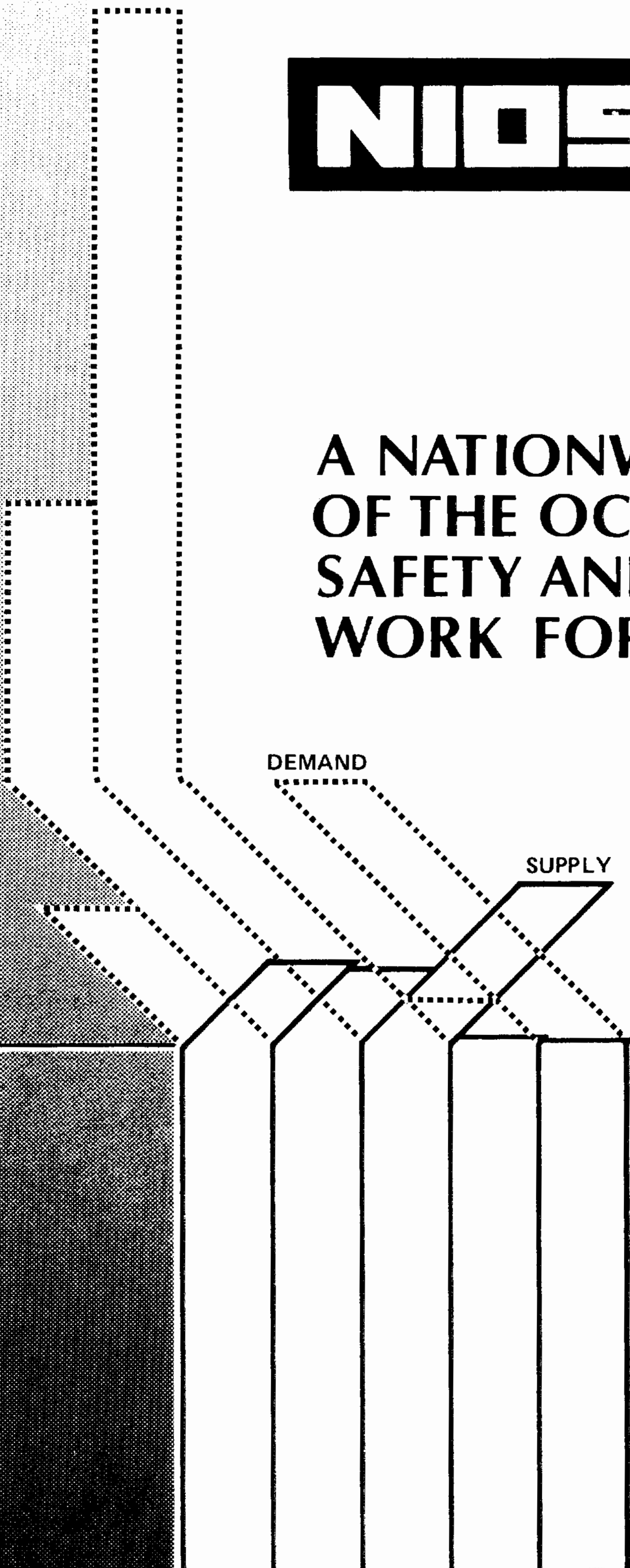
NIOSH

A NATIONWIDE SURVEY OF THE OCCUPATIONAL SAFETY AND HEALTH WORK FORCE



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

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Cincinnati, Ohio

July 1978

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

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The Division of Training and Manpower Development (DTMD), National Institute for Occupational Safety and Health (NIOSH), has primary responsibility for the development of the criteria and recommendations for manpower development. This project was accomplished to provide information relative to that responsibility. The data were collected, analyzed, and formulated into the final report by John Short and Assoc., Salt Lake City, Utah, under Contract No. CDC–210–76–0192. James S. Ferguson, DTMD, was the Project Officer. William J. Weis, III, DTMD, served as Assistant Project Officer.

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The views expressed and conclusions reached in this publication are those of NIOSH. They are not necessarily those of the industries, federal agencies, and individuals contacted.

DHEW (NIOSH) Publication No. 78-164

PREFACE

One of the major NIOSH mandates of the Occupational Safety and Health Act of 1970 is a specific charge in Section 21(a) "to conduct directly or by grants or contracts educational programs to provide an adequate supply of qualified personnel to carry out the purposes of the Act. ..." The education and training programs of the Institute must be designed and carried out to fulfill the occupational safety and health manpower requirements of the nation in protecting the health and safety of every American worker.

The Nationwide Survey of the Occupational Safety and Health Workforce was designed to provide information for assessment and guidance to educational institutions, individuals interested in careers in occupational safety and health, governmental agencies, foundations – in short anyone with an interest in manpower needs and development in this field. In particular, the National Institute for Occupational Safety and Health will use this survey, and future updates of it, as a programming and evaluative tool in order to rationally plan and manage the manpower development support activities to meet the needs for an effective, balanced and responsive national program.

The science or, perhaps more properly, art of manpower forecasting is, at best, inexact in that there are many independent variables that influence the need/demand for certain skill categories. For example, the demands for new personnel in the occupational safety and health disciplines may be subject to significant change depending upon the development and promulgation of standards for exposure limits, implementation of regulations at the state and federal levels for medical and environmental monitoring and recordkeeping requirements, etc. The level of inspection and compliance enforcement of workplace health and safety standards will also be an obvious influence. These levels are subject to a great deal of variability depending upon political, socio-economic, and technological feasibility factors which in turn are difficult to predict.

Support for training and education will be directed in such a way as to provide the coverage and flexibility to approach an optimum program to meet occupational safety and health manpower needs. Careful review and evaluation of the information provided in this survey, conditioned by continuing evaluation of the changing forces over time, should provide the means to do this. The NIOSH Occupational Safety and Health Educational Resource Center grant program, in conjunction with the individual training project grant program, provides an appropriate mechanism.

We are pleased to provide this report and hope it will be a valuable source of data and useful for planning purposes for those who, like NIOSH, are specifically concerned with occupational safety and health manpower.

not estimated. A report by the Bureau of the Census ("Characteristics of Persons in Engineering and Scientific Occupations: 1972 Technical Paper No. 33, U.S. G.P.O., Wash., D.C., 1974") stated that scientists and engineers change occupations in very significant numbers. For example:

23.3% of U.S. engineers changed occupations.
24.4% of U.S. life scientists changed occupations.
29.7% of U.S. physical scientists changed occupations.
13.4% of U.S. environmental scientists changed occupations.

Rates for occupational safety and health personnel were not determined specifically in the above survey. However, they are probably similar to those mentioned. Therefore, the forecasts of total employment and new hires are no doubt conservative.

4. All known educational institutions offering safety and health programs were surveyed to ascertain the forecast supply of occupational safety and health graduates; however, the data may be biased upward since they are based on what educators think will happen in the future. In the absence of an accreditation process for most occupational safety and health educational programs, the quality of the forecasted supply of future graduates has not and cannot be addressed in this survey. If an accreditation process were established, it is conceivable that many program directors would forego expansion and reallocate resources to the upgrading of their existing programs.

5. Two alternative future sets of assumptions (see below) were used for the forecasts. Significant shifts in future OSHA requirements could, however, have a drastic effect on the annual forecast of demands for new hires.

With these caveats in mind, the principal results of the study were:

The estimated 1977 occupational safety and health work force, derived by applying the survey-determined occupational safety and health employment coefficients to national work force estimates, contains 84,850 occupational safety- and health-related employees (i.e., personnel who spend more than 50% of their time in occupational safety- and health-related activities). The characteristics of the work force include:

- a bimodal age distribution, with modes at the 30 to 34 age cohort and the 50 to 54 age cohort;
- an average of 14.7 years of education for each member; and
- an average experience of 6.8 years on the present job.

Employers participating in the survey were also requested to indicate what their minimum requirements for new hires would be. Their responses indicate that:

- 80 percent of the new entrants will be required to have at least some college;
- an average of 3.9 years of experience is expected;
- less than 13 percent of the employers would require some form of occupational safety- and health-related certification; and
- the average salary for such a new hire would be $13,500 per annum.

EXECUTIVE SUMMARY

This study was funded by the National Institute for Occupational Safety and Health (NIOSH) in response to diverse estimates of potential manpower shortages in the occupational safety and health field. NIOSH, charged with the responsibility of assuring a sufficient occupational safety and health labor force to implement the Occupational Safety and Health Act of 1970, undertook a feasibility study in 1974 to determine whether a nationwide survey could accurately describe the existing occupational safety and health work force and to develop a manpower forecasting model capable of estimating future occupational safety and health work force requirements. The goal of the study reported here was to provide NIOSH, other federal agencies, educational institutions, private industry, and individuals interested in entering the occupational safety and health field with an assessment of the demand for additional trained employees.

This report presents the results of the *Nationwide Survey of the Occupational Safety and Health Work Force,* which was undertaken in 1977. The survey focused on firms and organizations employing more than 100 workers within all nonagricultural Standard Industrial Classifications including state, local, and federal agencies. Almost 3,300 responding units, representing 8 percent of the targeted wage and salary work force, completed the survey instruments. Inferences from the survey results were made and used to estimate the current number of occupational safety and health employees in all sectors of the economy, to forecast future demand of occupational safety and health personnel, to indicate the characteristics of occupational safety and health job roles, to generate demographic profiles of occupational safety and health employees, and to describe the organizational setting of their work places. In addition, a separate survey of all known educational institutions offering occupational safety- and health-related degrees was undertaken to ascertain the existing, and forecast the supply of, occupational safety and health personnel. These data were then compared with the annual demand data.

Based on the magnitude and variance of the sample responses, the existing occupational safety and health work force is estimated to contain between 79,250 and 90,440 employees at a 95 percent confidence level. (A separate Technical Appendix available from National Technical Information Service discusses in detail the survey methodology, data reliability, estimations, and job classification forecasting methodologies.) In reviewing the estimates and forecasts, the following caveats must be considered in any application of this report:

1. The survey experienced a 50 percent response rate that may have biased the estimates upward, in that firms without significant safety and health employees were possibly less inclined to reply.

2. Organizations containing fewer than 100 employees were omitted, and therefore safety and health consulting firms, clinics, and labs with occupational safety and health professionals were not included. This would tend to bias the estimates downward.

3. Although attrition due to death, disability, and retirement was taken into account, the number of occupational safety and health employees who will either be promoted into management and out of the safety and health field or who will change career paths was

Forecasts of the occupational safety and health work force were made for the years 1980, 1985, and 1990 by applying occupational safety and health employment incidence coefficients to Bureau of Labor Statistics employment forecasts. Two alternative sets of assumptions concerning the future were developed. The initial set, termed "status quo," was based on the assumption that the existing incidence coefficients would remain unchanged throughout the forecast period. Using this forecast, the estimated number of occupational safety- and health-related employees in 1980 would be 94,230, increasing to 99,720 by 1985, and reaching a level of 104, 360 by 1990.

A second set of alternative assumptions, termed "accelerated growth," was based on some subjective assumptions, suggested by the study's Technical Advisory Committee, concerning the impact of existing and proposed regulatory efforts on the demand for occupational safety and health personnel. Under this set of assumptions, the total occupational safety and health work force is forecast to reach 104,640 by 1985, and 110,840 by 1990.

Both sets of occupational safety and health work force forecasts were then subjected to an attrition model that provided forecasts of annual new hires demanded during the forecast period. Again, no consideration was given to employees leaving the occupational safety and health field for reasons other than death, disability, and retirement. Total annual new hires between 1977 and 1980 are forecast to be 5,300. This figure is expected to decrease to between 3,040 (status quo) and 4,410 (accelerated growth) annually between 1981 and 1985 and to level off at 3,100 annually for both alternatives between 1986 and 1990. Growth in demand is concentrated in those job classifications that "inspect, interpret, investigate, and plan" in the safety and general basic areas of occupational safety and health responsibility.

The future supply of occupational safety and health personnel was also investigated. A survey of 112 educational programs designated by NIOSH as providing a degree, specialty of emphasis, or certificate in an occupational safety- and health-related field was undertaken by the contractors and by NIOSH. The institutions were requested to indicate the number of graduates produced between 1970–76 and to forecast their growth in output for 1980, 1985, and 1990. These data were then added to the estimated training outputs of insurance carriers and the federal government. After comparing the annual new hire forecasts with the forecast supply data, apparently there will be a chronic shortage of graduates in the safety and occupational nursing basic areas that may persist throughout the 1980–90 forecast period. The occupational physician and general basic areas are currently experiencing a shortage. The industrial hygiene basic area may be in an equilibrium position.

Furthermore, NIOSH must continue its long-established effort in improving the quality of the existing workforce through the short-course continuing education route. In conjunction with efforts to establish and conduct educational programs at the University level, ". . . . an adequate supply of qualified manpower to carry out the purposes of the the Act," will be assured.

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ACKNOWLEDGEMENTS

We appreciate the cooperation of the many respondents who participated in the survey, with special thanks to the loss prevention and control insurance carriers. Our appreciation is extended to Bernard V. Preston, Dun & Bradstreet, Inc., and the Marketing Services Division staff who were responsible for collecting and processing a major portion of the survey data. We also wish to thank the Technical Advisory Committee for their valuable input and assistance in this study – Wayne Christensen, Harry Partlow, American Society of Safety Engineers; Richard Konzen, Ph.D., Herbert Walworth, American Industrial Hygiene Association; Josephine Cipolla, R.N., American Nurses Association and American Association of Industrial Nurses; Marcus M. Key, M.D., University of Texas; Ralph J. Vernon, Ph.D., Texas A & M University; Al Blackman, Minerva Math, and Robert D. Mahon, National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare; Earl D. Heath, Ph.D., and Marilyn Powers, Occupational Safety and Health Administration, U.S. Department of Labor.

CHAPTER I

DESCRIPTION OF THE 1977 OCCUPATIONAL SAFETY AND HEALTH WORK FORCE

A. INTRODUCTION AND PURPOSE

The Occupational Safety and Health Act of 1970 (the Act) was enacted as a result of the growing concern regarding the number and severity of occupationally related injuries and illnesses. The intent of the Act was to ensure safe and healthful working conditions for working men and women. Meeting this objective (thereby positively altering the past trends in the incidence of injuries and illnesses) demands an increased commitment on the part of federal government, state and local government, business and industry, and the workers themselves. This commitment, however, will be to little avail if individuals with knowledge, expertise, and experience in the areas of occupational safety and health are not available to employers and to working men and women.

As indicated by statistics on the incidence and severity of injuries and illnesses and also by studies in the area of illness and injury prevention, it is evident that safe and healthful working environments and practices do not occur spontaneously, nor by application of "common sense." Specialized help must be available if the incidence of illness and injury is to be reduced. The National Institute for Occupational Safety and Health (NIOSH) was mandated by the Act "to conduct directly or by grants and contracts, educational training programs aimed at providing an adequate supply of qualified personnel to carry out the purposes of the Act. . . ."

Historically, little has been known about the number of individuals employed in the area of occupational safety and health, their present duties and qualifications, or the present and future needs of the governmental and private sectors regarding occupational safety- and health-specialized employees. This situation is understandable. Before the enactment of the Act, diverse federal and state programs and regulations affected the private sector. The amount and types of efforts aimed at controlling health and safety hazards of the industries and their workers were uneven. State programs varied greatly, and none were as extensive in power or coverage as the program established by the Act.

In the private sector, the size of staff involved and the amount of expenditures made by a given company or organization to operate safety and health programs generally depended on upper management's perceptions of, and attitudes toward, the benefits of such programs. Also, these programs mainly dealt with safety and seldom considered environmental health hazards and safeguards. There was no systematic definition of need for occupational safety and health personnel by the private sector or government; consequently, as a profession, occupational safety and health lacked definitions concerning both the areas of specialization within the field and the qualifications (including skills, education, and work experience) required to fill the roles that would aid in the prevention of illness or injury.

This discipline has yet to establish areas of recognized specialization such as those in the professions of medicine, law, psychology, and education. This situation presents several problems if NIOSH is to achieve the objective of providing an adequate supply of qualified personnel to carry out the purposes of the Act. The development of appropriate educational programs demands:

- a thorough, empirically based understanding of the number, demographic characteristics, assigned duties, education, and experience of individuals now performing related duties in the various industries;

- an assessment of the future need for such personnel; and

- an anticipation of requirements to meet minimum standards required of those professions.

This report presents the results of a nationwide survey of the occupational safety and health work force for the purpose of forecasting short- and long-run occupational safety and health manpower needs and demands for the United States. Such data are necessary to develop and implement manpower programs in the public and private sectors. Data generated from this survey may be used by:

- The National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) to determine the number, type, and location of future educational programs.

- OSHA to assess manpower availability to support its standards development, enforcement, and consultation programs.

- Private and public educational institutions to evaluate the curricula of existing occupational safety- and health-related programs and to determine the need for additional curricula and new programs.

- Occupational safety and health professional societies to assist in planning and development.

- Individuals to assist in career selection.

The methodology for the nationwide survey was developed and reported in the *Feasibility Study Concerning the Nationwide Occupational Safety and Health Manpower Survey:* (HEW Publication No. (NIOSH) 75-138). The data collection methodology, sampling plan, and forecasting model were specified in the *Feasibility Study.* (A detailed description of the sampling results and the statistical reliability of the data reported herein is contained in the Technical Appendix to this report, available from NTIS.

B. DATA COLLECTION METHODOLOGY

As reported in the *Feasibility Study,* the relevant universe of work places included all firms employing 100 or more in mining, construction, manufacturing and transportation, communication and utilities, and all firms employing 500 or more in the trades and services industries and in non-occupational safety- and health-related state and local agencies. Loss prevention insurance carriers and occupational safety- and health-related state and federal government agencies were to be dealt with separately, via a more intensive sample of those respective strata. The decision to exclude firms employing less than 100 (or less than 500 in the trades, services, and nonoccupational safety and health state and local agencies) was based on the extremely low incidence of occupational safety and health personnel found in the smaller organizations by the *Feasibility Study* survey. The incidence of persons spending 20 percent or more of their time in occupational safety- and health-related activities was so low (less than 0.2 per firm) that the acquisition of extensive, statistically valid data would become extremely expensive. The problem is analogous to looking for pins in a haystack: to accurately access the magnitude of occupational safety and health personnel in these categories, literally thousands of small firm responses would be required. Furthermore, none of the individuals initially contacted in these small firms spent more than 50 percent of their time on occupational safety- and health-related activities (see the *Feasibility Study* pages 44–45 for additional discussion on this point).

Three individual survey instruments were used to collect data for this study. One questionnaire was directed toward the responding organization and its safety and health operations. The second instrument elicited information concerning each of the occupational safety and health positions (or job roles) within the organization. A third questionnaire was addressed to each of the individuals who filled these various safety and health job roles. (The Technical Appendix describes the development of these questionnaires, the contact strategy involved, and the number and type of respondents who participated in the survey.)

C. JOB CLASSIFICATION SYSTEM

Manpower forecasts must be centered around generic job titles that represent a broad clustering of similar duties and responsibilities. This requires the aggregation of hundreds of position titles into a few distinct categories that define the types of occupational safety and health occupations to be forecast by the manpower model.

Developing such a job classification system that would be descriptive, exhaustive, and yet meaningful to professional societies, education institutions, employers, and government agencies was a primary challenge to this study. Because of the inconsistent and arbitrary array of professional and technical occupational safety and health job titles throughout industry (the *Feasibility Study* identified 124 different occupational safety and health titles for 328 employees), one of the objectives of the study was constructing a job classification system that:

- Would provide enough disaggregation to indicate significant differences in activities, responsibilities, and training and experience, and yet remain broad enough to cluster together similar positions.

- Would comply with the various professional societies' efforts to standardize, certify, and license occupational safety and health positions, and yet be sufficiently general so that the significant number of existing occupational safety and health personnel who did not meet the various societies' guidelines would not be excluded nor be placed into a miscellaneous category.

- Could be computerized and based on a minimum number of interview questions so that the incidence of specific occupational safety and health specialists could be statistically calculated from the results of thousands of interviews.

- Would be exhaustive; that is, the system had to be capable of placing at least 90 percent of all responses into an appropriate job classification.

The initial attempts at developing a computerized and exhaustive job classification system are well documented in the *Feasibility Study.* Those efforts resulted in the formulation of a two-phased classification process in which job roles or occupational positions were to be classified first by their "basic area" of responsibility and, secondly, with respect to their conformity to various statistically defined clusters of occupational safety and health activities. Six basic areas of responsibility were assumed to exhaust the set of occupational safety and health areas of knowledge. These basic areas, and the decision rules utilized, are:

Basic Area	Decision Rule
Safety	Spends more than 50% of the time in the prevention or treatment of occupational injury.
Radiation	Spends more than 50% of the time in the prevention or treatment of occupational illness due to radiation.
Industrial Hygiene	Spends more than 50% of the time in the prevention or treatment of occupational illness due to causes other than safety and radiation.
Fire Protection	Spends more than 50% of the time in the prevention of fire.
General	Spends 25% or more of the time between two or more of the above basic areas.
Medical	Practices medicine or practices nursing.

Note, these decision rules are exclusive, and therefore they classify each job role into only one basic area. Once this initial step had been accomplished, the second level of classification occurred; that of identifying the degree of specialization within the basic area. The assumption is that some job roles apply principally to administrators, whereas others apply more to professionals or technicians. The problem centers on how to identify such distinctions.

The second step in the job classification system centered on classifying the job roles within the above basic areas, according to the responses to a list of 27 occupational safety- and health-related activities listed in the Job Role Questionnaire (See Technical Appendix). This list is the result of testing a much larger set of occupational safety- and health-related activities during the *Feasibility Study.* Based on the pattern of responses to the pilot survey instrument, these activities were selected for the nationwide survey.

The responses were then investigated to determine if any statistical clusterings of activities emerged that discriminated between job roles (see Table 1). This clustering process involved the application

Table 1: Job cluster titles by key words and occupational safety and health-related activities.

Job Cluster Titles	OSH-Related Activities Taken From Job Role Questionnaire
Administrates, Advises, and Interprets	(10) Advises top level management (20) Attends professional meetings and reviews pertinent scientific findings and studies to determine significance to organization (21) Interprets current OSH laws, regulations, and standards in terms of the impact on organization and the action necessary to assure compliance (22) Plans and develops programs in the area of occupational safety and health (23) Administrates (directs, manages)
Inspects, Interprets, Investigates, and Plans	(1) Inspects work place to identify existing or potential hazards (5) Investigates to determine cause of illness, injury or fire (10) Advises top level management (14) Provides education and training to employees by conducting training sessions (17) Inspects equipment for compliance with established OSHA regulations and standards (20) Attends professional meetings and reviews pertinent scientific findings and studies to determine significance to organization (21) Interprets current OSH laws, regulations, and standards in terms of the impact on organization and the action necessary to assure compliance
Analyzes Plans and Develops Procedures	(4) Analyzes proposed plans or specifications to identify potential hazards (7) Develops operating procedures to eliminate or control hazards
Provides Training	(15) Provides education and training to employees through personal contact (16) Provides education and training to employees by other means (bulletins, posters, memos)
Performs and Analyzes Tests	(2) Performs tests and measurements (3) Analyzes results of tests or measurements
Maintains, Repairs, and Adapts Equipment	(18) Maintains and repairs equipment (19) Adapts or modifies existing equipment to meet a specified need
Physician	(25) Practices medicine
Nurse	(26) Practices nursing

of conditional probability theory to identify those activities that were strongly related to each other. For example, the probability of answering activity #2, given that activity #1 had been checked (and the conditional probabilities of all other combinations of activities) was also determined. (A technical derivation of the job classification system is included in the separate Technical Appendix.) In each of three tests of distinct subsets of the sample results, the same six unique occupational clusters emerged; thus substantiating the hypothesis that activity groupings of occupational safety and health personnel did exist and could be identified. Note that the physician and nurse job clusters are predicated on the designation of practicing medicine or nursing, respectively, and were not subject to the clustering scheme. The eight activity clusters (including physician and nurse) are presented in Table 1 with the key-word title used to identify the job clusters as presented in succeeding chapters. All of the 1977 estimates and subsequent forecasts are presented using these job cluster titles; thus the reader must keep the full activity description in mind when reviewing the remaining chapters.

D. ESTIMATED SIZE OF THE 1977 OCCUPATIONAL SAFETY AND HEALTH WORK FORCE

Based on the incidence rates derived from the survey of private firms, insurance carriers, and government organizations, an estimated 84,850 employees spend 50 percent or more of their time in occupational and safety- and health-related activities. The estimated size of the 1977 occupational safety and health work force, tabulated by industrial classification and basic area, is presented in Table 2. Almost half (44%) of the work force is employed in the safety-related area (i.e., the prevention or treatment of occupational injuries). Yet another 24 percent works in the multi-basic area or general category (i.e., spends 25% or more of their time between two or more basic areas). The medical area (consisting of physicians and nurses) makes up the third largest category with 9,990. The fire prevention, industrial hygiene, and radiation basic areas are estimated to contain 4,950; 4,810; and 1,370, respectively.

The national equivalent of 6,480 workers (7.6% of the work force) does not fit into any of the basic areas (due primarily to incomplete responses to the survey instrument). Based on the relative standard error of 3.3 percent, the total estimated work force is within 7 percent of the actual number of occupational safety and health personnel, at the 95 percent confidence level. As expected, manufacturing contains the greatest number of occupational safety and health personnel (44% of the total) followed by trades, services, and nonoccupational safety- and health-related government organizations, and loss-prevention insurance carriers. Again, the estimates for insurance, occupational safety- and health-related state agencies, and the federal government are based on intensive sampling of the largest occupational safety and health employers in these sectors (see Technical Appendix for a description of the sample source).

There are some problem areas in regard to these estimates. For example, the lack of occupational safety and health personnel specializing in radiation in the transportation, communication, and utilities sector suggests that the survey missed those individuals employed in nuclear power plants. Apparently, the sample did not include any utility companies that relied on nuclear power generation. A second problem is the lack of medical personnel in the loss prevention insurance sector. Again, the 28 largest loss-prevention insurance carriers were surveyed with 23 firms responding. In the literally hundreds of responses describing job roles, and in the thousands of employee charac-

Table 2: Estimated 1977 national occupational safety and health work force by industry and basic area.*

	Basic Area							
Industry	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total*
Mining	1,170	50	200	90	750	10	60	2,330
Construction	2,350	40	0	30	380	100	190	3,080
Manufacturing	16,440	180	1,130	1,770	8,380	7,320	2,450	37,670
Transportation, Communication, and Utilities	4,261	0	150	250	1,580	140	850	7,230
Trades, Services, and Non-OSH Govt.	3,970	440	200	1,910	3,750	2,190	1,270	13,720
Insurance	4,330	0	190	810	3,350	0	850	9,520
OSH-Related State Govt.	1,910	0	1,120	0	460	20	520	4,020
Federal	2,840	660	1,820	90	1,360	220	290	7,270
Total**	37,260	1,370	4,810	4,950	19,990	9,990	6,490	84,850

*See page 4 for basic area definitions.
**Totals may not add due to rounding.

teristics responses, no employee indicated that he was either a doctor or nurse, and no employer indicated that he employed either. Because the decision to include or exclude employees in the organization's response was left to the employer, insurance carriers with medical departments apparently excluded those personnel from their responses, even though physicians and nurses were explicitly used as examples in the sample instrument's set of instructions.

The work force estimates, tabulated by job cluster and basic area, are presented on Table 3. Those involved with "inspection, interpretation, investigation, and planning" make up 37 percent of the work force, followed by occupational safety and health personnel who "administrate, advise, and interpret" (with 21 percent of the work force). The heaviest concentration of those performing activities usually associated with technician level positions is found in the industrial hygiene area. Over 60 percent of those personnel in the industrial hygiene basic area "perform tests" and "analyze" their results. Most of those individuals performing administrative tasks are found in the safety and general basic areas.

The estimate of nurses who are employed as nurses in occupational safety- and health-related activities is 8,980. An additional 1,020 individuals with RN or LPN designations work in occupational safety- and health-related activities but do not practice nursing. Most are in administration or professional level clusters in the safety basic area. This estimate of 10,000 nurses in the safety and health field conflicts sharply with a previous estimate of the occupational nursing population. According to the results of a survey of public health nurses undertaken in 1972, there were an estimated 19,784 full-time and 1,622 part-time occupational nurses (both RN and LPN's).* This estimate was based on a sample of 1,399 occupational health units employing 3,467 nurses. Their sample results, when inferred to the universe of occupational health units, suggested that there were 12,063 occupational health nurses in 1972. For reasons not explained in HRA 76–8 or another NIOSH study,** an additional 9,346 imputed nurses were then added to the estimates. The sources of these additions were not described. However, the fact that two nationwide surveys, using different survey techniques, generated remarkably similar estimates should not be overlooked. The 12,000 nurses estimated from the "Survey of Public Health Nursing 1968–1972" is well within the initial error bounds of the 10,000 nurse estimate generated by the current survey. Recognizing that the current survey did not sample firms with less than 100 employees, a lower estimate than the 1972 "Survey. . . . " was to be expected. As for the additional 9,346 imputed occupational nurses, apparently neither the 1972 public health nursing survey nor this current effort could verify their existence. Additional study of the nursing population would be required to further refine these estimates.

It is important to note that the estimated 84,850 occupational safety and health positions currently in the work force, approximately 3,600 (or 4.2 percent) were vacant. In other words, an estimated 3,600 occupational safety- and health-related job openings were available during the survey period. Of the "unmet demand" for occupational safety and health employees, the federal government accounted for 1,500 of the openings. The private sector also required about 1,500 of the vacant safety and health positions. For the federal government, 51 percent of the openings were

*Prepared by Division of Nursing. "Survey of Public Health Nursing 1968–1972." DHEW Publication No. (HRA) 76–8, November 1975; and,

**Lee, J. A., Herzog, R. R., Morrison, J. H., Jr., "Licensed Practical Nurses in Occupational Health," HEW Publication No. (NIOSH) 74–102, 1974.

Table 3: Estimated 1977 national occupational safety and health work force by job cluster* and basic area.**

	Basic Area							
Job Cluster	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total***
Administrates, Advises, Interprets	10,210	310	410	990	6,070	...	340	18,320
Inspects, Interprets, Investigates, Plans	18,090	110	610	2,790	9,110	...	400	31,100
Analyzes Plans, Develops Procedures	3,430	80	80	170	1,350	...	30	5,140
Provides Training	1,420	0	40	130	700	...	20	2,300
Performs and Analyzes Tests	1,000	650	3,200	130	980	...	60	6,000
Maintains, Repairs, and Adapts Equipment	410	20	30	360	410	...	30	1,260
Physician	...	...	...	...	...	1,010	0	1,010
Nurse	...	...	...	...	...	8,980	0	8,980
Not Classified	2,720	210	450	390	1,370	...	5,610	10,740
Total***	37,260	1,370	4,810	4,950	19,990	9,990	6,478	84,850

*See page 6 for job cluster definitions.
**See page 4 for basic area definitions.
***Totals may not add due to rounding.

for personnel who "inspect, interpret, investigate, and plan" in the safety area, and 33 percent were for persons in job roles that "perform and analyze tests" in the general and industrial hygiene basic area. For the private sector, the largest unmet demand was for personnel to "inspect, interpret, investigate, and plan." Since these unfilled positions account for a portion of the total demand, the incidences of occupational safety and health persons used to forecast future occupational safety and health employment were adjusted to reflect the vacancies.

E. DESCRIPTION OF THE WORK FORCE

Several descriptive questions were included in the survey instrument to gain a profile of both the existing composition of the occupational safety and health work force and the minimum requirements for new hires entering into existing job roles. What follows is a presentation of the data with suggested implications concerning their relevance to the training and education needs of the occupational safety and health work force.

1. Age

As reflected on Table 4, the average age for the entire work force is 42 years. All of the basic areas cluster around 41 to 45 years, with the exception of radiation (36.2) and industrial hygiene (36.9). Similarly, there is little divergence among the average ages of the job clusters, with the physician's 50.3 years and nurse's 44.7 years being the oldest and the "performs and analyzes tests" cluster's 37.5 years being the youngest.

More descriptive is the age distribution of the occupational safety and health work force. As reflected in Figure 1, the distribution is distinctly bimodal around the 30 to 34 year and the 50 to 54 year age cohorts. This finding is of extreme importance to educational institutions, since it suggests that the number of required replacements due to retirements and deaths will increase sharply in the next decade, diminish for the following decade, and then increase again. This roller coaster effect will require educational institutions to plan wisely in order to effectively respond to the immediate decade's needs and yet not overproduce occupational safety and health personnel in the succeeding decade. As indicated in the next chapter of this study, the manpower forecasts take age-specific attrition into effect, along with economic growth, to determine the annual number of new hires that will be demanded by private industry and government organizations. These "new hire" forecasts clearly reflect the above-mentioned roller coaster effect.

Another interesting aspect of the work force age distribution is the relatively small percentage of workers in the 20 to 24 age cohort. This suggests that the education and experience required of individuals entering the work force makes early entry (i.e., during the early 20's) difficult. Rather, increased emphasis on college or technical degrees has forestalled early entry into the field. However, the large percentage of workers in the 25–30 year age cohort clearly indicates the recent increased interest in safety and health concerns. The following data on education and experience support this finding.

2. Education

The average number of years of formal education for the entire work force is 14.7. As shown on Table 5, the industrial hygiene basic area approached 16 years (15.8) or the

Table 4: Average employee age of the 1977 occupational safety and health work force by job cluster* and basic area.**

	Basic Area							
Job Cluster	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	WT. AV.
Administrates, Advises, Interprets	42.9	37.7	43.2	43.3	42.5	. . .	41.7	42.7
Inspects, Interprets, Investigates, Plans	41.8	41.7	37.1	43.4	42.1	. . .	41.9	41.9
Analyzes Plans, Develops Procedures	42.6	47.6	37.7	41.3	45.0	. . .	30.0	43.1
Provides Training	42.1	. . .	52.4	36.6	43.8	. . .	40.8	42.5
Performs and Analyzes Tests	43.2	34.9	35.6	37.1	37.8	. . .	33.2	37.5
Maintains, Repairs, and Adapts Equipment	41.3	33.0	44.3	45.3	42.0	. . .	47.0	42.6
Physician	. . .	. . .	. . .	. . .	. . .	50.3	. . .	50.3
Nurse	. . .	. . .	. . .	. . . .	. . .	44.7	. . .	44.7
Not Classified	40.7	31.2	36.2	48.3	45.8	. . .	41.0	41.6
WT. AV.	42.2	36.2	36.9	43.5	42.6	45.2	41.0	42.3

*See page 6 for job cluster definitions.

**See page 4 for basic area definitions.

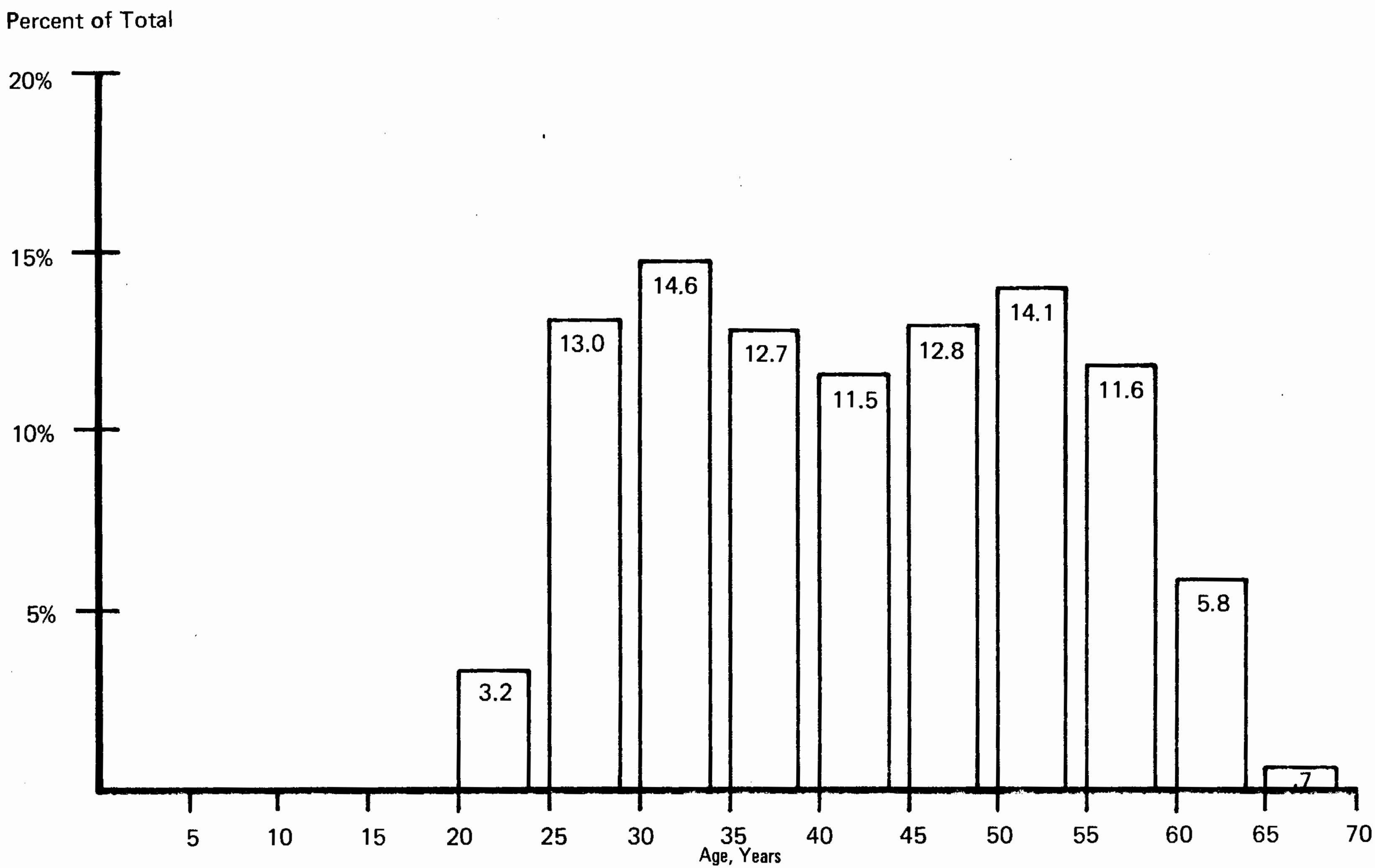

Figure 1: Percent frequency distribution of age in five-year cohorts, 1977 occupational safety and health work force.

Table 5: Average years of formal education of the 1977 occupational safety and health work force by job cluster* and basic area.**

Job Cluster	Basic Area							
	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	WT. AV.
Administrates, Advises, Interprets	15.0	16.0	15.3	14.6	15.4	. . .	14.0	15.1
Inspects, Interprets, Investigates, Plans	14.5	16.6	15.3	13.6	14.5	. . .	14.4	14.4
Analyzes Plans, Develops Procedures	15.2	17.3	15.7	14.6	14.5	. . .	16.0	15.0
Provides Training	14.5	. . .	14.6	14.2	14.9	. . .	17.6	14.6
Performs and Analyzes Tests	14.1	15.0	16.2	13.8	15.8	. . .	17.1	15.6
Maintains, Repairs, and Adapts Equipment	13.7	12.0	10.8	11.9	12.7	. . .	12.5	12.8
Physician	. . .	. . .	. . .	. . .	. . .	N/A	. . .	N/A
Nurse	. . .	. . .	. . .	. . .	. . .	14.6	. . .	14.6
Not Classified	14.3	14.5	15.1	13.8	14.7	. . .	15.0	14.7
WT. AV.	14.7	15.4	15.8	13.5	14.6	N/A	14.9	14.7

*See page 6 for job cluster definitions.

**See page 4 for basic area definitions.

equivalent of a baccalaureate degree; fire protection was 13.5 years. In virtually every basic area, the "administrates, advises, interprets" job clusters reflected a higher average than the "inspects, interprets, investigates, plans" or "performs and analyzes tests" job clusters. Conversely, the "maintains, repairs, and adapts equipment" clusters contain a uniformly lower average educational level than the other job clusters. In a series of tests, these educational differences were found to be highly statistically significant, lending further credence to the independence of the job clusters shown.

3. Experience

The employee characteristics questionnaire, in addition to asking the employee's age and number of years of formal education, also requested the number of years on the present job. As suggested in the age distribution, the existing work force is relatively experienced. Average years on the job was 6.8 for all workers, with the medical and fire protection areas close to, or exceeding, 8 years. The radiation and industrial hygiene basic area average are both less than 6 years. Table 6 presents the experience data by job cluster and basic area. In reviewing the job cluster averages, "administrates, advises, interprets" and "analyzes plans, develops procedure" and "physician" are high experience clusters. "Performs tests and analyzes" is low, with an average of 5 years.

To shed further light on the nature and extent of the experience of the existing work force, employees were also asked whether their prior job was related to the safety and health field. Over 40 percent (42.9%) indicated that it was related, suggesting that the total occupational safety- and health-related experience of the work force far exceeds the 6.8 years indicated above. A detailed breakdown of the percentage of workers with prior related jobs is presented on Table 7. High "previous experience" basic areas are those of medical (56.4%) and radiation (50.4%), whereas safety (40.0%) and fire protection (34.6%) are areas with lower percentages.

4. Employee Profiles

Reviewing the data presented thus far, one may construct profiles of individual job clusters and begin to ascertain a general description of employees associated with these groupings. For example, the profile of those who "maintain, repair, adapt equipment" indicates that these employees have had, relatively speaking, more job experience, but less formal education, and fewer of them have worked in "prior related" jobs. This suggests that the typical worker in this cluster probably received on-the-job training in his/her present job role and, hence, is less mobile than are workers in other clusters. Those who "administrate, advise, interpret" are somewhat older than employees in other groups, have had 15 years of formal education, relatively greater experience on their present job, and a higher proportion have previously held a related job (as might be expected).

Intermeshing such profiles with the complete description of the various job clusters described earlier in this chapter will assist the reader in understanding more fully the nature and complexion of the existing occupational safety and health work force. The next section of this chapter deals with employers' perceptions of the minimum requirements for new hires to replace existing workers who may be promoted or retired.

Table 6: Average years on existing job of the 1977 occupational safety and health work force by job cluster* and basic area.**

	Basic Area							
Job Cluster	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	WT. AV.
Administrates, Advises, Interprets	7.0	3.6	5.3	9.3	7.1	...	5.2	7.1
Inspects, Interprets, Investigates, Plans	5.9	10.8	6.6	8.5	7.0	...	6.8	6.5
Analyzes Plans, Develops Procedures	9.5	16.1	5.2	5.1	6.9	...	1.0	8.6
Provides Training	6.3	...	3.0	7.4	7.3	...	3.0	6.6
Performs and Analyzes Tests	8.3	3.4	3.5	4.1	5.8	...	4.8	5.0
Maintains, Repairs, and Adapts Equipment	7.0	2.0	6.1	10.0	7.8	...	19.5	8.2
Physician	...	...	...	...	...	9.4	...	9.4
Nurse	...	...	...	...	...	7.8	...	7.8
Not Classified	6.0	4.9	4.4	11.3	7.1	...	5.3	6.1
WT. AV.	7.2	5.2	4.3	8.7	7.0	7.9	5.5	6.8

*See page 6 for job cluster definitions.

**See page 4 for basic area definitions.

Table 7: Percent of the 1977 occupational safety and health work force with prior related job.

	Basic Area**							
Job Cluster*	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	WT. AV.
Administrates, Advises, Interprets	43.3	82.2	53.0	41.8	49.3	...	44.1	46.0
Inspects, Interprets, Investigates, Plans	42.2	40.8	46.0	32.2	42.2	...	34.1	41.3
Analyzes Plans, Develops Procedures	25.2	100.0	100.0	62.1	59.7	...	...	37.5
Provides Training	35.5	40.5	34.6	33.3	47.1	...	21.7	38.9
Performs and Analyzes Tests	32.9	20.0	50.6	39.1	56.2	...	57.2	46.7
Maintains, Repairs, and Adapts Equipment	43.5	...	...	37.8	26.9	...	...	33.8
Physician	...	...	...	...	...	58.0	...	58.0
Nurse	...	...	...	...	...	56.2	...	56.2
Not Classified	36.9	30.5	31.2	17.0	50.0	...	27.8	32.7
WT. AV.	40.0	50.4	48.3	34.6	46.6	56.4	29.0	42.9

*See page 6 for job cluster definitions.

**See page 4 for basic area definitions.

F. NEW HIRE PROFILE

The data reported in this section center on describing the minimum job requirements in terms of education, experience, and certification, and relate the minimum salary employers indicate they are willing to pay to attract such personnel. This section begins with a presentation of the percentage distribution of worktime spent among the four basic areas.

Table 8: Average percent of employee time spent by occupational safety and health responsibility and basic area.

	Occupational Safety and Health Responsibility			
Basic Area	Prevention or Treatment of Injury	Prevention or Treatment of Illness Due to Radiation	Prevention or Treatment of Illness Due to Other Causes	Prevention of Fire
Safety	77.1%	0.7%	9.6%	12.6%
Radiation	3.2	91.2	4.4	1.5
Industrial Hygiene	8.2	4.0	85.7	2.6
Fire Protection	16.5	0.3	4.0	79.3
General	44.2	2.8	24.4	28.8
Medical	73.7	1.0	23.2	2.2
Not Classified	11.7	2.0	5.8	3.6
Total Basic Areas	57.6	2.7	18.5	18.4

As indicated in Table 8 above, job roles in all the basic areas contain some responsibilities across the safety and health spectrum. In general, over 75 percent of the worker's time is spent in his basic area of specialization (i.e., individuals in the safety basic area spend an average of 77.1 percent of their time in the prevention or treatment of occupational injury). The remaining time is then divided between the other areas, with the prevention or treatment of injury usually being emphasized (note that both the general and medical basic areas focus on this category).

An additional area of interest is the percentage of jobs which are full time. The survey was defined to include all workers who spend 50 percent or more of their time in the prevention or treatment of occupational illness or injury, or in the prevention of fire. Table 9 presents the percentage of job roles which are full time, tabulated by job cluster and basic area. Note that 68.4 percent of all job roles were reported as full time positions. The radiation, medical, and industrial hygiene areas all reported over 85 percent of their existing occupational safety and health jobs as being full time. As would be expected, in both the safety and general areas almost two-thirds (62%) of the job roles were full time positions. Most of the full time positions are in the "performs tests and analyzes" and nursing clusters. The "administrates, advises, interprets" and "inspects, interprets, investigates, and plans" clusters contain a high percentage (again almost two-thirds) of full time safety and health job roles.

Table 9: Percent of occupational safety and health job roles reported as full time by job cluster* and basic area.**

	Basic Area							
Job Cluster	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	WT. AV.
Administrates, Advises, Interprets	54.9	87.9	75.0	85.7	62.8	---	51.4	60.0
Inspects, Interprets, Investigates, Plans	63.4	87.5	60.9	76.8	61.0	---	43.0	63.6
Analyzes Plans, Develops Procedures	88.6	100.0	100.0	55.6	77.6	---	100.0	84.8
Provides Training	40.5	---	---	51.1	39.1	---	21.7	39.9
Performs and Analyzes Tests	84.6	100.0	97.8	100.0	70.0	---	100.0	90.9
Maintains, Repairs, and Adapts Equipment	42.7	100.0	100.0	80.1	42.3	---	50.0	54.7
Physician	---	---	---	---	---	61.8	---	61.8
Nurse	---	---	---	---	---	88.8	---	88.8
Not Classified	56.1	100.0	88.3	56.3	66.5	---	95.3	68.5
WT. AV.	62.5	95.8	88.4	76.5	62.3	86.1	73.9	68.4

*See page 6 for job cluster definitions.

**See page 4 for basic area definitions.

The profile of new hire requirements, as indicated by the employers responding to this survey, is presented below. When coupled with the description of the existing work force as discussed above, these requirements present an interesting picture of where employers believe the job market is going.

1. **Education**

The minimum educational requirements for the various job roles, as reported by surveyed employers, are presented on Table 10. Note that over a third of the new hires will be required to have a bachelor's degree, with an additional 20 percent requiring some college (technical school or business school) training. In all, almost 80 percent of the existing and anticipated hires in the occupational safety and health field will be required to have some college level training.

However, most of that training will be at or below the bachelor's degree level. Only 1.5 percent of the new hires are expected to have master's degrees and 1.3 percent more advanced degrees. In fact, when the M.D. degree requirements are removed, less than 0.2 percent of the new hires will need be required to have obtained a Ph.D. degree. This lack of emphasis on graduate degrees reflects the fact that the survey requested minimum educational requirements for replacements in given job roles. Therefore, the bias was probably centered on the new entrant candidate with a basic educational background and with some, but not extensive, experience.

Educational requirements by basic area are presented on Table 11. The industrial hygiene area requires the greatest proportion of baccalaureate or higher degrees. However, the radiation area requires the highest proportion of master's level degrees of a new entrant. Fire protection requires the lowest minimum educational background. The appearance of LPN's and RN's in other than the medical basic area indicates that these employer respondents desired new entrants with either a LPN or RN to do other than nursing related activities. Hence, these candidates would need the appropriate registration but would presumably not work in the practice of nursing.

2. **Experience**

The new entrant hypothesis is borne out by the "minimum experience" data presented on Table 12. Employers, on the average, are requesting 3.9 years of minimum experience for new hires. Recruits in the safety basic area are being required to have 4.2 years of previous experience: those in the general basic area are required to have 3.9 years of experience. Among job clusters, those who "administrate, advise, and interpret" and "analyze plans and develop procedures" are required to have markedly greater experience at the new hire level than those found in the remaining job clusters. Overall, it appears that employers are demanding at least 3 years of past-related experience for their vacant positions, regardless of basic area and job clusters.

3. **Certification**

Employers were also asked to specify whether any formal or professional certification or registration would be required as a prerequisite for a new hire. Their responses are

Table 10: Percent of job roles by anticipated minimum educational requirement and job cluster* for new hires.

Job cluster	None	H.S.	Some College	Grad. Tech. School	B.S.	M.S.	L.P.N.**	R.N.**	Ph.D. M.D.	Other	WT. AV.
Administrates, Advises, Interprets	1.0%	13.9%	24.0%	5.1%	49.9%	3.3%	0.2%	0.8%	0.2%	1.5%	100.0%
Inspects, Interprets, Investigates, Plans	2.6	29.4	27.4	5.1	31.9	0.7	0.4	0.9	0.0	1.7	100.0
Analyzes Plans, Develops Procedures	1.7	17.4	5.7	8.3	65.9	0.7	0.0	0.0	0.0	0.9	100.0
Provides Training	2.0	28.3	29.9	5.5	29.9	0.0	1.2	2.0	0.4	2.4	100.0
Performs and Analyzes Tests	0.3	18.4	4.3	6.9	66.2	2.6	0.3	0.5	0.0	0.7	100.0
Maintains, Repairs, and Adapts Equipment	21.7	18.8	25.4	19.6	8.7	8.0	0.0	0.0	0.0	0.0	100.0
Physician	---	---	---	---	---	---	---	---	100.0	---	100.0
Nurse	---	3.5	2.1	1.8	3.8	0.5	15.9	71.3	0.1	0.5	100.0
Not Classified	5.4	27.3	20.6	4.6	35.5	0.8	0.8	2.9	0.5	2.0	100.0
WT. AV.	2.2%	20.4%	19.8%	5.2%	36.9%	1.5%	2.2%	9.1%	1.3%	1.4%	100.0%

*See page 6 for job cluster definitions.

**Although it is recognized that LPN and RN are not degrees, they do reflect differing levels of education achievement and hence were used as educational proxies.

Table 11: Percent of job roles by anticipated minimum education requirements and basic area* for new hires.

Basic Area	None	H.S.	Some College	Grad. Tech. School	B.S.	M.S.	L.P.N.**	R.N.**	Ph.D. M.D.	Other	WT. AV.
Safety	2.3	23.5%	23.5%	5.8%	41.0%	1.1%	0.5%	0.8%	0.0%	1.6%	100.0%
Radiation	0.0	11.6	10.0	27.6	33.2	16.7	0.0	0.8	0.0	0.0	100.0
Industrial Hygiene	0.0	9.6	6.9	2.8	74.7	3.6	0.0	1.6	0.2	0.6	100.0
Fire Protection	6.6	38.4	17.5	4.3	29.6	0.0	0.0	0.2	0.5	2.8	100.0
General	1.9	21.9	26.1	5.7	39.8	1.7	0.3	1.2	0.1	1.4	100.0
Medical	---	---	---	---	---	---	---	---	---	---	---
Not Classified	9.4	22.2	17.9	2.7	41.8	4.4	0.0	1.6	0.0	0.0	100.0
WT. AV.	2.2%	20.4%	19.8%	5.2%	37.0%	1.5%	2.1%	9.1%	1.3%	1.4%	100.0%

*See page 4 for basic area definitions.

**Although it is recognized that LPN and RN are not degrees, they do reflect differing levels of education achievement and hence were used as educational proxies.

CLINICAL STUDY

Childhood Diet, Overweight, and CVD Risk Factors: The Healthy Start Project

Christine L. Williams, MD, MPH; Barbara A. Strobino, PhD

Cardiovascular disease (CVD) risk factors can be identified in children and tracked over time. We studied 519 children (mean age, 3.9 years) and reevaluated CVD risk factors 4 years later. Baseline and follow-up (FU) measures included height, weight, body mass index (BMI), blood pressure level, blood lipid values, and 24-hour dietary intake. Nutritional predictors of CVD risk factors (lipid levels and BMI) were identified using regression analysis at follow-up. Energy intake at baseline and FU, as well as increasing BMI over time, were directly associated with total cholesterol levels. Dietary intake of monounsaturated fat and dietary fiber were significant predictors of total cholesterol level at follow-up (inverse associations). Increasing BMI, waist circumference at FU, and intake of sucrose at FU were inversely associated with high-density lipoprotein cholesterol levels at FU. Waist circumference and BMI at FU were associated with higher triglyceride levels, while percent energy from monounsaturated fat was associated with lower values. This study provides further evidence that dietary intake influences CVD risk factors in childhood. (Prev Cardiol. 2008;11:11–20) ©2008 Le Jacq

The prevalence of overweight among children in the United States has been increasing. Between the 1960s and 1999–2002, the prevalence among 6- to 11-year-old children increased from 4.2% to 15.8%, almost a 4-fold increase.[1,2] Similarly, for 12- to 19-year-old children, the prevalence increased from 4.6% to 16.1%. Currently (1999–2002), 16% of 6- to 19-year-olds are overweight (body mass index [BMI] ≥95th percentile), and an additional 15% are "at risk for overweight" (BMI between the 85th and 95th percentile values).[1,2] The prevalence of overweight has also doubled among US preschool children aged 2 to 5 years in the past 30 years. In the National Health and Nutrition Examination Survey (NHANES) 1999–2002 survey, 10.3% of 2- to 5-year-old children were overweight (BMI ≥95th percentile), compared with 5.0% in the NHANES I survey (1971–1974).[2,3]

Increasing prevalence of overweight among children has serious implications for children's health because it is associated with comorbidities during childhood, as well as increased risk of chronic disease and decreased life expectancy in adult life. Among the diseases for which risk is increased are hypertension, dyslipidemia, the metabolic syndrome, insulin resistance, diabetes, polycystic ovary syndrome, sleep apnea, asthma, endocrine abnormalities, orthopedic disorders, and psychological problems.[4–8]

Overweight is primarily due to an imbalance between energy intake and energy expenditure, operating within a framework of genetic susceptibility. Diet and physical activity are the major contributors to each energy factor; however, they are difficult to measure, especially in young children. The Healthy Start (HS) project is a National Institutes of Health–funded study of diet and cardiovascular disease (CVD) risk factors in a cohort of young children. Phase I (1995–1998) involved an intervention to modify the food service (ie, reduce saturated fat in foods) in Head Start centers and develop and implement a preschool health curriculum (for more information, see www.Healthy-Start.com). The food service and educational interventions resulted in a significant reduction in the total and saturated fat content of children's meals and snacks, lower blood cholesterol levels, and an increase in children's health and nutrition knowledge.[9–14] Phase II was a follow-up (FU) study of the children 5 years later (1999–2003) to assess changes in weight status, diet, and other CVD risk factors over time. This report explores the relationships between baseline and 4-year FU changes in weight status, lipid levels,

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Manuscript received May 29, 2007; accepted June 14, 2007

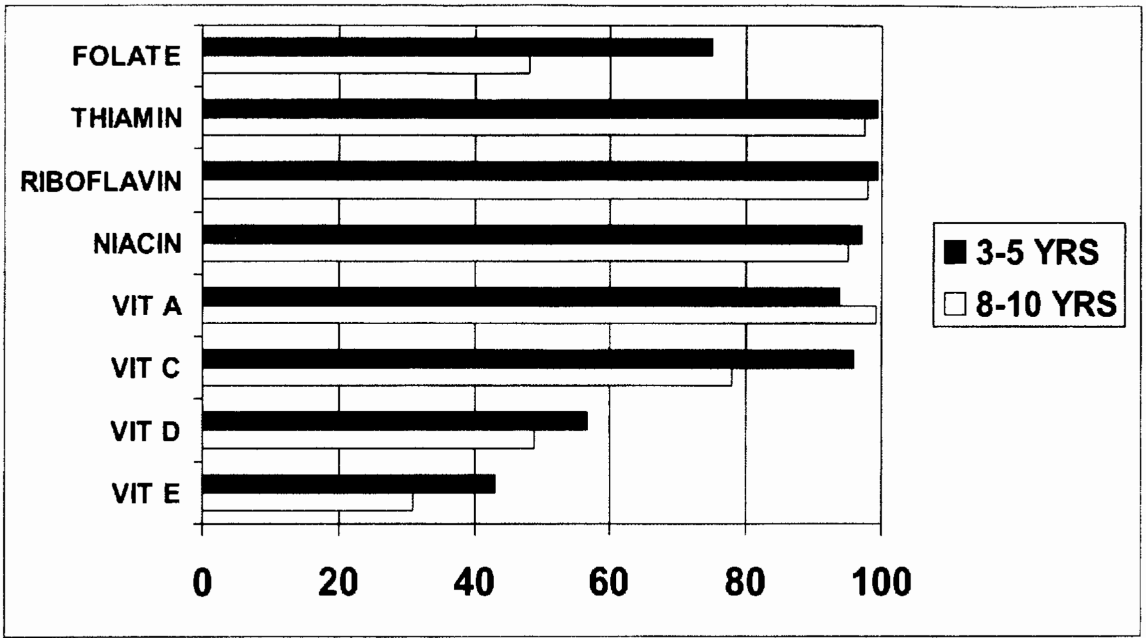

Figure 1. Children who met 100% of dietary reference intakes for selected vitamins.

and nutrient intake in the HS cohort of young, low-income minority children.

METHODS

One of the primary objectives of the HS project was to evaluate the relationship between dietary intake and selected CVD risk factors in young children. From 1995 through 1996 all children entering 1 of 9 participating HS preschools in upstate New York were eligible for entrance into the study. When the children entered preschool, baseline anthropometric and blood lipid parameters were measured. In addition, a 24-hour dietary intake was obtained. Four years later, from 2000 to 2003, the children were located and the same data were collected: (dietary recall, lipid profile, and anthropometric measurements) in this population of 7- to 10-year-olds. The study was approved by the institutional review board of Columbia University.

Dietary Assessment

An innovative combination methodology was employed to assess preschool dietary intake.[12] The goal was to collect 24-hour dietary recalls on children first entering the HS program in the fall of 1995 and 1996. Total intake for the day was obtained by (1) direct observation of the children as they ate their meals and snacks at the centers, with plate waste measurement to determine amounts of foods and beverages consumed and (2) telephone interviews with the primary adult food providers to determine types and amounts of foods/beverages consumed outside of the HS setting on the same day as the meal observation. The latter approach was assisted by completion of a written food record by the primary food provider to give the telephone interviewer a more accurate account of the child's food intake. The complete dietary intake assessment protocol was adapted from existing protocols proven to be reliable and valid.[12]

The 24-hour dietary recall at FU took place either at preschool fairs or in the child's home. The data were obtained through interview of both the child and the parent to obtain a complete history of foods eaten at home and outside the home. Nutrient content of the 24-hour recalls was calculated using the Nutrition Data Systems for Research software (version 4.01; Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN).

Reference values for folate were taken from the US Daily Reference Intakes (DRI). Dietary fiber intake was compared with the guidelines for children aged 5 and older,[15] while percent energy (E%) from saturated fat was compared with the National Cholesterol Education Program (NCEP) guidelines for children aged 2 to 19 years.[16]

Measurements

The same procedures and equipment were used at baseline and FU. Weight was measured with an electronic self-calibrating scale (SECA 707; Seca Corp, Hamburg, Germany). Height was measured with a rigid height bar (Seca Corp, Hamburg, Germany). Waist circumference was measured at the level of the umbilicus. Blood lipids were measured by a nonfasting capillary blood sample obtained from the finger and immediately analyzed for total cholesterol, high-density lipoprotein cholesterol (HDL-C), and triglyceride levels using the Cholestech LDX Analyzer system (Cholestech, Hayward, CA). All measurements

Table I. 24-hour Nutrient Intake at Baseline (Mean Age, 3.9 y) and at Follow-Up (Mean Age, 8.2 y), by Sex and Ethnicity of Child

	African American (n=99)		Hispanic (n=108)		Caucasian (n=33)		Total[a] (N=252)	
Age, y	3–4	7–10	3–4	7–10	3–4	7–10	3–4	7–10
Girls								
Total kcal	1467 (565)	1519 (554)	1396 (516)	1466 (495)	1391 (414)	1555 (645)	1416 (521)	1499 (536)
E% total fat	30.6 (7.1)	32.3 (8.0)	31.7 (7.0)	31.3 (6.8)	31.4 (7.4)	32.1 (7.8)	31.1 (7.1)	31.8 (7.5)
E% saturated fat	11.6 (3.5)	11.4 (3.4)	12.6 (3.8)	11.6 (2.7)	12.4 (3.9)	11.5 (3.2)	12.1 (3.7)	11.4 (3.1)[b]
E% MUFA	11.3 (3.0)	12.5 (3.6)	11.3 (3.0)	11.7 (3.7)	12.1 (3.4)	11.8 (3.6)	11.3 (3.1)	12.1 (3.7)[c]
E% PUFA	5.5 (3.1)	5.6 (3.0)	5.3 (2.8)	5.4 (2.9)	5.4 (3.4)	5.3 (3.0)	5.4 (3.1)	5.5 (2.9)
Cholesterol, mg	164 (119)	166 (146)	205 (133)	172 (124)	162 (93)	172 (138)	180 (122)	171 (138)
Folic acid, μg	276 (177)	166 (78)	235 (153)	201 (113)	281 (189)	192 (124)	258 (167)	189 (115)[d]
Fiber, g	10.8 (6.1)	9.7 (4.6)	10.7 (5.0)	10.2 (5.0)	10.7 (4.1)	11.2 (6.4)	10.6 (5.3)	10.1 (5.0)
Sucrose, g	35.8 (23.6)	37.3 (25.2)	35.9 (21.6)	34.6 (19.9)	32.4 (16.8)	39.2 (22.1)	35.3 (21.7)	36.5 (22.6)
Boys								
Total kcal	1397 (519)	1615 (544)	1389 (554)	1598 (462)	1526 (640)	1697 (434)	1422 (559)	1632 (497)[d]
E% total fat	30.5 (7.1)	32.2 (6.7)	29.3 (6.9)	31.8 (6.4)	30.8 (6.2)	32.2 (7.8)	30.1 (6.9)	32.0 (6.9)[c]
E% saturated fat	11.4 (3.3)	11.7 (2.9)	11.7 (3.8)	12.0 (3.2)	12.1 (3.8)	11.9 (3.2)	11.7 (3.6)	11.8 (3.1)
E% MUFA	11.3 (3.0)	12.3 (3.2)	10.4 (3.0)	11.8 (3.0)	11.6 (2.7)	12.3 (3.4)	11.0 (3.0)	12.1 (3.2)[d]
E% PUFA	5.5 (3.1)	5.7 (3.4)	5.2 (2.8)	5.5 (3.0)	5.3 (3.3)	5.6 (3.3)	5.5 (3.1)	5.6 (3.2)
Cholesterol, mg	157 (103)	176 (129)	189 (145)	183 (136)	161 (88)	178 (98)	171 (119)	179 (125)
Folic acid, μg	269 (199)	208 (165)	272 (170)	222 (111)	278 (196)	251 (153)	269 (186)	222 (143)[c]
Fiber, g	9.5 (4.4)	10.5 (5.8)	10.8 (5.7)	11.3 (5.0)	10.4 (6.1)	11.6 (4.1)	10.2 (5.3)	11.0 (5.2)
Sucrose, g	38.3 (18.5)	42.1 (24.4)	35.7 (24.7)	38.2 (23.8)	41.7 (30.3)	46.3 (24.5)	38.0 (23.8)	41.5 (24.4)

Abbreviations: E%, percent energy; MUFA, monounsaturated fat; PUFA, polyunsaturated fatty acid. Mean (standard deviation). [a]Totals include 19 children of mixed or unknown ethnicity. [b]$P<.05$; [c]$P<.01$; [d]$P<.001$.

were performed in duplicate (except for the blood test) by a team of doctors, nurses, and technicians who were trained and certified on their proficiency. A detailed description of the study design, dietary assessment methodology, and other measures and outcomes has been published elsewhere.[9–14]

Analysis

CVD risk factors included BMI and values of total cholesterol, HDL-C, and triglycerides at baseline and FU. After baseline assessments, children in 6 of the 9 preschools participated in a food service and educational intervention that resulted in short-term changes in dietary intake,[11] blood lipid profiles,[11] and health knowledge[13]; however, these differences were no longer present at the 4-year FU assessment. Therefore, this report compares data for all of the children at 4-year FU with their baseline preschool values. Linear regression models (SPSS version 12.0, SPSS, Inc, Chicago, IL) examined the relationship between the cardiovascular risk factors and the independent variables. Separate analyses were run for each of the dependent variables: total cholesterol, HDL-C, triglycerides, and BMI at FU. Nutrient intake at baseline (preschool) and FU based on the 24-hour recalls was entered into all models. Specific independent variables were total daily intake of kilocalories (kcal), saturated fat, monounsaturated fat (MUFA), total trans-fatty acids, fiber, and sucrose. Ethnicity and sex were dummy-coded and included as independent variables. For each model with a serum lipid as an outcome, change in BMI from baseline to FU was also entered into the model. With BMI at FU as the dependent variable, BMI at preschool age was included as an independent variable.

Additional analyses examined BMI categorically. Children whose BMI fell within the 85th to 94th percentile for their age and sex according to the 2000 US Centers for Disease Control and Prevention growth charts[17] were considered "at-risk" for overweight, and those at or above the 95th percentile were classified as overweight. Total cholesterol was defined as normal (<170 mg/dL), borderline high (170–199 mg/dL), or high (≥200 mg/dL). HDL-C was defined as desirable (>45 mg/dL), borderline low (35–45 mg/dL), or low (<35 mg/dL) based on the US NCEP guidelines.[16]

RESULTS

Population

There were 519 children who were assessed at baseline in the HS study and reassessed at FU by December 2003. At baseline, 98% of the children

Table II. Correlations Between Nutrient Intake of Children at Preschool Baseline (Mean Age, 3.9 y) and at Elementary School Follow-Up (Mean Age, 8.2 y)

	KCAL	PRO	CHO	TFAT	SFAT	MUFA	FE	CHOL	FIB	SUC	FOL	CA
Preschool, *r* values												
kcal	–											
Pro	–0.02	–										
CHO	–0.15[a]	–0.53[b]	–									
TFAT	0.17[b]	0.09[c]	–0.89[b]	–								
SFAT	0.10[c]	0.20[b]	–0.74[b]	0.77[b]	–							
MUFA	0.16[b]	–0.01	–0.77[b]	0.91[b]	0.56[b]	–						
FE	0.46[b]	0.06	0.02	–0.06	–0.01	–0.09[c]	–					
CHOL	0.45[b]	0.34[b]	–0.44[b]	0.34[b]	0.36[b]	0.26[b]	0.18[b]	–				
FIB	0.69[b]	0.01	0.11[c]	–0.11[c,a]	–0.14[a]	–0.10[c]	0.43[b]	0.20[b]	–			
SUC	0.64[b]	–0.23	0.16[b]	–0.06	–0.04	–0.03	0.21[b]	0.20[b]	0.42[b]	–		
FOL	0.35[b]	–0.01	0.07	0.07	–0.01	–0.12[a]	0.67[b]	0.11[c]	0.35[b]	0.19[b]	–	
CA	0.64[b]	0.22[b]	–0.20[b]	0.11[a]	0.35[b]	–0.02	0.41[b]	0.36[b]	0.36[b]	0.31[b]	0.36[b]	–
Elementary school, *r* values												
kcal	–											
Pro	.09[c]	–										
CHO	–0.13[a]	0.63[b]	–									
TFAT	0.21[b]	0.23[b]	–0.89[b]	–								
SFAT	0.09[c]	0.30[b]	–0.70[b]	0.72[b]	–							
MUFA	0.20[b]	0.16[b]	–0.80[b]	0.92[b]	0.55[b]	–						
FE	0.57[b]	0.01	0.09[c]	–0.12[a]	–0.10[c]	–0.10[c]	–					
CHOL	0.41[b]	0.30[b]	–0.49[b]	0.44[b]	0.30[b]	0.39[b]	0.15[a]	–				
FIB	0.63[b]	0.11[c]	0.15[b]	–0.08	–0.19[b]	–0.06	0.55[b]	0.09[c]	–			
SUC	0.53[b]	0.34[b]	0.25[b]	–0.10[c]	–0.03	–0.08	0.28[b]	0.07	0.31[b]	–		
FOL	0.42[b]	–0.02	0.15[b]	–0.17[b]	0.10[c]	–0.17[b]	0.81[b]	0.09[c]	0.50[b]	0.28[b]	–	
CA	0.49[b]	0.16[b]	–0.03	0.05	0.28[b]	0.14[a]	0.43[b]	0.10[c]	0.34[b]	0.32[b]	0.45[b]	–

Abbreviations: CA, calcium; CHO, carbohydrate; CHOL, cholesterol; FE, iron; FIB, fiber; FOL, folic acid; kcal, kilocalories; MUFA, monounsaturated fat; Pro, protein; SFAT, saturated fat; SUC, sucrose; TFAT, total fat. [a]$P<.01$; [b]$P<.001$; [c]$P<.05$.

were aged 3 or 4 years (mean age, 3.9±1.8 years). At FU, 97% of the children were aged 7 to 10 years (mean age, 8.2±1.0 years). Over three-fourths of the children enrolled in the project were of ethnic minority status, primarily African American (40%) and Hispanic (40%). Ninety percent of children lived in families with an annual income below the poverty level (<$15,100 for a family of 4 at baseline). Overall, 70% of the baseline cohort were reassessed at FU, with families scattered over a radius of more than 100 miles. There were no significant differences in baseline CVD risk factor status of children who participated in the FU and those who were lost to FU.

Dietary Intake

Energy intake (kcal/d) increased significantly from baseline to FU in boys but not in girls (Table I). Energy intake was also correlated with intake of specific nutrients at baseline as well as at FU (Table II). At baseline, energy intake was negatively correlated with E% from carbohydrate and directly correlated with intake of E% from total fat, saturated fat, and MUFA, as well as intake of cholesterol, fiber, sucrose, folate acid, calcium, and iron. At FU, energy intake showed the same significant correlations as at baseline, except that it was no longer associated with E% from saturated fat; and at FU energy intake was also negatively associated with E% from protein.

Correlations Between Nutrients

Statistically significant correlations were observed between specific nutrients both at baseline and FU (Table II). Intake of total fat was directly correlated with intake of saturated fat, MUFA, and cholesterol at both individual time periods. Large ($r \geq 0.80$) or moderate to large correlations ($r=0.51$–0.79) were observed at baseline as well as at FU between the E% from fat or protein and the E% from carbohydrate. These were inversely correlated (ie, children with high intakes of fat and protein tended to have lower intakes of carbohydrates, and vice versa). Moderate to large direct correlations were observed at both baseline and FU between intake of iron and folate and at FU between iron and dietary fiber intake (Table II).

Dietary intake of some nutrients at the baseline preschool assessment were correlated with dietary intake at FU. Small but statistically significant within-individual correlations between dietary intake at baseline vs FU were observed for dietary intake of sucrose (g/d), cholesterol (mg/d), energy (kcal/d), and E% from total fat, MUFA, and protein (Table III). There were no significant correlations for E% from carbohydrates or saturated fats or with intake of calcium (mg/d), iron (mg/d), fiber (g/d), or folate (μg/d).

Dietary Intake of Nutrients Affecting Lipids and CVD Risk. *Total Fat and Specific Fatty Acids.* Some differences were observed between baseline and FU for dietary components known to affect blood cholesterol and triglyceride levels (Table I). For girls, the E% from saturated fat decreased from 12.1% at baseline to 11.4% at FU ($P<.05$), and the E% from MUFA increased from 11.3% at baseline to 12.1% at FU ($P<.01$), resulting in a healthier balance of fatty acid intake. For boys, the E% from MUFA increased from 11% at baseline to 12.1% at FU ($P<.001$), and E% from total fat increased from 30.1% at baseline to 32% at FU ($P<.05$), but there was no change in the E% from saturated fat (11.7 vs 11.8 E%).

Table III. Correlation Between 24-h Nutrient Intake of Children at Baseline (Mean Age, 3.9 y) and at Follow-Up (Mean Age, 8.2 y)

	R Correlation Coefficient
Significant Correlation	
Sucrose, g	0.15[a]
Cholesterol, mg	0.12[a]
MUFA, E%	0.11[b]
Protein, E%	0.11[b]
kcal (energy, E)	0.10[b]
Total fat, E%	0.09[b]
No Significant Correlation	
Calcium	0.08
Carbohydrate, E%	0.07
Saturated fat, E%	0.06
Iron, mg	0.02
Fiber, g	−0.01
Folate, μg	−0.02

[a]$P<.01$; [b]$P<.05$. Abbreviations: E%, percent energy; MUFA, monounsaturated fat; kcal, kilocalories.

Dietary Fiber. Intake of dietary fiber at baseline and FU was similar in boys and girls. In girls, mean intake of dietary fiber at baseline was 10.6 g/d and at FU was 10.1 g/d. In boys, mean intake of dietary fiber at baseline was 10.2 g/d and at FU was 11.0 g/d.

Folate. Folate intake decreased significantly in both boys and girls in all ethnic groups between baseline and FU. In girls, mean dietary intake of folate at baseline was 258 μg/d, but on FU it decreased to 189 μg/d ($P<.001$). In boys, intake of folate decreased from 269 μg/d at baseline to 222 μg/d at FU ($P<.01$; Table I).

Ethnic Differences in Intake of Nutrients. Dietary intake was compared among children of African American, Hispanic, and Caucasian ethnicity. Hispanic children consumed significantly more dietary cholesterol (205 mg/d) than did African American (164 mg/d) or Caucasian (162 mg/d) children at baseline ($P<.01$), but there were no differences at FU. African American children consumed significantly less folate (166 μg/d) and fiber (9.7 g/d) than did Caucasian children (192 μg/d folate; 11.2 g/d fiber) at FU ($P<.05$). Dietary intake of sucrose was higher among

Table IV. Regression Analysis Relating CVD Risk Factors at FU (Mean Age, 8.2 y) to Individual Characteristics and 24-Hour Dietary Intake

	Standardized β Coefficients			
	BMI	Total Cholesterol	HDL-C	TG
Sex	0.02	−0.01	0.07	−0.05
Ethnicity	0.04	0.03	0.18[a]	−0.18[a]
BMI, 3–4 years old	0.67[a]	–	–	–
Δ From baseline to FU	–	0.22[b]	0.10	0.04
WC at FU	–	−0.04	−0.40[a]	0.24[b]
Dietary intake, 3–4 years old (baseline)				
kcal	0.12	0.10	0.01	0.05
Sucrose, g/d	−0.10[c]	0.02	0.06	−0.01
Fiber, g/d	−0.01	−0.14[c]	−0.07	−0.07
Saturated fat, E%	−0.01	0.02	0.10	−0.11
MUFA, E%	−0.04	−0.01	−0.12	0.16
Dietary intake, 7–10 years old (FU)				
kcal	−0.08	0.09	0.11	0.14
Sucrose, g/d	−0.01	−0.10	−0.14[c]	0.02
Fiber, g/d	0.004	0.10	0.01	−0.08
Saturated fat, E%	0.09	0.17	0.03	0.09
MUFA, E%	0.03	−0.38[b]	0.01	−0.25[c]
Total trans-fatty acids, mg/dL	0.02	0.15[c]	−0.03	0.03
Adjusted R^2	0.47[a]	0.09[a]	0.16[a]	0.12[a]

Abbreviations: BMI, body mass index; CVD, cardiovascular disease; E%, percent energy; FU, follow-up; HDL-C, high-density lipoprotein cholesterol; kcal, kilocalories; MUFA, monounsaturated fat; TG, triglycerides; WC, waist circumference. [a]$P<.001$; [b]$P<.01$; [c]$P<.05$.

Caucasian children at FU (39.2 g/d) than among African American children (37.3 g/d) or Hispanic children (34.6 g/d) ($P<.05$; Table I).

Children Meeting Dietary Guidelines. At least three-fourths of children met DRI guidelines for intake of niacin, riboflavin, thiamine, and vitamins A, B_6, B_{12}, and C at FU, but fewer than one-third met DRI guidelines for calcium and folate intake (compared with 60% at baseline; Figure 1 and Figure 2). The decrease in folate intake was greatest among girls and African American children. About 70% of children exceeded the American Heart Association guideline for saturated fat intake (<10 E%) both at baseline and FU. For dietary fiber intake, 60.1% of all children met the dietary guidelines for children aged 5 years and older at baseline but only 27.4% at FU.

Predictors of BMI at FU. Nutrient and other potential predictors of cardiovascular risk factors (BMI and levels of total cholesterol, HDL-C, and low-density lipoprotein cholesterol [LDL-C]) at FU were examined in separate regression analysis (Table IV). For BMI at FU, the most significant positive predictor was BMI at baseline ($P<.001$). Sucrose intake at baseline was significantly but inversely associated with BMI at FU ($P<.05$). Sucrose intake at FU was still negatively associated with BMI at FU, although it was no longer statistically significant.

Predictors of Lipid and Lipoprotein Levels at FU. Change in BMI from baseline to FU predicted total cholesterol levels at FU ($P<.01$). Figure 3 summarizes changes in BMI from baseline to FU and respective changes in total cholesterol, HDL-C, LDL-C, and triglycerides (nonfasting).

Dietary intake of fiber ($P<.05$) and MUFA ($P<.01$) was inversely associated with total cholesterol at FU. For HDL-C, African American ethnicity was a significant predictor of HDL-C levels at FU ($P<.001$). Waist circumference at FU was inversely associated with HDL-C at FU ($P<.001$). For dietary intake, sucrose intake at FU was negatively associated with HDL-C at FU ($P<.05$) (Table V). African American ethnicity was a significant (inverse) predictor of triglyceride levels at FU ($P<.001$). Dietary intake of MUFA (E%) was also inversely associated with triglyceride levels at FU ($P<.05$), and waist circumference at FU was directly associated with triglyceride levels at FU ($P<.01$; Table IV).

DISCUSSION

Dietary intake is a major contributor to CVD risk factors such as lipid and blood pressure values in both adults and children. Intervention studies that reduced saturated fat and cholesterol in the diet, increased viscous fiber, and added plant sterols have collectively demonstrated the ability of these dietary modifications to reduce LDL-C in adult

Table V. Mean Nutrient Intake (SD) by Level of CVD Risk Factors at FU (Mean Age, 8.2 y)

	Total kcal	Fiber	Sucrose	% SF	% MUFA	Trans Fat
Age 2–5 y: preschool						
BMI						
<85th percentile	1412 (540)	10.4 (5.2)	38.4 (22.9)	11.9 (3.7)	11.2 (3.2)	
85th–95th percentile	1521 (591)	11.0 (5.7)	36.4 (27.6)	11.7 (3.7)	11.3 (2.9)	
>95th percentile	1366 (498)	10.0 (5.2)	33.7 (18.6)[a]	12.0 (3.6)	11.0 (2.8)	
Total cholesterol, mg/dL						
Normal (<170)	1386 (537)	10.5 (5.4)	35.0 (21.1)	12.0 (3.7)	11.3 (3.1)	
Borderline (170–199)	1488 (579)	10.7 (5.3)	38.8 (20.3)	11.4 (3.7)	10.9 (3.0)	
High (>200)	1364 (363)	9.1 (4.0)	34.3 (16.2)	12.8 (3.8)	11.1 (2.9)	
HDL-C, mg/dL						
Desirable (>45)	1402 (520)	10.2 (5.1)	36.5 (21.5)	12.0 (3.7)	11.1 (3.1)	
Borderline low (35–45)	1418 (548)	11.1 (6.0)	32.8 (16.0)	12.2 (3.9)	11.4 (2.9)	
Low (<35)	1426 (635)	10.2 (5.0)	36.7 (19.0)	10.8 (3.9)	10.9 (2.6)	
Age 7–10 y: elementary school						
BMI						
<85th percentile	1580 (530)	10.5 (5.2)	40.2 (24.3)	11.4 (3.1)	12.1 (3.4)	4.5 (3.3)
85th–95th percentile	1541 (458)	10.3 (4.6)	36.3 (18.8)	11.8 (2.8)	12.0 (3.0)	4.5 (3.2)
>95th percentile	1560 (544)	10.8 (5.3)	38.7 (25.6)	12.0 (3.2)[a]	12.2 (3.8)	4.5 (3.4)
Total cholesterol, mg/dL						
Normal (<170)	1561 (544)	10.5 (5.3)	39.1 (23.9)	11.7 (3.0)	12.2 (3.5)	4.5 (3.4)
Borderline (170–199)	1590 (462)	10.9 (4.8)	38.7 (22.9)	11.8 (3.0)	12.4 (3.6)	4.7 (3.4)
High (>200)	1552 (594)	11.0 (5.4)	36.8 (24.8)	11.0 (3.3)	11.0 (3.5)[a]	4.4 (3.4)
HDL-C, mg/dL						
Desirable (>45)	1605 (545)	10.9 (5.2)	38.7 (24.0)	11.7 (3.1)	12.1 (3.4)	4.6 (3.4)
Borderline low (35–45)	1428 (459)[b]	9.8 (5.1)	36.8 (22.1)	11.9 (2.6)	12.4 (3.9)	4.1 (3.2)
Low (<35)	1513 (493)	10.3 (4.5)	46.7 (24.3)	11.0 (4.1)	10.8 (3.7)	4.4 (3.6)

Abbreviations: BMI, body mass index; CVD, cardiovascular disease; FU, follow-up; HDL-C, high-density lipoprotein cholesterol; kcal, kilocalories; MUFA, monounsaturated fat; SF, saturated fat. [a]$P<.05$; [b]$P<.01$.

and pediatric populations.[18] Similarly, the Dietary Approaches to Stop Hypertension (DASH) diet has been effective in reducing blood pressure levels.[19] Dietary factors contributing to the increasing prevalence of obesity in US children and adults have been more elusive. Increased consumption of dietary fat, carbohydrates, and sugar has been proposed as etiologic factors in the obesity epidemic. In our study, baseline BMI was the strongest predictor of overweight status at FU. The only dietary factor associated with BMI was sucrose intake, which had a significant inverse association at baseline. At FU, sucrose intake was still negatively associated with BMI; however, the association was no longer statistically significant.

Chung and associates[20] explored the relationship between sugar intake and BMI by examining trends in nutrient intake over the past 3 decades in US adults and children. Data from NHANES I (1971–1975; N=20,175) and NHANES III (1988–1994; N=28,663) showed that during this time period, mean energy intake increased by 7% (144 kcal/d), total sugar intake increased by 8% (9.2 g/d), total carbohydrate increased by 18% (26 g/d), and dietary fiber increased by 19% (1.6 g/d). Mean intake of total fat (E%) decreased by 7% and cholesterol intake (g/d) decreased by 27%. Overall, total caloric intake was the strongest predictor of obesity in the US population.[20]

Epidemiologic studies examining the relationship of diet, obesity, and CVD risk factors in young children are of special interest because they are relatively free of nonhereditary risk factors at birth but gradually acquire them throughout childhood. Dietary studies of preschool children are technically difficult, however, since the children are too young to report themselves and since many are in child care settings. Two cross-sectional studies among preschoolers found no relation between body composition and dietary fat as a percent of energy intake.[21,22] In one longitudinal study, children who had a significant increase in skinfold thickness between ages 3 and 7 years consumed greater amounts of dietary fat (g/d).[23] Similarly, in a study of low-income 2- to 5-year-old children enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC program), weight increase was correlated with

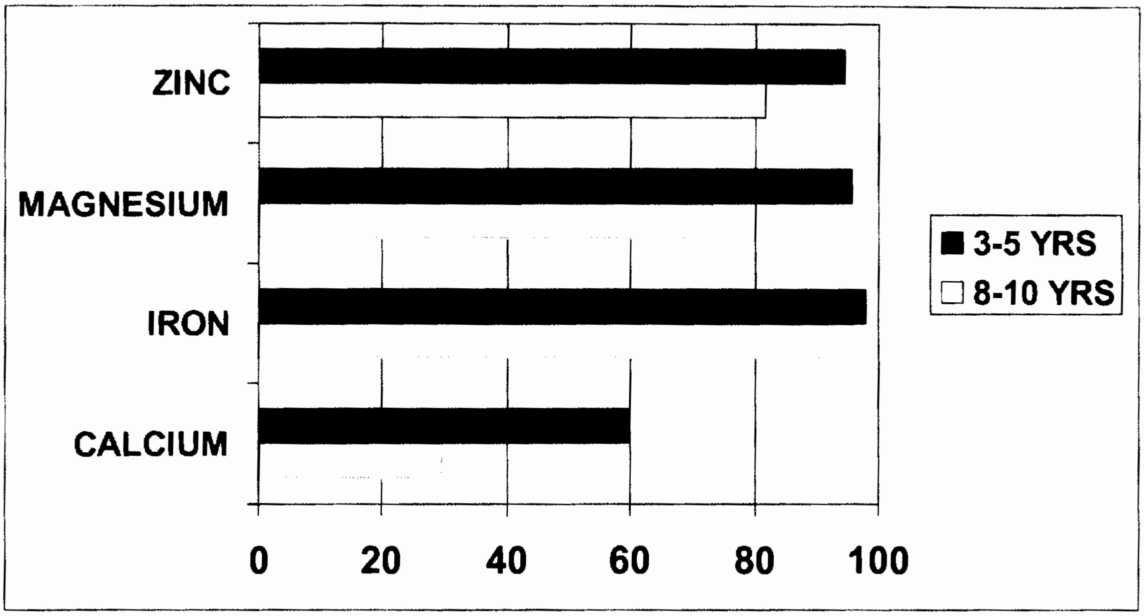

Figure 2. Percent of children who met 100% of dietary reference intakes for selected minerals.

intake of high-fat foods but not with E% from fat in the diet.[24] These authors also reported an inverse association between intake of breads and grain foods and weight gain.

In the present study, both dietary factors and anthropometric measures affected lipid levels at baseline as well as at FU. Total cholesterol level was lower in children with higher dietary intakes of MUFA and total dietary fiber at FU. Total cholesterol level was higher among children with higher energy intake at both baseline and FU and higher among children with BMI that increased from baseline to FU. HDL-C levels were lower at FU among children with increasing BMI, larger waist circumference, and higher dietary intake of sucrose at FU. Triglyceride levels were higher among children with greater waist circumference at FU and lower among children with higher intakes of MUFA.

Other investigators have reported variable associations between dietary intake and blood lipid values in preschool children. In a study of preschool Hispanic children in New York City, Shea and colleagues[25] found that intake of dietary fat, especially saturated fat, was significantly associated with total cholesterol and LDL-C levels. Nicklas and coworkers[26] examined dietary intake of nutrients and blood lipid levels in 50 African American and Caucasian preschoolers in Louisiana, at 4 and 7 years of age. Dietary intake of cholesterol and saturated fat were significantly associated with blood total cholesterol and LDL-C levels at 4 years of age. By age 7, however, only the relationship between cholesterol intake and LDL-C remained significant.[26] Crawford and colleagues[27] reported that E% from total fat as well as intake of dietary cholesterol were correlated with total cholesterol levels in 6-year-old children, and Rogers and Emmett[28] found that fat intake at 18 months of age was associated with total cholesterol levels at 31 months of age in boys but not at 43 months of age for either boys or girls.

The inverse association of HDL-C levels with dietary intake of simple carbohydrates has been observed by others. Starc and associates[29] reported lower mean HDL-C levels in children with higher intake of simple carbohydrates among 67 children aged 5 years who were referred to a lipid specialty clinic (r=−0.40; P<.001).

Intervention studies in young children have also demonstrated that lowering intake of dietary fat, especially saturated fat, can reduce blood total cholesterol and LDL-C. In Finland, infants were randomized to usual care or dietary intervention at 7 months of age (total fat 30 E%–35 E%; cholesterol <200 mg/d). By 5 years of age, children in the intervention group had 2 E% to 3 E% lower intakes of saturated fat and lower intakes of cholesterol than did children in the control group. Boys in the intervention group at this age had 9% lower levels of LDL-C than did controls, but there was no difference among girls.[30] Similarly, in an intervention study of preschool children enrolled in the HS program, Williams and colleagues[10] reduced the saturated fat intake in children in an intervention group from 12 E% to 9.5 E%, which resulted in lower blood cholesterol levels among these preschoolers by the end of the school year. Among older children, the Dietary Intervention Study in Children (DISC)[31] and the Child and Adolescent Trial for Cardiovascular Health (CATCH)[32] reduced blood lipid levels with

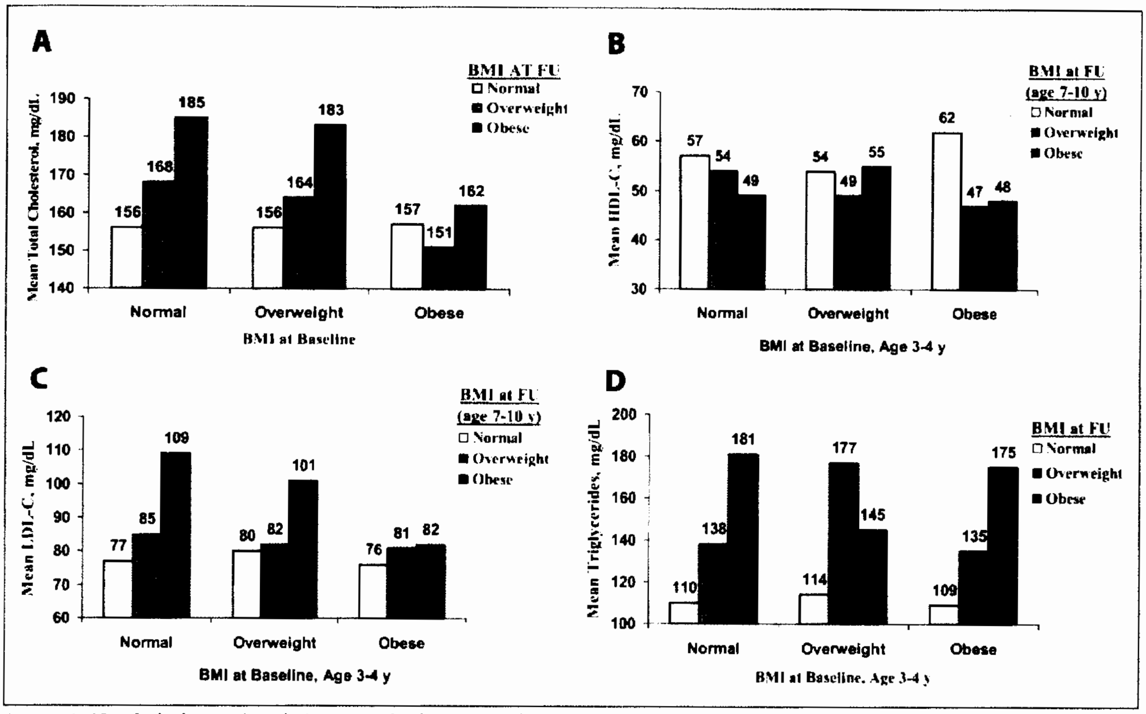

Figure 3. Total cholesterol and change in body mass index (BMI) from baseline to follow-up (FU) (A). High-density lipoprotein cholesterol (HDL-C) and change in BMI from baseline to FU (B). Low-density lipoprotein cholesterol (LDL-C) and change in BMI from baseline to FU (C). Triglycerides and change in BMI from baseline to FU (D). Normal = BMI <85th percentile; overweight, BMI = 85th–95th percentile; obese = BMI ≥95th percentile. Data from Ogden et al.[17]

dietary interventions that reduced intake of total fat, saturated fat, and cholesterol.[31–34]

In our study, central obesity, as measured by waist circumference, was associated with lower levels of HDL-C and higher levels of triglycerides. Cowin and Emmett[35] previously reported that the ratio of waist circumference to arm circumference was associated with lower levels of HDL-C and higher levels of triglycerides in preschool children. Freedman and coworkers[36] found that among 5- to 17-year-old children, a waist circumference in the 90th percentile (compared with the 10th percentile) was associated with higher mean concentrations of LDL-C, triglycerides, and insulin and lower concentrations of HDL-C. Thus, these components of the metabolic syndrome can often be identified early in childhood.

Our study, like others, has weaknesses. Dietary data collection by necessity differed somewhat at baseline and FU. At baseline, the children were too young to report on dietary intake, so a 3-pronged comprehensive dietary assessment methodology was chosen. This included direct observation of the child's diet intake in preschool, parental diary and interview for home intake, and menu/recipe analysis of meals and snacks cooked and served at preschool. At FU 4 years later, both children and parents could report on dietary intake, and assessments were conducted in the child's home. At this time, a 24-hour multiple-pass diet recall from both child and parent was utilized. Because of the young age of the children and the need to conduct assessments throughout the school day, nonfasting blood samples were collected for lipid measures. Although these are acceptable for total cholesterol and HDL-C screening,[37] it would have been preferable and more accurate to have assessed a full lipid profile on a fasting blood sample, if this had been logistically possible. Strengths of the study include the unique population of preschool children studied, which were low-income and predominately minority (70% Hispanic or African American), representing a group at especially high risk for eventually developing obesity, hypertension, type 2 diabetes, and premature CVD as adults. In addition, high rates of participation were achieved, especially at baseline, even with respect to collection of blood samples. Minimal staff turnover helped assure standard data collection at both baseline and FU.

CONCLUSIONS

In our study, higher intake of MUFAs was associated with more favorable lower levels of blood cholesterol and triglycerides. Higher intakes of dietary fiber were also associated with lower levels of blood cholesterol. Children with higher BMI values at baseline and FU and higher energy intake had higher levels of blood cholesterol. Higher BMI values and greater central obesity were associated with lower HDL-C and higher triglyceride levels.

Greater intake of sucrose at FU was associated with lower HDL-C level. Only BMI and sucrose intake at baseline were associated with BMI at FU. Thus, in our population of preschool children, dietary intake of some nutrients influenced the presence and severity of CVD risk factors, including lipid and lipoprotein levels, and overweight, reaffirming the importance of cardiovascular health promotion beginning very early in life.

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Table 12: Anticipated minimum years of experience by job cluster* and basic area** for new hires.

	Basic Area							
Job Cluster	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	WT. AV.
Administrates, Advises, Interprets	4.3	4.9	4.1	3.8	4.3	---	4.2	4.3
Inspects, Interprets, Investigates, Plans	4.3	4.4	3.8	3.7	3.4	---	3.1	4.0
Analyzes Plans, Develops Procedures	4.0	1.0	6.8	3.9	4.9	---	---	4.4
Provides Training	4.1	---	5.0	2.5	3.9	---	---	3.9
Performs and Analyzes Tests	3.1	1.5	2.6	2.7	3.9	---	3.1	2.8
Maintains, Repairs, and Adapts Equipment	4.8	2.0	2.0	3.4	4.2	---	5.0	4.0
Physician	---	---	---	---	---	4.1	---	4.1
Nurse	---	---	---	---	---	3.2	---	3.2
Not Classified	4.2	2.7	4.0	4.1	4.1	---	3.3	3.9
WT. AV.	4.2	2.9	3.4	3.7	3.9	3.2	3.5	3.9

*See page 6 for job cluster definitions.

**See page 4 for basic area definitions.

tabulated on Table 13 and generally indicate that less than 13 percent of the new hires would need to be professionally certified or registered. The industrial hygiene basic area placed the most emphasis on certification (approximately 20%); the remaining areas reported significantly less than that figure (11—15%) as a requirement. Perhaps the emphasis on certification in industrial hygiene is reflective of the health-related influence in that basic area. Among job clusters, those employers requiring employees who "maintain, repair, and adapt equipment" placed almost twice as great an emphasis on certification than they did in any other cluster.

The somewhat low percentage of certification requirements is probably due to the new entrant bias discussed above. The number of employers who would require certification or registration as a prerequisite to continued employment, promotions, or salary increases was not investigated. Hence, these data may tend to underestimate the importance of certification and registration.

4. Salary

The average salary currently being offered by employers to new hires in the various basic areas and job roles is reported on Table 14. The average new hire salary for the entire work force is $13,500. The safety, radiation, and general areas receive the highest average entrance pay of $13,800, with the nursing area at the low end with $10,700. Among job clusters, physicians lead with $28,600 (note this figure is biased downward because of the large number of occupational physicians who serve in a part-time capacity and are appropriately compensated). Employees who would be hired to "administrate, advise, and interpret" or to "analyze plans and develop procedures" are offered salaries consistently higher than those in any other job cluster, for virtually all the basic areas.

In reviewing the above components of the new hire profile, it becomes evident that new hires in industrial hygiene are expected to be relatively better educated, have less previous experience, face greater expectation of professional certification, yet have a lower starting salary. New hires in safety are required to have more previous experience, face a lower expectation of certification, yet get paid a higher starting salary. Similar profiles may be constructed for any job cluster and basic area combination to provide some insight as to the types of individuals currently being demanded in the occupational safety and health labor market. These profiles should be kept in mind when reviewing the forecast demand for occupational safety and health personnel for 1980, 1985, and 1990, which are detailed in the next chapter.

G. ADDITIONAL USES OF THE DATABASE

The survey results presented in this chapter represent merely a fraction of the available data. The database design for this project permits access to information concerning any question in order to construct a profile of the responses to that question (or series of questions). Therefore, if complete information is required concerning only those respondents classified in the safety or industrial hygiene basic areas, it can be segregated and all the survey instrument's responses generated by that group may be displayed. Similarly, if a specific job cluster or educational level or industry classification is desired, data from that subset of respondents may also be provided. Virtually any question, or group of questions, from the survey instruments may be targeted, and complete profiles produced, describing that subject.

Table 13: **Percent of employers anticipating requiring certification by job cluster* and basic area** for new hires.**

	Basic Area							
Job Cluster	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	WT. AV.
Administrates, Advises, Interprets	10.1	27.7	29.9	3.2	13.2	---	10.6	11.4
Inspects, Interprets, Investigates, Plans	9.2	30.0	23.1	17.4	13.1	---	18.8	11.6
Analyzes Plans, Develops Procedures	8.3	---	47.8	32.0	17.5	---	---	11.9
Provides Training	11.4	---	65.4	13.3	7.0	---	---	11.1
Performs and Analyzes Tests	14.8	10.5	17.2	19.6	7.0	---	27.8	14.8
Maintains, Repairs, and Adapts Equipment	29.8	---	---	6.6	21.2	---	---	19.1
Physician***	---	---	---	---	---	***	---	***
Nurse***	---	---	---	---	---	***	---	***
Not Classified	26.6	8.4	19.7	8.6	9.4	---	.8	12.0
WT. AV.	11.1	15.4	20.3	13.4	12.9	***	3.6	12.5

*See page 6 for job cluster definitions.

**See page 4 for basic area definitions.

***All physicians and nurses must be licensed to practice.

Table 14: Average anticipated minimum salary (in thousands) offered to new hires by job cluster* and basic area.**

Job Cluster	Basic Area: Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	WT. AV.
Administrates, Advises, Interprets	$15.2	$18.2	$18.0	$12.6	$14.5	---	$15.8	$15.0
Inspects, Interprets, Investigates, Plans	12.9	16.3	14.5	12.0	12.5	---	13.9	12.8
Analyzes Plans, Develops Procedures	14.8	12.2	18.5	14.8	16.3	---	12.0	15.5
Provides Training	14.3	0	14.3	11.9	12.7	---	17.0	13.7
Performs and Analyzes Tests	12.1	12.9	12.0	13.8	14.7	---	9.6	12.5
Maintains, Repairs, and Adapts Equipment	13.4	9.0	13.0	12.1	10.9	---	11.5	12.2
Physician	---	---	---	---	---	$28.6	---	28.6
Nurse	---	---	---	---	---	10.7	---	10.7
Not Classified	13.8	10.9	13.9	13.1	15.8	---	12.0	13.8
WT. AV.	13.8	13.8	13.0	12.3	13.8	12.3	13.1	13.5

*See page 6 for job cluster definitions.
**See page 4 for basic area definitions.

The next chapter describes the forecast methodology and the employment and new hire forecasts to 1980, 1985, and 1990. Again, these forecasts are presented utilizing the basic area and job cluster definitions presented in this chapter. (More specific details concerning the methodological and empirical validity of the survey results and national inferences are presented in the Technical Appendix to this report.)

CHAPTER II

FORECAST OCCUPATIONAL SAFETY AND HEALTH WORK FORCE TO 1980, 1985, AND 1990

A. INTRODUCTION

The previous chapter presented estimates of the size of the 1977 occupational safety and health work force by job cluster, basic area, and Standard Industrial Classification. These estimates serve as a prelude to the principal challenge of this study, that of forecasting the future demand for occupational safety and health personnel. This chapter addresses that challenge by discussing the various forecast assumptions made and by presenting the occupational safety and health work force demand forecasts for the three target years of 1980, 1985, and 1990. The chapter also presents an analysis of the number of annual new hires required to attain the forecast work force for each of the target years. The analysis considers both attrition of the existing work force and growth in the occupation itself. In Chapter III, these forecasts for new hires will be compared with the annual supply of occupational safety and health workers expected to be generated by industry, government, and education institutions; the result is an assessment of the shortage or surplus areas of training. This information is intended to assist educators, government agencies, and private industry in planning and developing occupational safety and health-related training programs during the next decade.

B. DEMAND VERSUS NEED

An important distinction should be made at this juncture: these forecasts quantify the number of occupational safety and health personnel *demanded,* as opposed to the number *needed.* That is, the employer is either employing a worker or is actively seeking a worker to fill a specific job slot. This study does not deal with *need* per se, which concerns the number of occupational safety and health personnel believed necessary by some professional association or government body to adequately protect the labor force in the work place. These subjective assessments of need (of interest to policy makers) may reflect worthy goals or aspirations concerning levels of employment, but they do not measure the *actual entry* by employees into the marketplace. Subjective assessments are useful in designing alternative scenarios that reflect the impact of potential shifts in enforcement, utilization, and emphasis in the occupational safety and health field. Therefore, the forecast methodology (detailed in the Technical Appendix) was designed to investigate an unlimited number of alternative futures, where each alternative is defined by a different set of assumptions regarding the impact that exogenous forces (e.g., new government regulations) will have on the *demand* for occupational safety and health workers. Although only two such sets of assumptions and their resulting forecasts are presented below, additional forecasts may be produced based on other perceptions regarding the future.

C. ALTERNATIVE FUTURES

1. Status Quo

The status quo forecast assumes that the existing 1977 distribution of the occupational safety and health work force, throughout the economy, will remain unchanged through 1990. This suggests that there will be no major shift in enforcement emphasis that will create a greater relative demand for occupational safety and health personnel. Conversely, it also assumes that nothing will have a downward effect on employment (e.g., the productivity of the existing work force will remain constant and occupational safety and health workers will not perform their jobs more efficiently). This alternative, then, predicts there will be the same incidence of physicians in 1990 as there were in 1977. The same will be true for any other basic area by job cluster by industry sector cell. It also assumes that occupational safety- and health-related state, federal, and insurance employment will maintain their respective 1977 proportionate shares of the total occupational safety and health work force over the forecast period.

2. Accelerated Growth

To reiterate: the status quo forecasts of the number of occupational safety and health employees are based on the assumption that the respective incidences of occupational safety and health personnel will remain constant throughout all industry sectors until 1990. In other words, government or industry stimuli to modify the occupational safety and health incidences either will not be generated, or, if generated, will not be effective in altering the relative levels of occupational safety and health employees in the future. This is a potentially restrictive assumption, especially since the presence of occupational safety and health positions within firms has been in developmental stages during the last decade. It is entirely possible that federal government activities, especially with respect to OSHA regulations, could effectively alter (presumably increase) the incidence of occupational safety and health employees within the work force. A more subtle change, that of placing more or less emphasis on specific job clusters within a given basic area, is also conceivable. This type of change would probably be generated by industry itself, based on cost-effectiveness or productivity criteria.

To investigate the impact of these potential changes on the current occupational safety and health work force structure, a second set of forecasts was generated. The project's Technical Advisory Committee (names of committee members are listed in Exhibit 1), drawing from their experience and knowledge of the occupational safety and health environment, produced an array of likely changes in the present incidences of occupational safety and health employees. For the safety basic area, an overall 2.0 percent increase in incidence is expected, with all of the change centered in job clusters that either "provide training" or "perform and analyze tests." In radiation, an across-the-board 1.0 percent increase is anticipated. Industrial hygiene will potentially increase the most, with an evenly distributed 50.0 percent. A 10 percent increase in the fire protection basic area is projected, with an emphasis in the administration and inspection job clusters. The general basic area will probably expand by an overall 10 percent, the medical area by 5 percent, and no change is projected for the "not classified" area. Another change is that occupational safety- and health-related state government will not increase beyond its current level (i.e., it will remain constant throughout the forecast period). This is based on the observation that very few occupational safety and health state plans are being produced or approved. Insurance and federal occupational safety and health employment will reflect changes similar to those projected in the other sectors.

Using these suggested percent changes, the numbers of occupational safety and health personnel were appropriately modified to generate a second alternative future (the accelerated growth forecast). Note that it is assumed that these changes will not occur until after 1980, and therefore, their impact cannot be measured until 1985 and 1990.

D. FORECAST OF TOTAL OCCUPATIONAL SAFETY AND HEALTH EMPLOYMENT

Based on the alternative futures assumptions specified above, Tables 15, 16, and 17 present the total number of occupational safety and health employees to be demanded in 1980, 1985, and 1990 by industry and basic area. Total demand is forecast to increase from 84,850 in 1977 as estimated in the previous chapter, to 94,230 by 1980: an 11.1 percent increase over the 3-year period. Again, it is assumed that the accelerated growth future will not begin to take effect until after 1980. Demand will grow an additional 5.8 percent (status quo) to 12.6 percent (accelerated) over the next 5-year period (1980—1985) and will finish out the decade with an estimated increase of between 4.7 percent (status quo) and 4.4 percent (accelerated) during the 1985 to 1990 period. This diminishing growth in total demand reflects an overall stabilization of employment in those sectors (specifically manufacturing and transportation, communication, and utilities) that make up a significant component of occupational safety and health work force demand.

The industries with greatest forecast percentage growth in demand are construction (with between a 42.2 and 45.1 percent increase between 1977 and 1990) and trades, services, and nonoccupational safety and health government (with a 41.2 to 47.4 percent increase over the forecast period). The industries with the greatest anticipated numerical growth in demand are manufacturing (which will demand another 5,870 to 8,300 workers), and trades, services, and nonoccupational safety and health government (which will demand an additional 5,650 to 6,500 employees). In examining Tables 15 through 17 from the perspective of basic area, radiation and fire protection have slightly greater growth rates and the largest numerical increase in demand will come in the safety and general basic areas under the status quo alternative. However, under the accelerated growth forecast, there is a significant increase, both percentage and absolute, in the demand for industrial hygiene, general, and medical personnel.

Table 15: Forecast 1980 national occupational safety and health work force by industry and basic area.*

Industry	Basic Area							
	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total**
Mining	1,340	50	230	100	860	20	70	2,670
Construction	2,720	40	0	30	440	110	220	3,560
Manufacturing	18,260	200	1,260	1,970	9,310	8,130	2,720	41,850
Transportation, Communication, and Utilities	4,650	0	170	280	1,720	150	930	7,900
Trades, Services, and Non-OSH Govt.	4,380	490	220	2,110	4,130	2,410	1,400	15,140
Insurance	4,800	0	210	900	3,720	0	940	10,570
OSH-Related State Govt.	2,120	0	1,250	0	510	20	570	4,470
Federal	3,150	740	2,020	100	1,510	240	320	8.070
Total**	41,420	1,520	5,350	5,490	22,190	11,080	7,180	94,230

*See page 4 for basic area definitions.
**Totals may not add due to rounding.

Table 16: Forecast 1985 national occupational safety and health work force by industry and basic area.*

	Basic Area															
	Safety		Radiation		Industrial Hygiene		Fire Protection		General		Medical		Not Classified		Total**	
Industry	Status	Accel	Status	Accel	Status	Accel	Status	Accel	Status	Accel	Status	Accel	Status	Accel	Status	Accel
Mining	1,350–	1,400	50–	50	240–	360	100–	110	870–	1,030	20–	20	70–	70	2,700–	3,030
Construction	3,040–	3,110	50–	50	0–	0	40–	40	490–	490	130–	130	250–	250	3,990–	4,070
Manufacturing	18,810–	19,160	210–	210	1,300–	1,940	2,020–	2,200	9,590–	10,410	8,370–	8,790	2,810–	2,810	43,110–	45,520
Transportation, Communication, and Utilities	4,830–	5,000	0–	0	180–	260	290–	320	1,790–	2,110	150–	160	970–	970	8,200–	8,800
Trades, Services, and Non-OSH Govt.	4,990–	5,050	560–	570	250–	370	2,400–	2,650	4,710–	4,900	2,750–	2,880	1,590–	1,590	17,250–	18,010
Insurance	5,080–	5,160	0–	0	220–	330	960–	1,080	3,930–	4,000	0–	0	1,000–	1,000	11,190–	11,560
OSH-Related State Govt.	2,250–	2,020	0–	0	1,320–	1,680	0–	0	540–	460	20–	20	610–	520	4,730–	4,690
Federal	3,340–	3,340	780–	790	2,140–	3,210	110–	120	1,590–	2,390	250–	270	340–	340	8,550–	10,450
Total **	43,690–	44,210	1,650–	1,660	5,630–	8,160	5,920–	6,500	23,510–	25,770	11,690–	12,270	7,630–	7,540	99,720–	106,120

*See page 4 for basic area definitions.
**Totals may not add due to rounding.

Table 17: Forecast 1990 national occupational safety and health work force by industry and basic area.*

	Basic Area															
	Safety		Radiation		Industrial Hygiene		Fire Protection		General		Medical		Not Classified		Total**	
Industry	Status	Accel	Status	Accel	Status	Accel	Status	Accel	Status	Accel	Status	Accel	Status	Accel	Status	Accel
Mining	1,560–	1,600	60–	60	270–	410	120–	130	1,000–	1,180	20–	20	80–	80	3,100–	3,480
Construction	3,340–	3,420	50–	50	0–	0	40–	40	540–	540	140–	150	270–	270	4,380–	4,470
Manufacturing	19,000–	19,350	210–	210	1,310–	1,960	2,040–	2,210	9,690–	10,520	8,460–	8,880	2,840–	2,840	43,540–	45,970
Transportation, Communication, and Utilities	4,930–	5,090	0–	0	180–	270	290–	320	1,820–	2,150	160–	170	980–	980	8,360–	8,980
Trades, Services, and Non-OSH Govt.	5,610–	5,670	630–	640	280–	420	2,700–	2,980	5,290–	5,500	3,080–	3,240	1,790–	1,790	19,370–	20,220
Insurance	5,320–	5,400	0–	0	230–	350	1,000–	1,130	4,120–	4,180	0–	0	1,040–	1,040	11,710–	12,100
OSH-Related State Govt.	2,350–	2,020	0–	0	1,380–	1,680	0–	0	560–	460	20–	20	640–	520	4,950–	4,690
Federal	3,490–	3,490	820–	830	2,240–	3,360	110–	130	1,670–	2,500	260–	280	360–	360	8,950–	10,940
Total**	45,590–	46,030	1,770–	1,780	5,880–	8,440	6,300–	6,930	24,680–	27,020	12,150–	12,750	8,000–	7,880	104,360–	110,840

*See page 4 for basic area definitions.

**Totals may not add due to rounding.

Again, notice that under both alternatives there is a significant surge in immediate demand followed by a leveling off in the growth rates among all the basic areas. Therefore, caution should be exercised by educational and government organizations to prevent overreacting to these immediate stimuli and hence overproducing trained occupational safety and health personnel for the remainder of the 1980's.

A comparable picture is presented on Tables 18, 19, and 20, which indicate the forecast by job cluster and basic area for 1980, 1985, and 1990. The largest quantitative growth in demand is registered in the "inspects, interprets, investigates, plans" job cluster, requiring a demand for between 7,090 and 7,670 additional jobs by 1990. This cluster is followed by the "administrates, advises, interprets" group, with a growth of between 4,300 and 4,560 jobs, and by nurses, with 1,920 and 2,460 additional requirements. Again, a pronounced change is reflected in job clusters within the industrial hygiene basic area under the accelerated growth forecast. In 1985, the number of occupational safety and health personnel who "perform and analyze tests" increases by more than 3,000 job slots in the accelerated growth forecast than it does in the status quo forecast. Only minimal changes are recorded in other job clusters.

It is important to remember that the forecast presented under the two alternative sets of assumptions are quantified in terms of the total number of occupational safety and health personnel forecast to be demanded by 1980, 1985, and 1990. The next section presents the forecasts in terms of the number of new hires that will be demanded annually.

E. NEW HIRES

The preceding sections of this chapter have described the future occupational safety and health work force in terms of the total number of occupational safety and health personnel required to meet industry and government demand. This has been portrayed by the 1980, 1985, and 1990 forecast levels of the occupational safety and health work force under both the status quo and the accelerated growth alternative future scenarios. Given these forecasts, the next important consideration is to determine the required flow of occupational safety and health employees into the work force needed to meet the demand for the target year levels. This section discusses the expected annual flow of new hires into the occupational safety and health employment base.

New hires in the work force are affected by two major components:

1. Growth in the occupation to meet increased demand.

2. Replacement of existing employees who leave due to attrition.

Occupational growth is a relatively easy figure to compute. As specified above, a comparison of the required employment levels between target years produced estimates of the growth in occupational demand. The number of new hires required to replace employees who will leave the work force because of retirement, disability, death, etc., is a more difficult concept to quantify. Note that replacement due to attrition takes on special significance in the occupational safety and health setting since a large proportion of the existing work force (over 30% – see Figure 1) is 50 years or older. It is reasonable to assume that most of these employees will be retired and must be replaced by 1990.

Table 18: Forecast of the 1980 national occupational safety and health work force by job cluster* and basic area.**

	Basic Area							
Job Cluster	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total***
Administrates, Advises, Interprets	11,350	340	460	1,100	6,730	0	370	20,350
Inspects, Interprets, Investigates, Plans	20,110	120	680	3,080	10,120	0	440	34,560
Analyzes Plans, Develops Procedures	3,810	80	100	190	1,500	0	40	5,710
Provides Training	1,580	0	40	150	770	0	20	2,560
Performs and Analyzes Tests	1,110	720	3,550	140	1,090	0	70	6,680
Maintains, Repairs, and Adapts Equipment	450	30	30	400	460	0	30	1,390
Physician	...	...	...	...	...	1,120	...	1,120
Nurse	...	...	...	...	...	9,960	...	9,960
Not Classified	3,020	230	500	430	1,530	0	6,210	11,920
Total***	41,420	1,520	5,350	5,490	22,190	11,080	7,180	94,230

*See page 6 for job cluster definitions.

**See page 4 for basic area definitions.

***Totals may not add due to rounding.

Table 19: Forecast of the 1985 national occupational safety and health work force by job cluster* and basic area.**

	Basic Area							
	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total***
Job Cluster	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel
Administrates, Advises, Interprets	11,980–11,880	370– 370	480– 710	1,180–1,330	7,170– 7,170	0– 0	400– 390	21,570– 21,850
Inspects, Interprets, Investigates, Plans	21,210–21,040	130– 130	710–1,040	3,350–3,780	10,650–10,650	0– 0	470– 470	36,510– 37,110
Analyzes Plans, Develops Procedures	4,030– 4,030	90– 90	100– 150	200– 200	1,650– 1,650	0– 0	40– 40	6,110– 6,160
Provides Training	1,670– 2,160	0– 0	50– 70	160– 160	810– 1,780	0– 0	20– 20	2,700– 4,180
Performs and Analyzes Tests	1,160– 1,470	780– 790	3,750–5,380	150– 150	1,140– 2,510	0– 0	70– 70	7,050– 10,360
Maintains, Repairs, and Adapts Equipment	480– 480	30– 30	30– 40	420– 420	480– 480	0– 0	30– 30	1,470– 1,490
Physician	...	...	...	...	...	1,190– 1,250	...	1,190– 1,250
Nurse	...	...	...	...	...	10,510–11,030	...	10,510– 11,030
Not Classified	3,170– 3,160	250– 250	520– 760	460– 460	1,610– 1,540	0– 0	6,610–6,530	12,610– 12,690
Total***	43,690–44,210	1,650–1,660	5,630–8,160	5,920–6,500	23,510–25,770	11,690–12,270	7,630–7,540	99,720–106,120

*See page 6 for job cluster definitions.
***See page 4 for basic area definitions.
***Totals may not add due to rounding.

Table 20: Forecast of the 1990 national occupational safety and health work force by job cluster* and basic area.**

	Basic Area							
	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total***
Job Cluster	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel
Administrates, Advises, Interprets	12,510–12,380	400– 400	500– 740	1,240–1,410	7,550– 7,550	0– 0	420– 410	22,620– 22,880
Inspects, Interprets, Investigates, Plans	22,110–21,900	140– 140	740–1,080	3,590–4,060	11,120–11,120	0– 0	480– 480	38,190– 38,770
Analyzes Plans, Develops Procedures	4,210– 4,210	100– 100	110– 160	220– 220	1,790– 1,790	0– 0	40– 40	6,470– 6,520
Provides Training	1,740– 2,230	0– 0	50– 70	170– 170	840– 1,850	0– 0	20– 20	2,810– 4,350
Performs and Analyzes Tests	1,200– 1,510	830– 840	3,910–5,560	170– 170	1,190– 2,630	0– 0	80– 70	7,380– 10,770
Maintains, Repairs, and Adapts Equipment	510– 510	40– 40	30– 40	420– 420	500– 500	0– 0	30– 30	1,530– 1,540
Physician	...	...	...	...	...	1,240– 1,310	...	1,240– 1,310
Nurse	...	...	...	...	...	10,900–11,440	...	10,900– 11,440
Not Classified	3,310– 3,290	260– 260	540– 790	500– 500	1,680– 1,580	0– 0	6,940–6,830	13,220– 13,250
Total***	45590–46030	1,770–1,780	5,880–8,440	6,300–6,930	24,680–27,020	12,150–12,750	8,000–7,880	104,360–110,840

*See page 6 for job cluster definitions.
**See page 4 for basic area definitions.
***Totals may not add due to rounding.

To assess the effect of attrition on the number of new hires required in the future, age-specific attrition rates* were applied to the existing occupational safety and health employment base within each basic area by job cluster cell over the time period from 1977 to 1990. This procedure resulted in an estimate of the expected number of existing occupational safety and health personnel who will remain (i.e., will not retire or otherwise leave the labor force) in each of the future target years. The "survivors" were then subtracted from the forecast total demand in occupational safety and health personnel to determine the expected number of new hires required to maintain future employment levels. The total number of new hires was further disaggregated to represent those associated with occupational growth and those necessary for replacements. Table 21 summarizes the estimates of new hires for each of 1980, 1985, and 1990 by alternative future. In this case, a total 110,840 occupational safety and health employees will be required in 1990. Approximately 57,910 occupational safety and health personnel will still be available from the current occupational safety and health work force of 84,850, meaning that 26,940 new hires will be required to replace attrition to the existing employment base. An additional 25,990 occupational safety and health workers will also have to be trained to fill new positions generated by growth in the occupation. In all, almost 53,000 hires will be required between 1977 and 1990 under this alternative. It is interesting to note from Table 21 that less than 70 percent of the current occupational safety and health work force will remain in 1990.

Several assumptions were made in determining the number of new hires expected in the future:

- The attrition behavior of occupational safety and health personnel is similar to that of the entire U.S. labor force in 1970.
- Attrition rates will remain constant throughout the forecast timeframe.
- New entrants into the labor force will not retire or otherwise leave the labor force (i.e., the attrition scheme was directed solely toward the existing work force).
- Occupational safety and health personnel will not leave the occupational safety and health work force other than through attrition (i.e., occupational safety and health personnel will not change to occupations outside of the occupational safety and health purview, or if they do, this will be offset by new entrants of comparable age).

Major deviations from any of these assumptions could have a significant effect on the overall required number of new hires. For example, if occupational safety and health personnel develop a tendency for retirement earlier than do personnel in the average work force, or if they demonstrate a propensity for high mobility into nonoccupational safety and health occupations, then the required number of new hires could increase substantially.

For planning purposes, the total number of new hires presented in Table 21 has been disaggregated by basic area and job cluster in Tables 22 through 24. Note that these tables represent the *annual* number of new hires required between the various target years. For example in Table 22, between

*See Fullerton, Howard N. and James, Byrne J., "Length of Working Life for Men and Women 1970." *Monthly Labor Review,* February, 1976, U.S. Department of Labor, Bureau of Labor Statistics.

Table 21: Summary of total new hires required for replacements and growth.

Target Year by Alternative Future	Forecast Demand for OSH Personnel	Number of OSH Personnel Employed in 1977 Remaining in Labor Force	New Hires for Occupational Growth Between 1977 and Target Year	New Hires for Replacement of Attrition Between 1977 and Target Year	Total Number of New Hires Required Between 1977 and Target Year	Percent of Original 1977 OSH Work Force Remaining
1977	84,850	84,850	0	0	0	100.0%
1980	94,230	78,340	9,390	6,510	15,900	92.3%
1985 Status Quo	99,720	68,640	14,870	16,210	31,080	80.9%
1985 Accelerated Growth	106,120	68,640	21,270	16,210	37,480	80.9%
1990 Status Quo	104,360	57,910	19,510	26,940	46,450	68.2%
1990 Accelerated Growth	110,840	57,910	25,990	26,940	52,930	68.2%

Table 22: Annual new hires required between 1977 and 1980 by job cluster* and basic area.**

	Basic Area							
Job Cluster	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total
Administrates, Advises, Interprets	650	20	30	60	380	...	20	1,140
Inspects, Interprets, Investigates, Plans	1,110	10	40	170	680	...	20	1,890
Analyzes Plans, Develops Procedures	240	10	10	10	100	...	#	360
Provides Training	80	0	#	10	40	...	#	130
Performs and Analyzes Tests	70	30	200	10	80	...	#	390
Maintains, Repairs, and Adapts Equipment	20	#	#	30	30	...	#	80
Physician	...	...	...	...	...	100	...	100
Nurse	...	...	...	...	...	600	...	600
Not Classified	190	10	30	20	80	...	330	640
Total	2,350	70	310	290	1,220	700	370	5,300

*See page 6 for job cluster definitions.
**See page 4 for basic area definitions.
#Between 1 and 7 new hires will be required annually.

Table 23: Annual new hires required between 1981 and 1985 by job cluster* and basic area.**

	Basic Area							
	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total
Job Cluster	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel
Administrates, Advises, Interprets	370– 370	10–10	10– 60	40– 70	240– 240	. . .	10– 10	680– 750
Inspects, Interprets, Investigates, Plans	580– 570	10–10	20– 90	120–200	350– 350	. . .	10– 10	1,030–1,170
Analyzes Plans, Develops Procedures	140– 140	10–10	0– 10	10– 10	70– 70	. . .	0– 0	220– 230
Provides Training	40– 140	0– 0	0– 10	0– 0	30– 220	. . .	0– 0	70– 370
Performs and Analyzes Tests	40– 100	20–20	110–360	0– 0	40– 320	. . .	0– 0	220– 910
Maintains, Repairs, and Adapts Equipment	10– 10	0– 0	0– 0	10– 10	10– 10	. . .	0– 0	30– 30
Physician	. . .	. . .	. . .	. . .	. . .	60– 70	. . .	60– 70
Nurse	. . .	. . .	. . .	. . .	. . .	360–470	. . .	360– 470
Not Classified	100– 100	0–10	20– 70	10– 10	40– 40	. . .	210–210	360– 400
Total	1,290–1,440	40–50	160–690	190–310	710–1,180	420–540	230–220	3,040–4,410

*See page 6 for job cluster definitions.
**See page 4 for basic area definitions.

Table 24: Annual new hires required between 1986 and 1990 by job cluster* and basic area.**

	Basic Area							
	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified	Total
Job Cluster	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel	Status Accel
Administrates, Advises, Interprets	380– 370	20–20	20– 20	40– 40	260–260	0– 0	10– 10	710– 710
Inspects, Interprets, Investigates, Plans	590– 580	0– 0	20– 20	130–130	330–330	0– 0	20– 20	1,050–1,050
Analyzes Plans, Develops Procedures	130– 130	0– 0	0 0	10– 10	70– 70	0– 0	0– 0	220– 220
Provides Training	40– 50	0– 0	0– 0	10– 10	30– 30	0– 0	0– 0	80– 90
Performs and Analyzes Tests	40– 40	20–20	100–110	10– 10	40– 50	0– 0	0– 0	220– 230
Maintains, Repairs, and Adapts Equipment	20– 20	0– 0	0– 0	10– 10	10– 10	0– 0	0– 0	40– 40
Physician	...	...	...	...	...	50– 50	...	50– 50
Nurse	...	...	...	...	...	360–360	...	360– 360
Not Classified	110– 100	0– 0	20– 20	20– 30	40– 30	0– 0	230–230	370– 360
Total	1,310–1,300	50–50	160–170	210–220	730–740	410–410	250–250	3,080–3,090

*See page 6 for job cluster definitions.
**See page 4 for basic area definitions.

1977 and 1980, an estimated 5,300 occupational safety and health new hires will be required annually. The largest portion of this demand will be for personnel to work in the safety basic area and have skills to "inspect, interpret, investigate and plan." Between 1980 and 1985, the status quo forecast requires an annual 3,040 new hires; the accelerated growth alternative requires 4,410 new hires per year (Table 23). Comparisons between these two alternative futures indicate that in the status quo alternative, only 160 annual industrial hygiene positions will be demanded between 1980 and 1985. Under the accelerated growth alternative, an annual 690 new hires in industrial hygiene will be required. Between 1985 and 1990, the number of new hires per year will be at a level of 3,100 under both forecasts (Table 24). Their similarity is because the specific basic area by job cluster cells that the accelerated growth forecast focuses on are concentrated in those industries having a forecast of stabilized employment (i.e., manufacturing, transportation communication, and utilities).

In reviewing the individual basic area by job cluster cells in Table 22 through 24, note that these new hire rates disregard the possibility of upward mobility within the occupational safety and health employment structure. For example, under the job cluster "administrates, advises and interprets," 710 positions per year between 1985 and 1990 are projected to be vacant (both replacements and new growth). Since a number of these positions will undoubtedly be filled by employees currently in other occupational safety and health job clusters (especially from the "inspects, interprets, investigates and plans" and the "analyzes plans and develops procedures" clusters), occupational safety and health training institutions will not have to produce all 710 employees for these jobs. Conversely, since some employees currently in the professional level job clusters will be moving into administrative positions, occupational safety and health training institutions may have to produce more new hire candidates in professional positions than are indicated as being necessary in Tables 22 through 24. Consequently, educational institutions, in planning for future course developments, must interpret these annual new hire estimates in light of potential "career-ladder" upward mobility.

Although beyond the scope of this study, it is interesting to contemplate the expected pattern of new hires after 1990. In doing so, an observation made in Chapter I is reiterated. Because of the bimodal age distribution of the existing occupational safety and health work force (see Figure 1), the number of new hires required as replacements for attrition is expected to decrease noticeably after 1995. At that time, most of the occupational safety and health employees currently 45 years and older will have left the labor force because of attrition. Assuming that most of the new hires into occupational safety and health positions will be in the 25–29 year old cohort, the proportion of older occupational safety and health employees in 1995 (currently in the 35–45 year age brackets) will be relatively small compared with the existing profile. Consequently, fewer replacements will be required as they retire. Again, this suggests that educational institutions should closely monitor the demand for new hires in order to respond to fluctuations associated with changing age distributions, attrition and mobility patterns, and industry/government hiring criteria.

F. SUMMARY

This chapter presented a primary product of this study: the forecast of annual new hires of occupational safety and health personnel by job cluster and basic area. Two sets of alternative future assumptions were used: the initial forecast assumed the status quo incidence of demand and the accelerated growth forecast assumed a higher numbers set of incidence, based on discussions with the Technical Advisory Committee and federal officials.

The forecasts indicate an annual demand for 5,300 occupational safety and health-related personnel between 1977—1980, tapering off to between 3,000 (status quo) and 4,400 (accelerated) annually throughout the decade. The decline in annual new hires is primarily a function of the diminished number of retirements and a leveling out of employment growth from 1985 to 1990, as forecast by the Bureau of Labor Statistics. Most of the demand is focused on the "inspects, interprets, investigates, and plans" and the "performs tests and analyzes results" job clusters in the safety and general basic areas.

These demand forecasts must be placed in perspective by matching them against existing and anticipated supply throughout the forecast period. The next chapter (Chapter III) attempts to describe the principal sources of supply and to quantify the output of graduates and trainees.

CHAPTER III

SUPPLY OF OCCUPATIONAL SAFETY AND HEALTH PERSONNEL

A. INTRODUCTION

The previous chapter concluded with a presentation of the estimated number of annual new hires needed to fill the future occupational safety and health personnel replacement and growth requirements. These forecasts, based upon the two alternative future scenarios (also presented in Chapter II), define the future demand for occupational safety and health-related personnel scenarios. Demand, however, describes only half of the market for safety and health personnel. Such information must be placed into proper perspective by examining the supply side of the market. A primary purpose of this study was to inform existing and potential suppliers of trained occupational safety and health personnel, together with individuals interested in the safety and health field, about the future demand for occupational safety- and health-related workers. This chapter begins with a description of the existing sources of supply, and goes on to present a forecast of the annual number of occupational safety and health trained workers who will probably enter the work force to fill one of the job slots forecast to be demanded in Chapter II. The information presented will serve as a guide to education, government, and industry officials in their quest to provide and maintain an adequately trained occupational safety and health work force of sufficient size and skill to satisfy the demand for occupational safety- and health-related personnel through time.

B. SOURCES OF THE SUPPLY OF OCCUPATIONAL SAFETY AND HEALTH PERSONNEL

The principal suppliers of trained occupational safety and health personnel (trained, as used herein, refers to both institutional and on-the-job-training (OJT)) may be grouped into four broad categories:

- educational institutions;
- insurance carriers (especially loss-prevention and control carriers);
- government (through various academies such as the National Mine Health and Safety Academy and the OSHA Training Institute); and,
- industry (via formal or informal OJT programs).

The difficulties in quantifying the nature and magnitude of occupational safety and health personnel produced by each of these sources involve the same classification problems (described in Chapter I) encountered in surveying the demand side of the market.

C. EDUCATIONAL INSTITUTIONS

According to the NIOSH Division of Training and Manpower Development, there are an estimated 80 baccalaureate and graduate safety and health programs in the country and 32 degree or certificate programs at the associate degree level.* Each of these institutions was contacted and was requested to furnish the number of occupational safety and health graduates produced annually since 1970.** In addition, each institution was requested to project the number of graduates anticipated in their existing or proposed occupational safety and health degree programs for the years 1980, 1985, and 1990.

Responses were received from 67 of those educational institutions offering baccalaureate and graduate degrees and from 21 of the associate degree institutions. These data provide a fairly accurate indication of the nature and magnitude of this source of occupational safety and health manpower supply. The responses were classified among the following categories:

- Baccalaureate/Graduate Degree in Occupational Safety.
- Baccalaureate/Graduate Degree in Occupational Safety and Health (perhaps analogous to the "general" basic area).
- Baccalaureate/Graduate Degree in Industrial Hygiene.
- Baccalaureate/Graduate Degree in Occupational Medicine or Nursing.
- Associate Degree in Occupational Safety and Health.

These categories correspond to those identified in the NIOSH catalogues* (referred to above). Comparisons between the forecast demand for occupational safety and health job roles (presented in Chapter II) and the supply data (presented under the above categories) may not interface exactly. However, such comparisons may provide useful approximations that could help to determine those activity areas for which too few, or too many, related-degree graduates are being produced. In this way, potential shortages or surpluses of occupational safety and health graduates might be forestalled.

The historical data concerning the number of degrees awarded annually from the 51 percent of all schools offering occupational safety and health programs which responded to the questionnaire are presented on Tables 25 through 30.

Certificate programs (not presented on Table 25) account for an additional 103 awards in 1977. The total number of occupational safety and health program graduates, from the 67 schools responding to the survey, has increased from 144 in 1970 to 684 in 1976, or a 375 percent increase in

*_Undergraduate and Graduate Degree Programs in Occupational Safety and Health, 1977._ National Institute for Occupational Safety and Health, Division of Training and Manpower Development, Washington, D.C., 1977; and,

Associate Degree Programs in Occupational Safety and Health, 1977. National Institute for Occupational Safety and Health, Division of Training and Manpower Development, Washington, D.C., 1977.

**Initial contacts were made via a mail survey; each contact was followed by telephone to verify the information and minimize non-responses. This followup effort was made by Mr. William Weis, Manpower Officer, NIOSH.

6 years. It is precisely this rapid, and in some respects government-generated, growth in the supply of occupational safety and health personnel that prompted NIOSH to authorize and fund this nationwide survey and to develop the forecasts of demand presented in this report.

Table 25: Total occupational safety and health degrees awarded by responding institutions, 1977.

Program Classification	Number of Degrees
Occupational Safety	367
Occupational Safety and Health	173
Industrial Hygiene	182
Occupational Medicine/Nursing	26
Associate Degree	208
Total	956

Table 26: Degrees awarded annually in occupational safety, 1970–1976.

Degree	1970	1971	1972	1973	1974	1975	1976
B.S., B.A.	20	20	61	69	95	130	185
M.A.							4
M.S.	30	63	35	51	61	75	168
Ph.D.	0	4	3	4	4	3	1
Other	8	12	6	2	5	3	12
Total	58	99	105	126	165	211	370

Table 27: Degrees awarded annually in occupational safety and health, 1970–1976.

Degree	1970	1971	1972	1973	1974	1975	1976
B.S.					11	10	19
M.S.	3	2	2	1	1	1	5
Ph.D.	1	2	1				
Other							
Total	4	4	3	1	12	11	24

Table 28: Degrees awarded annually in industrial hygiene, 1970–1976.

Degree	1970	1971	1972	1973	1974	1975	1976
B.S., B.A.	5	18	54	47	44	77	61
M.S.	47	24	56	80	59	78	80
Ph.D.	22	26	32	42	34	53	38
M.A.	0	1	1	6	3	6	4
Other	6	5	16	15	14	14	12
Total	80	74	159	190	154	228	195

Table 29: Degrees awarded annually in occupational medicine and nursing, 1970–1976.

Degree	1970	1971	1972	1973	1974	1975	1976
M.S.					1	2	
Ph.D.							
Dr. P.H.							
Residency	2	2	3		6	6	7
M.P.H.				2	6	4	
Total	2	2	3	2	13	12	7

Table 30: Associate degrees awarded annually in occupational safety and health, 1970–1976.

Degree	1970	1971	1972	1973	1974	1975	1976
A.A.						4	4
A.A.S.						13	12
A.S.					3	36	72
Certification				11	2	1	103
Total				11	5	54	191

The responding institutions' estimates of future graduate production are presented on Tables 32 through 37 and are summarized on Table 31 below:

Table 31: Forecast of occupational safety- and health-related degrees for sampled institutions (1977, 1980, 1985, and 1990).

Program Classification	1977	1980	1985	1990
Occupational Safety	367	540	709	776
Occupational Safety and Health	173	335	421	477
Industrial Hygiene	182	290	397	454
Occupational Medicine	17	47	67	71
Occupational Nursing	9	38	59	63
Associate Degrees	208	188	250	317
Total	956	1,438	1,903	2,158

These forecasts reflect dramatic continuing expansion of the production of occupational safety- and health-related graduates. The responding educational institutions are apparently gearing up to produce an additional 1,200 occupational safety- and health-related graduates per year by 1990. This means that annual awarded occupational safety and health degrees will have increased 126 percent from 1977 to 1990; should those estimates be reached, there will have been a staggering 1,400 percent increase between 1970 and 1990.

Table 32: Anticipated annual degrees to be awarded in occupational safety (1977, 1980, 1985, and 1990).

Year	B.A., B.S.	M.S.	Ph.D.	Ed.D.	Total
1977	223	139	3	2	367
1980	305	226	6	3	540
1985	402	297	7	3	709
1990	445	318	10	3	776

D. INSURANCE CARRIERS

The major loss prevention and control carriers have long served as a training source for the nation's safety and health personnel. Several of the largest carriers maintain extensive training facilities that, when coupled with OJT field work, provide an excellent educational/career ladder for employees entering the occupational safety and health field. Although there has not been any census of the number of new hires employed and trained annually by these carriers, some industry officials have estimated that fully 50 percent of all new entrants hired by the loss prevention carriers are trained internally. According to the national survey results, loss prevention carriers hired an estimated 530 occupational safety and health-related personnel in 1977. If the above estimate of internal training

Table 33: Anticipated annual degrees to be awarded in occupational safety and health programs.

Year	B.S.	M.S.	Ph.D.	Total
1977	83	84	6	173
1980	191	130	14	335
1985	230	174	17	421
1990	245	210	22	477

Table 34: Anticipated annual degrees to be awarded in industrial hygiene.

Year	B.S.	M.S.	Ph.D.	Total
1977	23	147	12	182
1980	41	231	18	290
1985	90	281	26	397
1990	115	310	29	454

Table 35: Anticipated annual degrees to be awarded in occupational medicine.

Year	M.S.	Dr. P.H.	Residency	Total
1977	0	4	13	17
1980	1	6	40	47
1985	3	9	55	67
1990	5	12	54	71

Table 36: Anticipated annual degrees to be awarded in occupational nursing.

Year	M.S.	Ph.D.	M.P.H.	Nursing	Total
1977	0	0	2	7	9
1980	7	0	3	28	38
1985	19	2	8	30	59
1990	20	3	8	32	63

Table 37: Anticipated annual associate degrees to be awarded in occupational safety and health.

Year	A.A.S.	A.S.	Certification	Total
1977	20	103	85	208
1980	54	90	68	212
1985	45	95	80	250
1990	55	120	107	317

is accurate, the insurance industry hired roughly 265 employees who did not have a prior background in occupational safety and health activities. The status quo forecast of new hires by loss prevention carriers is presented on Table 38.

Table 38: Status quo forecast of annual new hires by loss prevention carriers.

Basic Area	1977	1980	1985	1990
Safety	270	270	160	160
Industrial Hygiene	10	10	10	10
Fire Protection	50	50	30	30
General	200	200	120	120
Total	530	530	320	320

Source: Nationwide occupational safety and health manpower survey, 1977.

Making the assumed internal training adjustment of 50 percent would result in diminishing the figures on Table 38 by half and would indicate that only the remaining new hires will require external occupational safety and health training resources.

E. FEDERAL GOVERNMENT

The federal government supports two residential academies that provide safety and health training, principally to federal employees:

- The National Mine Health and Safety Academy, located in Beckley, West Virginia. This academy trains all new mining inspectors and has been producing between 200 and 250 graduates per year. Officials at the Academy are forecasting the same level of production into the foreseeable future.

- The OSHA Training Institute, located in Rosemont, Illinois. The Institute provides continuing education courses in a number of safety and health-related areas to federal and state compliance officers and to other federal employees on a special program basis. Most of the training focuses on upgrading existing skills that are related to the inspection activities required of compliance officers. Therefore, although the Institute trained 1,226 federal employees in 1976, virtually all these trainees entered with prior backgrounds in safety and health. Hence, the Institute must be viewed as a provider of continuing education and not as a source of primary supply.

Although there are other occupational safety and health-related training programs (including those provided by NIOSH's Division of Training and Manpower Development) in both federal and state government, they principally provide continuing education to upgrade or expand existing skills of occupational safety and health personnel throughout the public and private sectors. Therefore, only those graduates in the National Mine Health and Safety Academy should be included in the primary supply of safety and health personnel.

F. INDUSTRY

It is impossible to assess the number of formal and informal occupational safety- and health-related training programs currently being carried on by private firms, based on existing information. Obviously, before 1970, industry had been filling its demanded safety and health slots largely through upgrading existing employees with OJT. Since that time, there has been a shift toward greater reliance on educational institutions to provide trained personnel for industry's occupational safety and health requirements. This point is well documented in the data presented on Table 26 through 30. This trend should continue, and in fact, the forecast production of graduates (reflected on Tables 32 through 37) indicates that educational institutions are counting on it to continue. It appears that reliance on internal occupational safety and health training in the private sector is diminishing and will continue to do so. In the future, such OJT activity will be relied on primarily to fill unplanned gaps or to overcome short-run shortages.

G. A SUMMARY OF THE EXISTING AND FORECAST SUPPLY OF OCCUPATIONAL SAFETY AND HEALTH PERSONNEL

A summary of the existing and forecast annual supply of occupational safety- and health-related personnel is presented on Table 39.

Table 39: Summary of the existing and forecast annual supply of occupational safety- and health-related personnel.

Basic Area	1977	1980	1985	1990
Safety	730	900	1,020	1,080
Radiation		Insufficient Data		
Industrial Hygiene	190	300	400	460
Fire Protection		Insufficient Data		
General	270	440	480	510
Physician	17	47	67	71
Nurse	9	38	59	63
Associate Degree Level	210	190	250	320
Total	1,426	1,915	2,276	2,504

Note that in the areas of radiation and fire protection, data were insufficient to estimate the supply. The results of this survey cannot accurately predict an under supply or oversupply of occupational safety and health personnel by 1990. What can be said at this time is: 1) demand exceeds supply for safety personnel, occupational health nurses, occupational health physicians and occupational safety and health generalists, and 2) demand equals supply for industrial hygienists. With this information, we now recommend:

1. Determine OS&H attrition rates and compute demand.
2. Monitor supply from universities and government training programs annually or bi-annually and publish results.
3. Modify training project and ERC grant programs accordingly.

CHAPTER IV
ORGANIZATIONAL CHARACTERISTICS

A. INTRODUCTION

A concluding product of the survey provides information concerning the occupational safety and health programs of the organizations and firms surveyed. Information was collected regarding several safety and health program components, including:

- Participation of nonoccupational safety and health management in occupational safety and health training.
- Frequency of occupational safety and health training.
- Sources of occupational safety and health services.
- Presence of safety committees.
- Impact of the Occupational Safety and Health Act on hiring.

A summary of the responses to the questions concerning these components, summarized in Tables 40–45, provides an informative profile of safety and health program characteristics.

B. PARTICIPATION OF NONOCCUPATIONAL SAFETY AND HEALTH MANAGEMENT IN OCCUPATIONAL SAFETY AND HEALTH TRAINING

All respondents (except government agencies and insurance carriers) were asked the following question:

- Do management personnel not specializing in safety and health activities receive any training in occupational safety and health?

  ( ) Yes　　　　( ) No　　　　( ) Don't Know

The percentage distribution of the responses to this question are presented on Table 40. Note that almost two-thirds of all the respondents indicated such training programs for nonoccupational safety and health management personnel. Furthermore, there is little divergence between SIC's in the affirmative responses, indicating that this practice is fairly prevalent throughout all industries. However, nonoccupational safety and health management training is somewhat more widespread in larger firms and organizations.

Table 40: Percentage of firms providing occupational safety- and health-related training to non-occupational safety and health management.

Industry	Employment Size 100 to 499	Employment Size 500 and Above	Total
Mining	67.9%	80.0%	69.6%
Construction	67.1	81.8	67.8
Manufacturing	61.7	78.9	64.5
Transportation Communication, and Utilities	64.6	85.6	68.0
Trades and Services	---	61.7	61.7
Total	62.6%	72.9%	65.0%

Source: Nationwide occupational safety and health manpower survey, 1977.

C. FREQUENCY OF OCCUPATIONAL SAFETY AND HEALTH TRAINING

A second training-related response dealt with the frequency of occupational safety and health training. Specifically, organizations were asked:

- How frequently is safety and health training provided to workers? Check all that most closely apply.

( ) Orientation or Introductory Training
( ) Weekly
( ) Monthly
( ) Quarterly
( ) Yearly
( ) No Training

The distribution responses to the question are presented in Table 41.

Table 41: Frequency of occupational safety- and health-related training by industry.

Industry	Percent of Firms Offering Training: Orientation	Weekly	Monthly	Quarterly	Yearly	None
Mining	56.5%	22.2%	41.5%	17.1%	24.2%	6.1%
Construction	38.9	44.6	26.8	13.8	14.5	8.1
Manufacturing	59.7	8.8	35.0	12.3	11.9	13.0
Transportation Communication and Utilities	49.7	19.2	44.7	15.6	15.9	9.8
Trades and Services	63.6	4.5	28.6	18.6	15.7	14.1
Total	57.3%	12.6%	35.0%	13.4%	13.9%	12.2%

Source: Nationwide occupational safety and health manpower survey, 1977.

Comparing the industry responses, several interesting patterns of training emerge. For example, those organizations providing relatively less orientation usually compensate by providing more extensive weekly or monthly occupational safety and health training sessions. However, it is somewhat disturbing to find that over 12 percent of those firms contacted provided no occupational safety and health training.

D. SOURCES OF OCCUPATIONAL SAFETY AND HEALTH SERVICES

To assess the use of various government, private, and professional organizations as occupational safety and health resources, respondents were asked to identify the sources of their occupational safety- and health-related services:

- From which of the following types of organizations does this organization use occupational safety- and health-related services (inspection, training, advice, medical services)?

( ) Insurance Carriers
( ) Government Agencies
( ) Medical Personnel or Clinics
( ) Parent Company or Division of Your Organization
( ) Private Consultants
( ) Trade Organizations
( ) Professional Societies
( ) National or State Safety Councils
( ) None of the above

Table 42 indicates the percentage of respondents, by industry, using these resources. Once again, all industries generally responded along the same lines. The resource most used by all industrial sectors is that of insurance carrier, which provided services to 78.4 percent of the firms. Safety councils, parent companies or divisions within an organization, and government agencies were used by roughly 40 percent of the firms. Medical personnel or clinics provided services to 25 percent of the respondents: trade organizations, professional societies, and private consultants were involved with 20 percent or less of the sampled organizations.

Table 42: Sources of occupational safety- and health-related services

Source	Mining	Construction	Manufacturing	Transpor. Commun. Utilities	Trades Services	Total
Insurance Carrier	69.7%	84.5%	80.8%	64.7%	72.1%	78.4%
Government Agencies	41.4	31.7	32.0	31.3	49.4	33.6
Medical Personnel	26.2	11.8	27.5	21.0	28.6	25.7
Parent Company	49.5	17.5	42.1	41.5	18.2	38.2
Private Consultants	14.1	8.6	14.8	9.0	15.2	13.7
Trade Organization	26.2	44.6	18.6	24.1	13.0	20.8
Professional Societies	26.2	17.2	16.6	16.2	26.8	17.7
Safety Councils	38.2	35.2	41.4	54.2	50.2	43.0
Other	2.8	4.3	5.0	4.5	4.3	4.3

Source: Nationwide occupational safety and health manpower survey, 1977.

E. PRESENCE OF A SAFETY COMMITTEE

Another indication of the breadth of occupational safety and health activities within a firm is the presence or absence of a safety committee; therefore, the following question was posed to all respondents:

- Is there a safety committee in this organization?

( ) Yes ( ) No ( ) Don't Know

The responses (Table 43) indicate that a vast majority (82%) of organizations do have safety committees. Only in the construction industry does the figure fall below 60 percent. This is probably due to the fluid work site and union hall hiring practices that mitigate the chances of establishing a stable safety committee for construction firms. Overall, only 18 percent of the sampled firms did not have a safety committee. As expected, the incidence of a safety committee was higher in larger firms (with the somewhat perplexing exception of mining).

Table 43: Presence of a safety committee.

	Employment Size		
Industry	100–499	500 and Above	Total
Mining	71.4%	60.0%	69.7%
Construction	52.6	63.6	53.2
Manufacturing	84.4	93.5	86.2
Transportation, Communication, and Utilities	72.6	85.6	74.7
Trades and Services	---	84.4	84.4
Total	80.1	88.5	82.0

F. IMPACT OF THE OCCUPATIONAL SAFETY AND HEALTH ACT ON HIRING

Integral to forecasting the future level of occupational safety and health employment is an assessment of the motivation or rationale that U.S. industry has for hiring occupational safety and health employees. Passage of the Occupational Safety and Health Act provided a potential stimulus for firms to hire additional occupational safety and health personnel. To test this hypothesis, the following question was posed:

- Have the requirements of the Occupational Safety and Health Act resulted in this organization hiring or contracting with additional occupational safety and health personnel?

( ) Yes ( ) No ( ) Don't Know

Table 44 displays the responses. It appears that a large majority of employers (except in mining, which is actually covered by MSHA) view OSHA as having no significant impact on their demand for occupational safety and health personnel; only 23.2 percent of the firms indicated that OSHA was in some way responsible for their organization hiring additional occupational safety and health employees. It is interesting to note the relative consistency in attitude among the various industries towards the perceived impact of OSHA requirements on hiring and contracting with additional occupational safety and health personnel. Also note that, without exception, larger firms have a higher number of affirmative responses to this question than do the smaller organizations.

Table 44: Percent of firms indicating that OSHA impacted on their occupational safety and health hiring level.

Industry	100–499	500 and Above	Total
Mining	35.7%	53.3%	38.3%
Construction	23.9	36.4	24.5
Manufacturing	20.5	38.5	23.5
Transportation Communication and Utilities	13.4	36.0	17.1
Trades and Services	---	23.9	23.9
Total	20.4%	32.9%	23.2%

G. OCCUPATIONAL SAFETY AND HEALTH INSPECTION ACTIVITY

A final question pertaining to the occupational safety and health characteristics of the sample firms regarded the presence of occupational safety- and health-related state or federal inspection activity:

- In the last year, has this organization been inspected by a state or federal occupational safety and health agency?

  ( ) Yes ( ) No ( ) Don't Know

The distribution of responses to this question (Table 45) follows closely the emphasis in recent OSHA inspection activity. Almost 75 percent of the construction firms indicated they had been inspected; less than 36 percent of the trades and services organizations answered yes to this question. Larger and smaller firms indicated virtually the same number of occupational safety- and health-related inspection.

Table 45: Percent of firms indicating they had been inspected during the last year.

Industry	Firm Size		Total
	100–499	500 and Above	
Mining	50.0	66.7	52.5
Construction	72.9	93.9	74.0
Manufacturing	56.6	66.9	58.3
Transportation, Communication, and Utilities	45.9	63.1	48.7
Trades and Services	---	36.0	36.0
Total	56.8	55.3	56.5

H. SUMMARY AND CONCLUSIONS

In summary, most firms and organizations have fairly formalized occupational and health-related training programs. Although the quality of these efforts were not a focus of this study, the mere presence of scheduled training/safety committees and the emphasis on training management indicates significant commitment to at least attempting to incorporate an adequate safety and health program. In addition, the strong reliance on insurance carriers and safety councils further lends emphasis to that commitment. Clearly firms are indicating, in their response to the impact of the Occupational Safety and Health Act, that they are committed to providing a safe and healthful work place regardless of the pressures of state and federal government. It is hard to believe,however, that without the current incidence of inspection (over half being inspected within the last year) recent improvements in safety and health programs would have occurred.

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☆ U.S. GOVERNMENT PRINTING OFFICE: 1978— 757-141/1842

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