1277	0.1716
Work-loss days in bed						
All data	13,069	1.516	0.0508	1.568	0.0518	0.0592
Real data	10,970	1.530	0.0556	1.578	0.0568	0.0652
Cut-down days						
All data	17,123	6.831	0.1681	6.881	0.1697	0.3343
Real data	15,724	6.609	0.1721	6.639	0.1735	0.3322
Restricted-activity days						
All data	17,123	13.746	0.2559	13.805	0.2573	0.4716
Real data	14,049	13.036	0.2732	13.064	0.2742	0.4658

Table IV

Sample size, means, standard errors, and element variance for total charge for a hospital outpatient department visit, by data type: United States, 1980

Estimates in this table are presented for illustrative purposes. Calculations were made prior to data modifications described in Appendix II.

Data type	Sample size	Unweighted estimates: Mean	Unweighted estimates: Simple random sampling standard error	Weighted estimates: Mean	Weighted estimates: Simple random sampling standard error	Complex standard error	Element variance ($\times 10^{-3}$)
All data	9,529	51.86	1.030	51.61	1.018	1.914	9.87
Real data only	4,688	52.28	1.436	52.27	1.430	2.936	9.59
Imputed data	4,841	51.45	1.476	50.98	1.447	1.600	10.14
Real data							
Not donor	929	47.83	2.108	48.53	2.117	3.935	4.17
Donor once	2,789	55.85	2.016	55.76	1.982	3.386	11.00
Donor twice	841	48.61	3.525	49.37	3.579	4.879	10.78
Donor 3–5 times	120	29.45	7.340	28.97	7.987	11.64	7.66

population because the amount of missing data for these measures is small (approximately 7 or 8 percent).

For other measures that have larger amounts of missing data, imputation has larger effects. Consider the means and standard errors for total charge for a hospital outpatient department visit shown in Table IV. Of 9,529 hospital outpatient department visits (real visit records plus those generated from the attrition imputation process), 4,841 have a total charge that was imputed from one of the other hospital outpatient department visit records. Thus, more than one-half of the total charges were missing for this particular medical event. Despite the large amount of missing data, the weighted means using all the data and using only real values are quite similar; weighting does not affect the estimated means. However, sampling errors are changed substantially when imputed values are added to real values to form an estimate. The weighted and unweighted simple random sampling standard errors are markedly smaller for all data than for the real data.

To investigate whether this decrease in sampling error is caused by changes in sample size, changes in the element variance, or both, the element or total variances were estimated by multiplying the weighted simple random sampling variances by the sample sizes. Inspection of Table IV suggests that the element variances are quite similar using all data and real data; the differences in standard error when all data and only real data are used can be attributed mostly to the loss in sample size when going from all data to real data.

Not all of the real data were used as donors for imputation, and some of the real data were used as donors several times. Table IV also suggests that those real values not used as donors have a lower mean total charge than those used as donors, but values used as donors more than twice tend to have even smaller mean total charges. The means for donors used once, twice, or more frequently are a function of the use of imputation classes, within which the mean total charge and the amount of missing data varied.

The difference in complex standard errors between all data and the real data in Table IV illustrates the large effects of imputation. However, neither the complex standard error computed using all the data nor that computed using only the real data is the correct standard error for the weighted mean estimated using all the data. The mean computed using all data includes 4,841 values that were actually subsampled with replacement from the 4,688 real values. In addition, imputations were made across the primary sampling units and strata used in both the sample selection process and the variance estimation procedure. It is assumed in the variance estimation procedure that the observations were selected independently from primary sampling units and strata. That assumption is incorrect in this case. Hence, the complex standard error for all data shown in Table IV fails to account for two sources of variability: the double sampling used to select values for imputation and the correlation between primary sampling units and strata induced by imputation. At the same time, the complex standard error for the weighted mean computed using only the real data is an incorrect estimate of the standard error of the mean based on all the data. The actual sampling

Figure II

Estimated mean charges per hospital outpatient department visit, by 4 family income classes for all and real data: United States, 1980

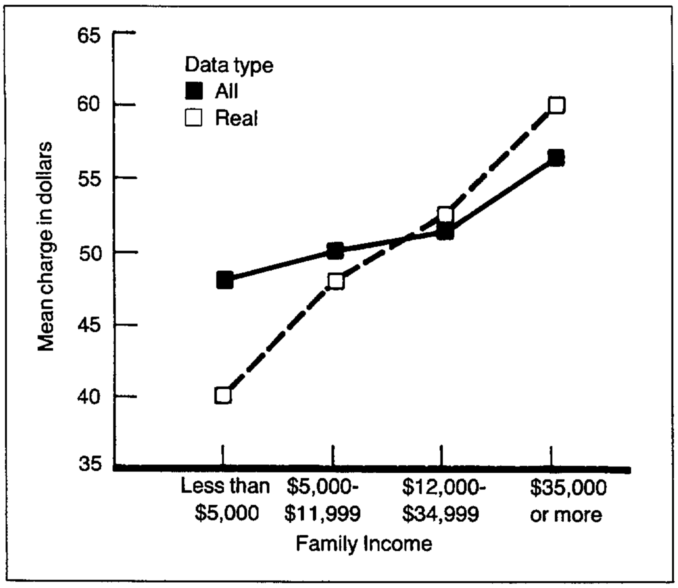
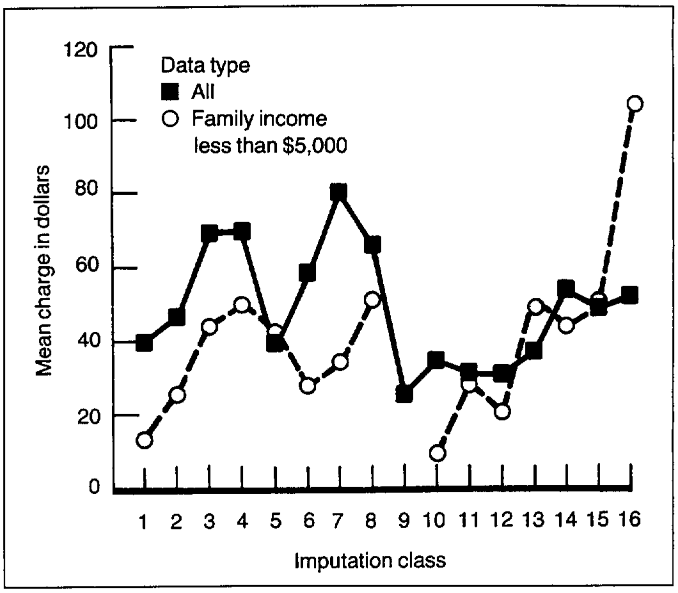


Figure III

Estimated mean charges per hospital outpatient department visit, by 16 imputation classes for all persons and for persons in families with income less than $5,000: United States, 1980



error of the weighted mean for all the data is probably larger than that shown for the mean estimated using all the data; it may even be larger than the sampling error computed using only the real data.

As a final illustration of the effects that imputation can have on survey results, Figure II presents estimated mean charges per hospital outpatient department visit for four family income groups computed using all the data and using only the real data. For the real data, the mean charge per visit increases in a linear fashion as the family income increases. However, when all the data are used to estimate the mean charge per visit, the mean charge does not increase as rapidly with increasing family income. The strong relationship between family income and mean charge per hospital outpatient department visit in the real data has been attenuated by the imputed values.

The reason for this attenuation is shown in Figure III. Sixteen imputation classes were formed for the imputation of total charges for hospital outpatient department visits. Figure III shows mean charge by imputation class for real data for the total sample and for the subgroup with family incomes less than $5,000 in 1980. The low income group has lower mean charges than the total sample. Because family income was not one of the variables used to form imputation classes, low family income persons within an imputation class with missing hospital outpatient department visit total charges were imputed a charge that was, on average, higher than the mean charge for low income persons with real data. This occurs in almost every imputation class. When the real and imputed data are combined for persons with family incomes less than $5,000, the effect of imputation is to increase the mean charge for this subgroup. Conversely, for persons with family incomes of $35,000 or more, total hospital outpatient department visit charges for persons with real data tend to be larger than values imputed to persons with missing charges. The overall impact of the imputation process on the relationship between charges for hospital outpatient department visits and family income is a regression toward the mean charge for real data for low- and high-income subgroups.

The results in Tables III and IV and Figure II demonstrate the effect that imputation can have on estimated means, on estimated sampling errors, and on relationships between variables. Several strategies for handling imputation in estimation are suggested by these findings. It is beyond the scope of this discussion to evaluate various strategies and indicate the reasons why one was chosen for this report. The strategy used in preparing estimates for this report was to use all the data in all estimates despite the sizable effects caused by imputation. This strategy means that estimated means and totals presented in the report have been adjusted for item nonresponse, but sampling errors and relationships among some variables may be adversely affected by the imputation process. The reader should keep in mind that sampling errors for estimates that are subject to large amounts of item nonresponse may be underestimated, and the strength of relationships between a variable receiving imputed values and a variable that was not used to form imputation classes may be attenuated by the imputation process.

Estimation Procedures

Sample estimators from the NMCUES data, regardless of whether they are totals, means, medians, proportions, or standard errors, must account for the complexity of the sample survey design. Totals, means, and other estimates must include sampling weights to compensate for unequal probabilities of selection, nonresponse, and undercoverage. Stratification, clustering, and weighting must also be accounted for in the estimation of sampling errors. In addition, consideration must be given to time-adjustment factors to account for persons not eligible for the entire year and to imputations that were made to compensate for missing items.

A variety of estimators were used for the descriptive analyses. To illustrate the role of time adjustments, consider the following six specific estimates that were used in the analysis:

- Estimated total charges for a selected subgroup (e.g., persons with acute respiratory conditions).
- Estimated total population.
- Mean charge per visit.
- Mean charge per person.
- Proportion of charges that fall in a certain range of charges.
- Proportion of persons whose charges are less than or equal to a fixed level.

To define these estimators, the following notation for these quantities for the ith person is used:

y_i = total charges for health care in 1980;

x_i = total number of medical visits for 1980;

w_i = nonresponse and undercoverage adjusted person weight;

t_i = time-adjustment factor (i.e., the proportion of days in 1980 that the person was an eligible member of the population);

$$d_i = \begin{cases} 1, & \text{if total charges are less than or equal to a fixed value,} \\ 0, & \text{otherwise;} \end{cases}$$

$$e_i = \begin{cases} 1, & \text{if the total charge is between two fixed values,} \\ 0, & \text{otherwise; and} \end{cases}$$

$$\delta_i = \begin{cases} 1, & \text{if the } i\text{th person is a member of a designated subgroup of the population,} \\ 0, & \text{otherwise.} \end{cases}$$

Estimating total charges, or any quantity from NMCUES that was recorded only during periods when the person was a noninstitutionalized civilian in the United States, is a relatively straightforward task requiring only a weighted sum of charge values. In particular,

$$\hat{y} = \sum_i w_i y_i \delta_i$$

is the estimated total charge for a particular service for a selected subgroup. On the other hand, for estimates of total population, a time-adjusted estimator is required such as

$$\hat{y}' = \sum_i w_i t_i \delta_i .$$

Thus, $\hat{y}'$ denotes an estimate of the 1980 average subgroup population, and $\hat{y}$ denotes the 1980 charges for a subgroup of the noninstitutionalized civilian population.

Estimated means may or may not need to include a time-adjustment factor in the denominator. For example, to estimate the mean charge *per visit* during 1980, no time adjustment is needed. Hence,

$$\bar{y} = \sum_i w_i y_i / \sum_i w_i x_i$$

can be used to estimate mean charge per visit. However, to estimate mean charge *per person*, a time adjustment is required in the denominator because the denominator is actually an estimate of the total average population in 1980. In particular, the estimator has the form

$$\bar{y}' = \sum w_i y_i / \sum w_i t_i .$$

Estimates of mean charges for subgroups have a similar form, with the indicator variable δ_i included in the numerator and denominator for the appropriate subgroup of interest.

Estimated proportions are means that have an indicator variable in the numerator and a count variable in the denominator. Proportions may have time adjustments not only in the denominator but also in the numerator. For example, to estimate the proportion of persons who had charges less than or equal to a fixed value, an estimate of the form

$$p' = \sum w_i d_i t_i / \sum w_i t_i$$

was used. Appropriate indicator variables were added to the numerator and denominator to make estimates for selected subgroups.

On the other hand, the estimated proportion of total charges between two fixed levels of charges does not require time adjustments in the numerator or the denominator. In particular,

$$p = \sum w_i y_i e_i / \sum w_i y_i$$

is the estimated proportion of all charges for persons that occurred between two levels of charges.

Appendix IV. Sampling Errors

The NMCUES sample was one of a large number of samples that could have been selected from the U.S. civilian noninstitutionalized population using the same sampling procedures. Each possible sample could provide an estimate that might differ from the same estimate from another sample. The variability among the estimates from all possible samples that could have been selected is defined as the standard error of the estimate, or the sampling error. The standard error can be used to assess the precision of the estimate itself by creating a confidence interval. For each interval, there is a specified probability that the average estimate over all possible samples selected from the population using the same sampling procedures will be in the interval.

Preparation of sampling errors for every estimate in this report would be a sizable task, as would be presentation of sampling error estimates for every estimate. Rather than compute and display standard errors for every estimate in this report, standard errors were computed for a subset of estimates. A set of functions was fit to these estimated standard errors to identify a model that would allow computation of a standard error that would be reasonably close to the estimated standard error.

This appendix provides summary formulas derived from the estimated standard errors that can be used to approximate the standard error for any given estimate in the report. The formulas have been designed to allow computation of an estimated standard error using an electronic calculator with basic arithmetic operators and a square root function. The computed estimate will be an average or smoothed estimate of the actual standard error of the estimate.

The formulas for standard error estimates are presented for three types of estimates found in the report:

- Totals or aggregates (e.g., total charges for all health services used in 1980; total person years for males).
- Means (e.g., mean number of ambulatory visits; per capita charges for ambulatory visits).
- Proportions, percents, and prevalence rates (e.g., proportion of total charges paid out of pocket; percent of persons with hospital admissions; incidence rate of acute respiratory conditions for males 45–64 years of age).

Comparisons can also be made between point estimates from two different subgroups of the population. Formulas are given for computing standard errors for two types of comparisons:

- Comparisons of two mutually exclusive subgroups (e.g., comparing mean number of ambulatory visits for males and females, male and female subgroups having no members in common).
- Comparisons between a subgroup and a larger group in which the subgroup is contained (e.g., comparing proportion of hospital stay charges paid out of pocket for the lower respiratory infection subgroup with those for all persons in the acute respiratory condition group).

The standard error of a difference is based on the standard error of the totals, means, proportions, percents, or prevalence rates of interest. Certain covariances between estimates, which typically are small relative to the standard errors of the estimates themselves, are ignored.

The standard errors calculated from the formulas in this appendix can be used to form intervals about which confidence statements can be made for estimates from all possible samples drawn in exactly the same way as NMCUES was. The confidence level is determined by multiplying the estimated standard error by a constant derived from the standardized normal probability distribution. In particular, for the estimate $\hat{\theta}$ with estimated standard error $S_{\hat{\theta}}$, the upper limit for a $(1-\alpha) \times 100$ percent confidence interval can be formed by adding $z_{\alpha/2}$ times S_{θ} to θ. The lower limit is formed by subtracting $z_{\alpha/2}$ times $S_{\hat{\theta}}$ from $\hat{\theta}$. The value of $z_{\alpha/2}$ is obtained from the standard normal probability distribution. For example, a 95-percent confidence interval corresponding to $\alpha=0.05$ can be formed with $z_{0.025}=1.96$; a 99-percent confidence interval $(\alpha=0.01)$ uses $z_{0.005}=2.346$. Illustrations of these calculations are provided in the discussion section for each formula.

Confidence intervals for comparisons of estimates between two subgroups allow inferences to be made about whether the difference is statistically significant. If a $(1=\alpha) \times$ 100-percent confidence interval does not include the value zero, the difference is significantly different from zero.

Totals

Let $\hat{y}$ denote the estimated total or aggregate for which a standard error is desired. The standard error for the estimate can be calculated by the expression

$$S_{\hat{y}} = \left[a\hat{y} + b\hat{y}^2\right]^{1/2},$$

where a and b are constants chosen from Table V for the particular estimate of interest. This formula was derived from a study of the relationship between the estimated total $\hat{y}$ and its standard error $S_{\hat{y}}^2$ in which a parabolic or quadratic relationship was observed.

As an illustration of the use of this formula, suppose that the standard error of the estimated value of lost productivity from colds is needed. From Table D, $\hat{y} = \$2{,}309{,}000{,}000$, the estimated total value of productivity lost in 1980 by persons with colds. Table V contains the coefficients for lost productivity, $a = 11.593$ and $b = 9.1757 \times 10^{-4}$. The estimated standard error is then computed as

$$\begin{aligned} S\hat{y} &= \left[(11.593)(23.09 \times 10^8) + \right. \\ &\quad \left.(9.1757 \times 10^{-4})(23.09 \times 10^8)^2\right]^{1/2} \\ &= \left[(2.677 \times 10^{10}) + (4.892 \times 10^{15})\right]^{1/2} \\ &= 69{,}940{,}000. \end{aligned}$$

This estimated standard error for the total $\hat{y}$ can be used to create confidence intervals for the value of lost productivity for persons with colds. For example, a 68-percent confidence interval is obtained by adding and subtracting the standard error from the estimate. In this case, in 68 out of 100 samples drawn exactly in the same way as in NMCUES, the estimated value of lost productivity for persons with colds will range from \$2,239,000,000 to \$2,379,000,000. Similarly, a 95-percent confidence interval can be obtained by adding and subtracting from the estimate 1.96 times the standard error. Thus, for 95 of 100 samples drawn in the same way as in NMCUES, the estimated value of lost productivity for persons with colds would be from \$2,172,000,000 to \$2,446,000,000.

Table V

Coefficients for standard error formula for estimated aggregates or totals, by estimator

Estimator	Coefficient	
	a	*b*
Person years	3.0476×10^4	4.7081×10^{4}
Charges	1.0986×10^8	4.5524×10^{4}
Lost productivity and value of lost productivity	1.1593×10^1	9.1757×10^{4}
Visits, prescription acquisitions, or disability days	4.6408×10^2	5.7634×10^{1}

Means

A large number of means for different types of measures are presented in this report. Despite the variety of measures presented, a single formula is recommended for calculating an estimated standard error for a mean. The formula given here is based on the assumption that the standard error of the mean is determined by two quantities, the population variance and the effect of the sample design on the variances. The population variance for weighted survey data with weights w_i is estimated as

$$\hat{s}^2 = \frac{\sum w_i (y_i - \bar{y})^2}{\sum w_i - 1},$$

where y_i denotes the value of the characteristic Y for the ith sample person, and $\bar{y}$ is the weighted sample mean. The effect of the sample design on the variance of a sample mean is called the design effect, or "deff" (Kish, 1965), and is often expressed as

$$\text{deff} = \left[1 + [(n/a) - 1]\ roh\right],$$

where a is the number of clusters in the sample design and roh is a measure of within-cluster similarity among observations from the same cluster.

The estimated standard error for a mean $\bar{y}$ can be calculated as

$$\begin{aligned} S_{\bar{y}} &= \left[\text{deff} \cdot \frac{\hat{s}^2}{\hat{n}}\right]^{1/2} \\ &= \left[\left[1 + [\frac{\hat{n}}{1{,}795{,}637} - 1]\ roh\right] \cdot \frac{\hat{s}^2}{\hat{n}}\right]^{1/2}, \end{aligned}$$

where $\hat{n}$ is the estimated population total for the subgroup under consideration and 1,795,637 represents the number of clusters ($a = 138$) times the average basic person weight. Consequently, $\hat{n}/1{,}795{,}637$ is an estimator for n/a in the expression for deff. The values of roh and $\hat{s}^2$ for a variety of means appearing in this report can be obtained from Table VI. The table provides, for example, values of roh and $\hat{s}^2$ for mean charges and mean utilization measures of various types.

As an illustration, consider the standard error of the mean number of ambulatory visits for persons with colds. From Table E, for persons with colds $\bar{y} = 5.9$, and from Table VI, under the entry "Mean visits per person, Ambulatory visits," the values $roh = 0.048246$ and $\hat{s}^2 = 1.6398 \times 10^6$ are obtained. There were an estimated $\hat{n} = 57{,}638{,}000$ persons with colds in 1980 (Table A). Substituting these values into the expression for $S_{\bar{y}}$,

Table VI

Values for *roh* and $\hat{s}^2$ for standard error formula for estimated means, by estimator

Estimator	roh	$\hat{s}^2$
Mean charges per person		
All charges:		
Ambulatory visits	0.029644	2.4952×10^9
Hospital stays	0.029644	6.1652×10^{10}
Physician visits	0.029644	6.1914×10^8
Total	0.029644	7.2407×10^{10}
Emergency room visits	0.029644	9.9816×10^7
Prescribed medications	0.029644	9.6458×10^7
Hospital outpatient visits	0.031367	7.6646×10^8
Independent provider visits	0.031367	2.6559×10^7
Hospital outpatient visits (nonphysician provider)	0.031367	4.2419×10^8
Physician visits (nonphysician provider)	0.031367	5.3375×10^7
Dental and other medical expenses	0.031367	8.8305×10^7
Charges paid out of pocket:		
Ambulatory visits	0.029644	2.4323×10^8
Hospital stays	0.029644	2.4068×10^9
Physician visits	0.029644	1.0745×10^8
Total	0.029644	3.5873×10^9
Emergency room visits	0.029644	1.0038×10^7
Prescribed medications	0.029644	4.5416×10^7
Hospital outpatient visits	0.031367	8.6571×10^6
Independent provider visits	0.031367	2.4996×10^8
Hospital outpatient visits (nonphysician provider)	0.031367	2.5341×10^7
Physician visits (nonphysician provider)	0.031367	6.7847×10^8
Dental and other medical expenses	0.031367	3.8943×10^8
Mean charges per user		
All charges:		
Ambulatory visits	0.043633	3.0423×10^9
Hospital stays	0.043633	3.0044×10^{11}
Physician visits	0.043633	1.1955×10^9
Total	0.043633	8.7587×10^{10}
Emergency room visits	0.043633	3.3067×10^8
Prescribed medications	0.043633	1.2535×10^8
Charges paid out of pocket:		
Ambulatory visits	0.043633	2.9046×10^8
Hospital stays	0.043633	1.6296×10^{10}
Physician visits	0.043633	1.5871×10^8
Total	0.043633	5.3877×10^9
Emergency room visits	0.043633	7.5825×10^7
Prescribed medications	0.043633	6.2806×10^7
Mean charges per visit		
All charges:		
Ambulatory visits	0.018777	3.7690×10^7
Hospital stays	0.018777	8.4926×10^{11}
Physician visits	0.018777	2.4686×10^7
Emergency room visits	0.018777	9.7896×10^8
Prescribed medications	0.018777	6.7348×10^5
Charges paid out of pocket:		
Ambulatory visits	0.018777	8.8152×10^6
Hospital stays	0.018777	9.4998×10^{10}
Physician visits	0.018777	9.2576×10^6
Emergency room visits	0.018777	1.1109×10^8
Prescribed medications	0.018777	7.8309×10^5
Mean visits per user		
Ambulatory visits	0.048246	1.4117×10^6
Hospital stays	0.048246	4.3009×10^3
Physician visits	0.048246	4.4788×10^5
Emergency room visits	0.048246	7.9937×10^3
Prescribed medications	0.048246	1.3402×10^6
Mean visits per person		
Ambulatory visits	0.048246	1.6398×10^6
Hospital stays	0.048246	1.0029×10^4
Physician visits	0.048246	5.5650×10^5
Emergency room visits	0.048246	1.6024×10^4
Prescribed medications	0.048246	1.6651×10^6
Mean percent paid out of pocket		
Ambulatory visits	0.051674	2.3071×10^3
Hospital stays	0.011724	1.7959×10^2
Prescribed medications	0.056569	2.7935×10^3
Dental and other medical expenses	0.053301	2.6150×10^3
Mean length of hospital stay	0.013098	8.5018×10^5
Mean bed-disability days	0.023772	7.6885×10^6
Mean work-loss days	0.026868	5.2013×10^6
Mean restricted-activity days	0.058349	3.4354×10^7
Mean functional limitation score	0.050066	4.9489×10^4
Mean number of surgical procedures	0.0	1.4628×10^8

$$S_{\bar{y}} = \left[\left[1 + \left(\frac{57{,}638{,}000}{1{,}795{,}637} - 1\right)(0.048246)\right] \cdot \frac{1.6398 \times 10^6}{57{,}638{,}000}\right]^{1/2}$$

$$= \left[[1 + (32.099 - 1)(0.048246)]\,(0.028450)\right]^{1/2}$$

$$= [(2.8146)(0.028450)]^{1/2}$$

$$= 0.26671$$

The standard error of the mean number of ambulatory visits for persons with colds is 0.27.

Approximate confidence intervals may be constructed for the population mean by adding to and subtracting from the estimated mean a constant times the estimated standard error. For example, to form a 95-percent confidence interval for the estimated mean number of ambulatory visits for persons with colds, 1.96 times the estimated standard error (0.53) is added to and subtracted from the estimated mean $\bar{y}=5.9$. In this case, the 95-percent interval ranges from 5.4 to 6.4.

When the estimated sample size is about the same size as or smaller than the constant 1,795,637 in the standard error formula, the design effect effectively becomes equal to 1. Thus, when $\hat{n} \leq 1{,}795{,}000$, the design effect portion of the standard error formula is not necessary, and the estimated standard error can be calculated simply as

$$S_{\bar{y}} = [\hat{s}^2 / \hat{n}]^{1/2},$$

where $\hat{s}^2$ is again chosen from Table VI.

For example, there are an estimated $\hat{n} = 1{,}411{,}000$ black persons with nasopharyngitis (Table 3). To estimate the standard error of the mean number of ambulatory visits for these persons in 1980 ($\bar{y}=9.5$ visits from Table 3), the value $\hat{s}^2 = 1.6398 \times 10^6$ is obtained from Table VI as before, and

$$S_{\bar{y}} = \left[\frac{1.6398 \times 10^6}{1{,}411{,}000}\right]^{1/2}$$

$$= 1.0780.$$

To form an approximate 95-percent confidence interval for the mean visits, 1.96 times the standard error (2.1) is added to and subtracted from the estimated mean, $\bar{y}=9.5$. The 95-percent interval thus ranges from 7.4 to 11.6 visits.

Proportions, Percents, and Prevalence Rates

The standard error of a proportion is computed using a formula similar to that recommended for the standard error of a mean. Let $\hat{p}$ denote the estimated proportion for which a standard error is needed. The standard error for $\hat{p}$ is calculated as

$$S_{\hat{p}} = \left[\left[1 + [\frac{\hat{n}}{1{,}795{,}637} - 1]\, roh\right] \frac{13{,}012\, \hat{p}(1 - \hat{p})}{\hat{n}}\right]^{1/2},$$

where $\hat{n}$ is the estimated sample size on which the proportion is based, *roh* is a value selected from Table VII, and the constant 13,012 is the average time-adjusted weight for all persons in the sample. For proportions, the population variance can be estimated simply as

$$\hat{s}^2 = \hat{p}(1 - \hat{p}),$$

and hence can be estimated directly from the sample proportions themselves (i.e., no value of $\hat{s}^2$ is needed in Table VII). The design effect, the ratio of the actual sampling variance for the estimated proportion to the variance that would be achieved for a simple random sample of the same size, is calculated for proportions in the same way as it was calculated for means.

Table VII

Values of *roh* for standard error formula for estimated proportions, by estimator

Estimator	*roh*
Person years	0.069992
Charges	0.041917
Charges paid out of pocket	0.019816
Visits	0.084014

As an illustration of the use of the formula for $S_{\hat{p}}$, consider obtaining the standard error for the proportion of all charges for hospital inpatient care for all persons with acute respiratory conditions during 1980 (Table J), 41.5 percent of all charges. To calculate the standard error for percents, the same formula can be used as for proportions after the percent has been divided by 100. Thus, $\hat{p}=41.5 \div 100=0.415$. There are an estimated $\hat{n}=73{,}899{,}000$ persons in the category (Table J), and $roh=0.041917$ is obtained from Table VII. Substituting these values into the formula for $S_{\hat{p}}$,

$$S_{\hat{p}} = \left[\left[1 + (\frac{73{,}899{,}000}{1{,}795{,}637} - 1)(0.041917)\right] \cdot \frac{13{,}012\,(0.415)(1 - 0.415)}{73{,}899{,}000}\right]^{1/2}$$

$$= \left[\left[1 + (40.155)(0.041917)\right] \frac{3{,}159.0}{73{,}899{,}000}\right]^{1/2}$$

$$= [(2.6832)(4.2747 \times 10^{-5})]^{1/2}$$

$$= 0.010710$$

Because $S_{\hat{p}}=0.010710$ is the estimated standard error for the proportion $\hat{p}=0.415$, simply multiply $S_{\hat{p}}$ by 100 for a standard error of 1.0710 for the percent 41.5.

An approximate 95-percent confidence interval for the percent can now be calculated by adding to and subtracting from the estimated percent 1.96 times the estimated standard error. In this case, the 95-percent interval ranges from 39.4 to 43.6 percent of all charges for persons with acute respiratory conditions for hospital inpatient care.

When the estimated sample size is less than or equal to 1,795,637, the design effect is close to 1 and the formula can be simplified to

$$S_{\hat{p}} = \left[\frac{13{,}012\,\hat{p}(1-\hat{p})}{\hat{n}}\right]^{1/2},$$

as described for the standard error of a mean in the previous section. For example, 17.5 percent of visits for persons 12–17 years of age with otitis media were for otitis media conditions (Table 5). For the $\hat{n} = 998{,}000$ estimated persons in this subcategory, the standard error of the proportion associated with this percent is estimated as

$$\left[\frac{13{,}012\cdot(0.175)(1-0.175)}{998{,}000}\right]^{1/2} = 0.043386.$$

A 95-percent confidence interval for the estimated percent is calculated by multiplying this estimated standard error by $100\cdot(1.96) = 196$ and adding the result to and subtracting the result from the percent. Thus, the 95-percent interval ranges from 9.0 to 26.0 percent.

The same procedure can be used to calculate standard errors for prevalence rates. Prevalence rates are handled in the same way as percents are except that the rate is divided by 1,000 rather than 100 to obtain a proportion to use in the formula. For example, to obtain the estimated standard error for the prevalence rate for acute respiratory conditions in Table A (a rate of 504.0 per 1,000 person years), divide the rate by 1,000 (504.0/1,000 = 0.504) and observe that $\hat{n} = 222{,}824{,}000$ (all persons) and $roh = 0.069992$ from Table VII for person years. The estimated standard error can be calculated for this prevalence rate as

$$S_{\hat{p}} = \left[\left[1 + \left(\frac{222{,}824{,}000}{1{,}795{,}637} - 1\right)(0.069992)\right] \left[\frac{13{,}012\cdot(0.504)(1-0.504)}{222{,}824{,}000}\right]\right]^{1/2}$$

$$= \left[\left[1 + (123.09)(0.069992)\right]\frac{3{,}252.8}{222{,}824{,}000}\right]^{1/2}$$

$$= \left[(9.6155)(1.4598 \times 10^{-5})\right]^{1/2}$$

$$= 0.011848.$$

This standard error is multiplied by 1,000, and the 95-percent confidence interval for the estimated prevalence rate ranges from 480.78 to 527.22 per 1,000.

Mutually Exclusive Subgroup Differences

Many comparisons between the same estimate for two different subgroups in the population are made in this report. Let $\hat{d} = \hat{\theta}_1 - \hat{\theta}_2$ denote the difference between two subgroup estimates, where $\hat{\theta}_1$ and $\hat{\theta}_2$ are the estimates for the two subgroups. For example, suppose that the incidence of acute respiratory conditions per 1,000 males is to be compared with the rate per 1,000 females (Table 1). Then $\hat{\theta}_1 = \hat{p}_1 = 0.4703$ for males, $\hat{\theta}_2 = \hat{p}_2 = 0.5354$ for females, and $\hat{d} = \hat{p}_1 - \hat{p}_2 = -0.0651$. The standard error of this difference is computed as

$$S_{\hat{d}} = \left[S^2_{\hat{\theta}_1} + S^2_{\hat{\theta}_2}\right]^{1/2},$$

where $S^2_{\hat{\theta}_1}$ and $S^2_{\hat{\theta}_2}$ are the estimated sampling variances for $\hat{\theta}_1$ and $\hat{\theta}_2$, respectively. (This formula ignores the nonzero covariance between $\hat{\theta}_1$ and $\hat{\theta}_2$ that arises in complex samples such as NMCUES. This covariance is typically positive and small relative to the variances themselves. Ignoring the covariance will result in standard errors for differences that are on average somewhat larger than the actual standard errors.)

From Table 1, $\hat{n}_1 = 107{,}481{,}000$ and $\hat{n}_2 = 115{,}344{,}000$; from Table VI, $roh = 0.069992$. Hence,

$$S_{\hat{y}_1} = \left[\left[1 + \left(\frac{107{,}481}{1{,}795{,}637} - 1\right)(0.069992)\right] \cdot \frac{13{,}012(0.4703)(1-0.4703)}{107{,}481{,}000}\right]^{1/2}$$

$$= 0.012426$$

and

$$S_{\hat{y}_2} = \left[\left[1 + \left(\frac{115{,}344{,}000}{1{,}795{,}637} - 1\right)(0.069992)\right] \cdot \frac{13{,}012\,(0.5354)(1-0.5354)}{115{,}344{,}000}\right]^{1/2}$$

$$= 0.012339.$$

Therefore, the standard error of the difference is computed as

$$S_{\hat{d}} = \left[(0.012426)^2 + (0.012339)^2\right]^{1/2} = 0.017512.$$

This standard error can be used to form an approximate confidence interval for the difference in the same manner as described previously for estimates of totals, means, proportions, and percents. In this instance, the 95-percent confidence interval for the difference in incidence rates per 1,000 population is from 30.8 to 99.4. Since this interval does not include the value zero, it can be concluded with 95-percent confidence that incidence rates for females are higher than those for males. In other words, the chances are only 5 in 100 that the difference over a large number of identical surveys will be equal to zero.

Subgroup to Total Group Differences

Another type of comparison made in this report is between an estimate for a subgroup and the same estimate for a group that contains the subgroup. Let $\hat{d}=\hat{\theta}_1-\hat{\theta}_T$ denote the difference between a subgroup estimate and the estimate for a group in which the subgroup is contained, where $\hat{\theta}_1$ is the subgroup estimate and $\hat{\theta}_T$ is the estimate for the larger group. The standard error of this difference is computed as

$$S_{\hat{d}}=S_{\hat{\theta}_1}\left[1-(\hat{n}_1/\hat{n}_T)\right]^{1/2},$$

where $S_{\hat{\theta}_1}$ denotes the standard error of the estimator $\hat{\theta}_1$ and $\hat{n}_1$ and $\hat{n}_T$ denote the estimated sample sizes for the subgroup and for the larger group, respectively. (This formula is based on an assumption that the covariance between $\hat{\theta}_1$ and $\hat{\theta}_T$ is the same as the variance of $\hat{\theta}_1$, i.e., $S^2_{\hat{\theta}_1}$. This assumption results in an estimated standard error for the difference that is on average somewhat larger than the actual standard error.)

For example, suppose that the standard error of the difference between per capita surgical charges for persons with acute respiratory conditions and per capita surgical charges for all persons is needed. From Table G, $\hat{\theta}_1=\bar{y}_1=\$1{,}429$ and, $\hat{\theta}_T=\bar{y}_T=\$2{,}082$. From Table A, $\hat{n}_1=112{,}302{,}000$, and $\hat{n}_T=222{,}824{,}000$. Using the formula for estimating the standard error of the mean and values from Table VI under "Mean charges per visit, All charges, Hospital stays, and Surgery" (i.e., $\hat{s}^2=8{,}4926\times 10^{11}$ and $roh=0.018777$),

$$S_{\bar{y}_1}=\left[\left[1+(\frac{112{,}302{,}000}{1{,}795{,}637}-1)(0.018777)\right]\frac{8{,}4926\times 10^{11}}{112{,}302{,}000}\right]^{1/2}$$

$$=127.68\,.$$

Hence, the standard error of the difference, $\hat{d}=\$1{,}429-\$2{,}082=-\$653$, is computed as

$$S_{\hat{d}}=127.68[1-(112{,}302{,}000/222{,}824{,}000)]^{1/2}=89.922.$$

A 95-percent confidence interval can be constructed for the difference by adding to and subtracting from the estimated difference 1.96 times the estimated standard error of the difference. In this instance, the 95-percent confidence interval is from $-\$477$ to $-\$829$. It can be concluded with 95-percent confidence that persons with acute respiratory conditions have lower per capita surgical charges than all persons because this confidence interval does not include zero.

Appendix V. Definition of Terms

Age—This is the age of the person as of January 1, 1980. Babies born during the survey period were included in the youngest age category.

Ambulatory care visit—A direct personal exchange between an ambulatory patient and a health care provider is an ambulatory care visit. The visit may take place in the provider's office, hospital outpatient department, emergency room, clinic, health center, or the patient's home. Services may be rendered by a physician, chiropractor, podiatrist, optometrist, psychologist, social worker, nurse, or other ancillary personnel.

Bed-disability day—A bed-disability day is one on which a person stays in bed more than half of the daylight hours because of a specific illness or injury. All hospital days for inpatients are considered to be bed-disability days even if the patient was not actually in bed at the hospital.

Condition—Any entry on the questionnaire that describes a departure from a state of physical or mental well-being is included. A condition is any illness, injury, complaint, impairment, or problem perceived by the respondent as inhibiting usual activities or requiring medical treatment. Pregnancy, vasectomy, and tubal ligation were not considered to be conditions; however, related medical care was recorded as if they were conditions. Neoplasms were classified without regard to site. Conditions, except impairments, were classified by type according to the Ninth Revision of the International Classification of Diseases (World Health Organization, 1977) as modified by the National Health Interview Survey Medical Coding Manual; these modifications make the code more suitable for a household interview survey. Impairments are chronic or permanent defects, usually static in nature, that result from disease, injury, or congenital malformation. They represent decrease or loss of ability to perform various functions, particularly those of the musculoskeletal system and the sense organs. Impairments are classified by using a supplementary code specified in the coding manual. In the supplementary code, impairments are grouped according to type of functional impairment and etiology.

Condition-related disability day—Condition-related disability days include work-loss days, restricted-activity days, and bed-disability days for which the respondent listed the indexed condition as an underlying cause for staying home from work, cutting down on usual activities, or staying in bed.

Condition-related visit or hospital admission—Ambulatory visits or hospital admissions for which the respondent listed the indexed condition as an underlying reason for seeking medical services are classified as condition related.

Disability—Disability is the general term used to describe any temporary or long-term reduction of a person's activity as a result of an acute or chronic condition.

Disability day—Short term disability days are classified according to whether they are days of restricted activity, bed-disability days, hospital days, or work-loss days. All hospital days are by definition days of bed disability; all days of bed disability are by definition days of restricted activity. The converse form of these statements is, of course, not true. Days lost from work apply only to the working population. Work-loss days are also days of restricted activity. Hence, the restricted-activity day is the most inclusive term used to describe disability days.

Education of head of family—The years of school completed by the head of family, if the family head was 17 years of age and over, is classified. Only years completed in regular schools, where persons are given a formal education, were included. A "regular" school is one that advances a person toward an elementary or high school diploma or a college, university, or professional school degree. Thus, education in vocational, trade, or business schools outside the regular school system was not counted in determining the highest grade of school completed.

Employed—An individual is classified as employed if he or she worked at any time in 1980.

Family—A group of people living together and related to each other by blood, marriage, adoption, or foster care status is considered a family. An unmarried student 17–22 years of age living away from home was also considered part of the family even though his or her residence was in a different location during the school year.

Family head—At the time of the first interview, the respondent for the family was asked to designate a "family head." If no head was designated or this information was missing, a family head was imputed.

Family income in 1980—Each member of a family is classified according to the total income of the family of which he or she is a member. Because some persons changed families during the year, their family income is defined as the income of the family they were a member of the longest. If a family did not exist for the entire year, the family income is adjusted to an annual basis by dividing actual income by the proportion of the year the family existed. Unrelated persons are classified according to their own income. For each person, 12 categories of income were collected, including income from employment for persons 14 years of age and over and income from various government programs, pensions, alimony or child support, interest, and net rental income. When information was missing, data were imputed. The total income of persons who were members of more than one family was allocated to each family in proportion to the amount of time they were in that family.

Homemaker—An individual is classified as a homemaker if he or she did not work at all in 1980 (unemployed or not in the labor force) and claimed housekeeping as his or her main activity in 1979. Disabled homemakers are not included. (See "Unable to work for health reasons.")

Hospital admission—This is the formal acceptance by a hospital of a patient who is provided room, board, and regular nursing care in a unit of the hospital. A patient admitted to the hospital and discharged on the same day is considered to have had a hospital admission. Also included is a hospital stay resulting from an emergency department visit.

Household—Occupants of group quarters or of a housing unit that was included in the sample constitute a household. A household can comprise one person, a family of related people, a number of unrelated people, or a combination of related and unrelated people.

Housing unit—A group of rooms or a single room occupied or intended for occupancy as separate living quarters is a housing unit if the occupants do not live and eat with any other persons in the structure and if there was either direct access from the outside or through a common hall or there were complete kitchen facilities for the use of the occupants only.

Key person—A key person was (1) an occupant of a national household sample housing unit or group quarters at the time of the first interview; (2) a person related to and living with a State Medicaid household case member at the time of the first interview; (3) an unmarried student 17–22 years of age living away from home and related to a person in one of the first two groups; (4) a related person who had lived with a person in the first two groups between January 1, 1980, and the round 1 interview, but was deceased or had been institutionalized; (5) a baby born to a key person during 1980; or (6) a person who was living outside the United States, was in the Armed Forces, or was in an institution at the time of the round 1 interview but who had joined a related key person.

Limitation of activity—A functional limitation score was developed for classifying limitation of activity. It ranges form 0, indicating no limitation of activity, to 8, meaning severe activity limitation, and 9, indicating death during the survey period. The functional limitation score was developed from responses to a battery of questions designed to assess ability to perform various common functions such as walking, driving a car, and climbing stairs. For NMCUES, these questions were asked of persons 17 years of age and over.

Nonkey person—A person related to a key person who joined him or her after the round 1 interview but was part of the civilian noninstitutionalized population of the United States at the date of the first interview is considered nonkey.

Patient—A person who is formally admitted to the inpatient service of a short-stay hospital for observation, care, diagnosis, or treatment is considered a patient. In this report, the number of patients refers to the number of discharges during the year, including any multiple discharges of the same individual from one or more short-stay hospitals. The terms "patient" and "inpatient" are used synonymously.

Per capita charges—These charges were calculated by dividing the total charges by the number of people in the reference population.

Perceived health status—This measure is the family respondent's judgment of the health of the person compared with others the same age, as reported at the time of the first interview. The categories are excellent, good, fair, and poor.

Prescribed medicine acquisitions—Each time a person had a prescription filled, regardless of whether it was an initial filling or a refill of a prescription, is included in the number of acquisitions.

Prevalence of conditions—In general, prevalence of conditions is the estimated number of conditions of a specified type existing at a specified time or the average number existing during a specified interval of time—in the case of this survey, during 1980.

Race—The race of people 17 years of age and over was reported by the family respondent; the race of those under 17 was derived from the race of other family members. If the head of the family was male and had a wife who was living in the household, her race was assigned to any children under 17 years of age. In all other cases, the race of the head of the family (male or female) was assigned to any children under 17 years of age. Race is classified as "white," "black," or "other." The "other" race category includes American Indian, Alaskan Native, Asian, and Pacific Islander. The category "white and other" includes the categories "white" and "other."

Reporting unit—This is the basic unit for reporting data in the household component of NMCUES. A reporting unit consists of all related people residing in the same housing unit or group quarters. One person could give information for all members of the reporting unit.

Restricted-activity day—A restricted-activity day is one on which a person cuts down on his usual activities for the whole of that day because of an illness or an injury. The term "usual activities" for any day means the things that the person would ordinarily do on that day. A day spent in bed or a day home from work because of illness or injury is, of course, a restricted-activity day.

Round—A round was the administrative term used to designate all interviews that occurred within a given period of time and that used the same instruments and procedures.

Surgery—Surgery is a procedure involving incision and examination or removal of tissue for diagnostic or therapeutic purposes.

Work-loss day—A work-loss day is a day on which a person did not work at his or her job or business because of a specific illness or injury. The number of days lost from work is determined only for persons 17 years of age and over who reported that at any time during the survey period they either worked at or had a job or business.

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