4216

U.S. Department of Commerce
National Technical Information Service

PB89-190342

NATIONAL AND CROSS NATIONAL STUDY OF LTC (LONG TERM-CARE) POPULATIONS

HEALTH CARE FINANCING ADMINISTRATION
BALTIMORE, MD

DEC 88

4216

Draft

A NATIONAL AND CROSS-NATIONAL STUDY OF LTC POPULATIONS

by Kenneth G. Manton, Principal Investigator,
Max A. Woodbury, and Eric Stallard

Federal Project Officer: Herbert A. Silverman

Center for Demographic Studies
Duke University

HCFA Cooperative Agreement No. l&C-98641/4-03

December 1988

ACKNOWLEDGEMENTS

The investigators wish to acknowledge the fiscal support of HCFA for the research activities described herein and for the helpful comments and guidance of the HCFA project officer, Dr. Herbert A. Silverman, and other members of the HCFA Office of Research staff.

CONTENTS

List of Tables

A NATIONAL AND CROSS-NATIONAL STUDY OF LTC POPULATIONS

EXECUTIVE SUMMARY

I. Study Objectives

The demand for all types of long term care **(LTC)** services is expected to increase rapidly because of the projected rapid growth of the U.S. elderly population. By 1995, for example, the number of elderly **(65+)** persons in the U.S. is expected to increase 23 percent **from** 28.4 million persons (in 1984) to 34.7 million. The population aged 85 years and over (the "oldest-old") is expected to experience even more rapid growth--from 2.9 million in 1984 to 4.5 million persons in 1995. The growth of **the** oldest-old population is of particular to concern to policy makers since it is projected to consume the largest amount of federal benefits by the year 2000 **(Torrey,** 1984).

Currently, the bulk of publicly financed LTC service used by the elderly is provided by the Medicaid and Medicare programs in the form of reimbursement for nursing home and home health services. Other programs providing social, housing or nutritional services for the elderly are funded through Title III of the Older Americans Act, Title XX of the Social Security Act (Social Service Block Grants), the Veterans Administration, and a patchwork of state-sponsored programs. Coordination of these services has been studied under the National Channeling and other LTC demonstration projects.

Unfortunately, factors increasing the demand for LTC services, such as the unprecedented growth of the elderly population, and factors constraining the availability of both formal and informal services such as reductions in family size, as well as constraints on the future construction of nursing home beds, may adversely affect the potential to provide adequate levels of LTC services to meet the expected increased demand. This imbalance between future demand and supply of LTC services will require formulation of alternative service strategies and reimbursement policies to successfully meet the anticipated future **demand** for services.

To plan these alternative strategies for providing adequate **future** levels of LTC services one needs a comprehensive model to predict the nature and amount of LTC service needs required at different future points in time. To implement such a comprehensive model one needs both to develop adequate methodology for such a model and to analyze a wide range of data in order to determine the actual conditions and mechanisms affecting changes in demand for services and the ability of different sources of LTC services to meet different types of demand.

Thus, the primary objectives of this project were two-fold: **first,** to assess the size, characteristics and future growth of the elderly LTC population in the United States and a number of other countries; second, development of forecasting and simulation models that utilized this input in or&r to develop policy planning and evaluation tools. In addition we also analyzed a number of basic policy issues such as utilization of Medicare home health services and its reimbursement, the impact of PPS on temporal trends in hospital readmissions and mortality, recalibration of underwriting factors of the AAPCC, and studies of Medicaid spenddown on **the** use of nursing homes. We are also currently providing technical consultation on the 1982-1984 National Long Term Care Surveys public use tape and documentation. These objectives were addressed using the following research plan:

A. <u>Multivariate Analysis of the 1982 National Long Term Care Survey (NLTCS)</u>

The level and type of functional impairments, medical conditions and the LTC services and social context that support the disabled elderly in the community were assessed using multivariate procedures. These analyses were carried out using Grade of Membership (GOM) modeling techniques applied to both cross-sectional health and longitudinal service use data from the 1982 NLTCS. From that survey 56 Activities of Daily Living (ADL)[1], Instrumental Activities of Daily Living (IADL)[1], IADL2[1] and medical condition variables were analyzed (after analyses of much larger groups of variables) to identify subgroups characterized by differentials in health and functional status in the community resident LTC population. The association of formal and informal care service use with the subgroups was examined.

B. Cross-Sectional and Longitudinal Analyses of the National Long Term Care Survey

Cross-sectional multivariate analyses of the 1982 and 1984 NLTCS was conducted to determine if the profiles of the health and functional attributes that identified the subgroups of the noninstitutionalized LTC population had changed over that time period or if subgroup frequencies in the population had changed. A longitudinal GOM analysis of data on persons observed in both the 1982 and 1984 surveys was performed to assess changes in the profiles of disability, medical, and other attributes for individuals and the association of the multivariate profiles identified in 1982 with the risk of institutionalization or death in the period between the two surveys. In addition, life table analyses of different types of Medicare Part A service use were conducted for each of the subgroups found in the GOM analyses.

C. Projections and Forecasts

Projections and forecasting of the LTC population by sex, age, marital status, disability level and type over the period 1980 to 2040 were ma& to quantify the growth of *need* for LTC services. In addition to providing baseline projections utilizing the middle variant of the population projections produced by the Social Security Actuaries a number of simulation exercises and sensitivity analyses, involving alternative assumptions about the rate of growth of the national supply of institutional beds and about changes in future morbidity, mortality and disability rates were conducted. Outcome measures projected included the number of disabled persons, the number of informal caregivers needed to maintain current levels of informal care, the number of hours of informal care delivered and the need for different types of medical and LTC manpower.

D. Analysis of the International Variation of LTC Service Needs

Cross-sectional analysis of disability patterns in the community-based elderly populations was done in a number of developed and developing countries in order to (a) describe international patterns in the need for and delivery of LTC services, and (b) contrast the current pattern of LTC services used in the U.S. with service use patterns in other countries. The analyses employed the cross-sectional GOM statistical methods used in the studies of the 1982-1984 NLTCS applied to a number of national surveys of health and functioning among the elderly.

[1] ADL, IADL. and IADL2 describe different functions that a "normal" individual is expected to be able to carry out. ADLs, for example, involve such self-care activities as eating, bathing, dressing, toileting and mobility (e.g., getting in/our of bed; getting around inside). There are different ways that limitations in these functions can be ascertained depending upon the questions used. We have tended to use six very basic ADLs described by Katz and Akpom(1976) that tend to form a hierarchy of intensity of functional loss. IADLs represent a series of probability higher order functions requiring skills necessary for daily living, e.g., doing laundry, cooking, grocery shopping. They also involve activities that measure cognitive level, e.g., telephoning, taking medication, managing money. Being more complex functions they may represent limitations beyond those of the physical capacity to carry out activities, e.g., cooking may depend upon skills more commonly learned by women. The IADL2s represent the capacity to carry out basic physical actions, e.g., climbing stirs, holding, reaching, grasping. Thus, each of the three sets of functional measures relates to somewhat different dimensions of functional capacity.

E. Health Need and Service Utilization Profiles

We produced profiles of healthaeeds and service utilization among the elderly populations of a number of countries and analyzed them using life table models of the interrelation of mortality, disability, and mortality. These **procedures** were used to control for differences in the exposure of each of the functional and health status subgroups to different types of service use.

II. Data

A wide range of data was employed in these analyses.

A. The 1982 and 1984 National **Long** Term Care **Surveys**

The 1982 and 1984 National Long Term Care Surveys were designed to provide a longitudinal, nationally representative database describing the chronically disabled, elderly population residing in the community. The surveys covered five major areas of interest in that population, namely, (1) medical status, (2) functional status, (3) income and assets, (4) use of heath care services and sources of payment, and (5) housing and living arrangements.

1. The 1982 National Lone Term **Survey**

A core sample of 35,789 persons was drawn from the Medicate Health Insurance Skeleton Eligibility Write Off file. These records were selected by drawing "reduction sets" from a master sample of 55,000 records. The reduction sets were drawn and screened until 6,393 candidates for the detailed community survey were identified who required (or were expected to require) assistance with **ADLs** or **IADLs** for a period of three months or longer. Survey work began in June, 1982 and continued to October and produced 6,088 household interviews from the original group of 6,393. The detailed survey administered was divided into seven sections: (1) functional status (covering medical conditions, **disabilities,and** caregivers), (2) other functioning (covering mental and emotional status, social contacts and activities), (3) housing and neighborhood characteristics, (4) health insurance (covering type of public or private assistance/insurance plan and coverage provided), (5) medical providers and prescription medicine, (6) cognitive functioning, and (7) military service, **ethnicity,** income and assets. Although no interviews of institutionalized persons were conducted, a set of 1,992 such persons was identified from the screening interview.

A survey of informal caregivers was also administered to those providing care to the sample person **(N=1,626),** and a similarly structured survey was given to 299 persons who had stopped giving care.

2. **The 1984 National Long Term Care Survey**

Follow-up of the 1982 survey population was conducted in 1984 to determine factors contributing to or inhibiting change in functional and health status and institutionalization. This follow-up had both longitudinal and cross-sectional components, and included persons alive in 1984 who (1) had functional limitations and were eligible for the 1982 questionnaire **(N=5,010);** (2) were institutionalized and thus not eligible for the 1982 questionnaire (N= 1,182); (3) were screened, but not eligible for the 1982 questionnaire **(N=11,130),** or (4) attained age 65 since the 1982 survey **(N=4,860).**

Persons in the first two groups were automatically **administered** a detailed household questionnaire, and persons in the latter two groups were screened for functional limitations with persons reporting chronic ADL or IADL impairments receiving a detailed questionnaire. The total number of detailed interviews administered of all types was approximately 10,000. Three types of survey instruments were used in addition to the screener and control card. The first was the detailed community questionnaire-(administered to 5,934 subjects)--similar to the instrument administered to the 6,088 subjects interviewed in 1982. The second questionnaire inquired about persons who died between the survey dates. This instrument was unique to the 1984 survey arid was administered to 2,475 subjects' next-of-kin. The instrument covered health care, payment, caregiver and sociodemographic information. The third was an institutional questionnaire (administered to 1,690 subjects)--covering institutionalized persons' cognitive functioning, ADL limitations, admission to and payment. for nursing home services, and information on the institution itself (e.g., number of certified beds, Medicare and Medicaid certifications).

3.) Linkage of the 1982 and 1984 Surveys to Medicare Files

In addition to the survey records, all individuals in the 1982 cross-sectional sample were linked to Medicare Part A (and Part B records for Home Health services) records for the period 1978 to 1985. All persons in the 1982-1984 longitudinal file were linked to Medicare Part A records from 1980 to 1987 and to Medicare Part B records from 1984 to 1987. These record linkages provide a wide range of detailed service data on the federally reimbursed acute and post-acute medical care usage of the surveyed population.

B. International Datasets

1. Indonesian Disability Survey

During 1976-77, a survey focusing on disability, impairments, and handicaps was carried out by the Institute of Health Research and Development, Department of Health in Jakarta with technical support and financial backing from the World Health Organization. A sample of 4,604 households in 14 provinces from Sumatra, Java and Bali was selected, divided into a rural and urban domain. From the 4,604 households, information from 22,468 persons of all ages was obtained

The list of impairments, disabilities and handicaps used in the study was derived from a early draft of the World Health Organization Classification of Impairments, Disabilities, and Handicaps which was published in 1980 three years after the survey's completion. Disabilities and handicaps were selected to represent conditions common in Indonesian daily life, as were questions on socioeconomic status, education, occupation, welfare, and medical facilities. Questionnaires were administered by approximately 70 local physicians who had completed a special 2-week training course.

2. The Republic of Korea, Philippines, Malaysia, Fiji

In 1984, the World Health Organization carried out surveys of the elderly population of four countries in the Western Pacific Region: The Republic of Korea, Philippines, Malaysia, and Fiji. The surveys were administered to 3,504 persons and are representative of the population in selected areas for persons aged 60 years and over, by sex, and urban/rural status. Specific information was collected on health status, ADL and IADL limitations, health service use, living arrangements, and informal and social support

C. Other U.S. Data Sets

Though the 1982 and 1984 NLTCS provided most of the information for our analyses, use was also made of several other U.S. data sets. In particular, since the non-disabled population was not interviewed in the NLTCS use was made of the 1984 Supplement on Aging (SOA) (and its 1986 longitudinal follow-up, LSOA) survey to develop measures of the prevalence of medical problems among non-chronically disabled persons. Use was also ma& of both the 1977 and 1985 National Nursing Home Survey (NNHS) to provide detailed estimates of the current utilization of nursing homes for our projection and simulation models. Finally, a variety of series of the official estimates and projections of the Social Security and Medicare beneficiary population produced by the Social Security actuaries to estimate the current and future liabilities of the Social Security trust fund were utilized. The Census Bureau projections differ somewhat in detail from the Social Security Actuary projections but utilize many of their basic assumptions about such factors as mortality. Also the Census Bureau base and the Social Security base differ in that the Social Security projections are developed specifically for the trust funds. Given our interest in the Medicare eligible population, the SSA projections seemed to be the most appropriate projections to use.

III. **Methodology**

A major aspect of this study was the development of statistical methodologies appropriate to the special types of data to be analyzed. In particular, there has been little development of event history models to deal with the new type of data (i.e., surveys with complex sample designs of a nationally representative longitudinally followed population where health and functional status changes were described in terms of a large number of discrete response variables with survey records linked to continuous medical service use files) produced by the 1982 and 1984 NLTCS and its Medicare file linkages. Thus, major efforts were required to develop new statistical procedures to deal with this highly multivariate, multiple episode event history data generated from complex sample surveys. These newly developed analytic procedures were employed in the analyses undertaken in the research project. In this section, we will briefly describe each methodology and provide an overview of its range of application. Detailed discussions of these methodological techniques (including mathematical derivations) can be found in the Final Report.

A. <u>Transition Rates. Transition Probabilities. and Other Types of Probabilities</u>

Transition rates were estimated for the two-year transitions between 1982 and 1984. Of most interest were functional status changes a.) for the community population from the nondisabled to disabled states (specific to functional level) and from different disability states to other disability states (or nondisabled), b.) from community residence (either disabled or not) to institutions, c.) from institutional status to community status (specific to functional state), and d.) from all of the above states to death. These transitions were calculated for the total population and for sex, age, and morbidity status subgroups.

A critical methodological issue in these calculations was the determination of the appropriate sample weights. On the public use file the Census Bureau provided "longitudinal" sample weights which allow one to examine the 1982 status of persons who were surveyed in 1984. Thus, these are, in effect, "retrospective" because certain 1982 "non-response" groups were given "zero" sample weights. In order to calculate prospective weights (i.e., to determine transition rates for the 1982 population to their 1984 status), a new set of weights had to be calculated based on all persons in the 1982 sample who were <u>eligible</u> to be part of the 1984 sample. These new weights were then used in the transition analyses. In addition a series of judgements had to be made on how to resolve slight difference in procedures between the 1982 and 1984 surveys. For example, not all persons interviewed in 1982 were screened (i.e., persons in institutions or who were disabled in 1982 automatically were interviewed). Thus, judgements had to be made on how to derive the most comparable 1984 disabled population. A second issue involved differences in the way institutional status was determined in 1982 and 1984. In 1982, since no interviewing was done in institutions, only residence in a specific type of facility was ascertained. In 1984, in contrast, disability status was ascertained for persons in institutions. In addition, institutional status, as defined in the survey, is defined more broadly than in the NNHS. Hence, care had to be taken in developing as comparable-a set of definitions as possible appropriate to the specific analysis being conducted (e.g., cross-temporal comparisons of the 1982 and 1984 NLTCS; comparisons of the 1984 NLTCS and the 1985 NNHS).

B. The Grade of Membershin Model

The Grade of Membership model is a multivariate event history analytic strategy based on a "fuzzy set" classification procedure. This procedure can be utilized to identify subpopulations or "pure types" within a dataset that have similar physiological characteristics, similar demographic attributes, and similar responses to physical measurements as they relate to morbidity and disability. The mathematical development of this technique has been described previously (Woodbury et al., 1978; Woodbury and Manton, 1982), and has been successfully applied to several longitudinal data sets.

The Grade of Membership analysis is performed to describe subpopulations in terms of two types of parameters. The first represents the probabilities that persons in a given subpopulation have a particular attribute or quality. The second type of parameter represents how well individuals are described by each of the typical characteristics of the analytically defined subpopulations. Hence, they represent individual differences not captured by the multivariate descriptions of the subpopulations.

Two types of applications of the Grade of Membership analysis were developed: Cross-sectional and longitudinal. In the cross-sectional analyses the attributes measured at a given point in time were evaluated. In the longitudinal analysis two types of change were analyzed. The first were changes in the health and functional status of persons. Since the health and functional status of persons was summarized by a set of individual scores, the overall change in health is represented by the change in these scores calculated for the same person at two or more points in time. A second set of calculations involved assessing differences in the probability and duration of different types of service use (e.g., hospital, SNF, home health). This is done by calculating life tables for different types of Service use (see next section) for persons with different health and functional status scores. Thus, the impact of a rich set of health and functional status measures on service use transitions could be determined.

C. Life Table Analysis

Life tables are a methodology for examining the duration dependence of various types of transitions. For example, the best known use of life tables is to describe how the risk of death changes with age. Life table methodologies can, however, be used to describe the duration dependence of other types of transitions. In the analyses conducted, life tables were calculated for both different types of health care service use and for adverse health service outcomes such as mortality or rehospitalization. By calculating life tables for changes between different types of service use, mortality and the "end of study" it is possible to make adjustments in the duration weighted measures of service use for various types of "censoring" through competing risk adjustments. Such competing risk adjustments help control bias in our estimates of the duration and intensity of service use both for competing health changes and for artifacts of the data observation plan such as limits to the length of the study or the effects of periodic reassessment. Such life table based measures were used to analyze data from the Medicare Part A service use records.

D. Projections and Forecasts. 1980-2040

Using data from the 1982 National Long Term Care Survey, we initially generated projections of the long term care population by age, sex, marital status, and disability level after the population had been adjusted for nursing home residence rates estimated from the 1977 NNHS. This produced age, sex, marital status and disability level specific projections of the noninstitutionalized elderly population for 1980, 1990, 2000, and 2040. Similar projections were performed for the institutionalized population under the assumption that the annual nursing home utilization rate increased about 2.1 percent per year. In addition to projecting the number of disabled persons we also projected the numbers of informal caregivers and the hours of care required by these disabled persons. The projections were subsequently updated with data from the 1984 NLTCS, the 1985 NNHS and with new (1987; Series 99) SSA population projections.

Both sets of projections described above assume that the current rate structure is stable through time. However, changes in health status at later ages will have significant effects on the growth of the long term care community and institutionalized populations. To represent this effect, we computed another set of projections under the assumption that disability rates will be reduced proportionally as fast as the mortality rate declines assumed in the Social Security population projections. We also produced projections where the medical condition causing the disability was identified so that projections of disability could be modified to reflect assumptions about interventions in the risks of specific chronic conditions.

In addition to the U.S. projections a number of projections were prepared for an international study sponsored by the HCFA administrator and coordinated by the HCFA Office of Legislation and Policy. In those analyses rates of disability from the 1982 National Long Term Care Survey and the 1977 National Nursing Home Survey were applied to age and sex specific population counts from U.N. estimates and projections. This was done for all 151 countries that arc member states of the U.N. Those estimates were compared with the available data from specific countries to determine international differences in the epidemiology of disability and in institutionalization policies after population structure was controlled.

IV. Selected Major Findings

A. Projections of the Growth of the U.S. LTC Population

A fundamental issue in evaluating the service needs of the elderly population is to describe changes in the distribution of functional dependency and medical problems within that population. These parameters describe the context within which privately and publicly financed systems for providing acute, post-acute and long term health care must function. It also provides the standards against which the performance of those systems to meet LTC service needs must be assessed

In order to define these basic parameters we conducted a series of projections of the size of the functionally disabled population using, initially, data from the 1982 NLTCS, the 1977 NNHS, and the 1982 SSA Office of the Actuary projections of the social security beneficiary population. We subsequently updated those projections with data from the 1984 NLTCS, the 1987 NNHS and the 1987 SSA projections.

From those data sources we estimated current disability and institutionalization rates from the NLTCS and NNHS on an age, sex, functional status, and marital status specific basis. The rates were applied to age, sex, and marital status specific population projections for 1985, 1990, 2000, 2040, and 2060. Functional status was grouped into five categories, i.e., those with no chronic disabilities, those with an impairment in one or more instrumental activities of daily living (IADL) but no impairments in activities of daily living (ADL); and those with 1 to 2, 3 to 4, or 5 to 6 impairments in ADLs. Chronicity was based upon the NLTCS definition of an impairment lasting (or being expected to last) 90 days or more. These calculations produced estimates, by age, sex and marital status, of the numbers of functionally impaired persons at each of the projected dates. Selected numbers from the updated projections, specific to age, sex and level of functional impairment, are presented in Table 1 for 1985, 2000, 2020, and 2040.

The projections dramatically show the growth of the functionally impaired population in the community. For example, the community disabled population grows by 167% (from 5.5 to 14.8 million) from 1985 to 2040. Furthermore, this growth is most rapid (328%: from 1.1 to 4.7 million) for the oldest-old and most functionally disabled populations. The institutional population also grows more rapidly. Given the high level of need for both acute and LTC health services of these functionally impaired persons, this implies a huge increase in the future need for these services that likely can be met only by a coordinated public-private response.

The primary forces driving the dramatic increase in the population requiring LTC assistance are demographic. One demographic factor in this change is the future magnitude of reductions in mortality. As mortality is reduced at later ages, the period of time that persons will live at ages with high risk of serious functional impairment will increase. Projections in mortality are, however, uncertain.

A second demographic factor is the fact that birth cohorts have grown in size. Thus, given the same probability of surviving to age 65, there were 71% more persons passing age 65 in 1985 than in 1960. The initial size of cohorts are known to a high degree of precision from the decennial census. Thus, we see in Table 1 large increases in the population aged 65+ between 2000 and 2020 (41% increase), and of the population aged 85+ between 2020 and 2040 (82% increase), a result of the large post WWII baby boom cohorts passing ages 65 and 85 in those intervals. Thus, the growth of the need for LTC services will have a very uneven tempo due to differences in the size of the birth cohorts passing age 65 at different future dates.

Given the certainty of cohort size differentials and the uncertainty of future mortality changes, we present in Table 2 two alternative sets of projections for the total population specific to age and disability level. One set represents pessimistic mortality assumptions where the rate of decline in mortality is one half that in the "medium" variant SSA projections. The second is based on optimistic mortality assumptions where mortality reductions occurred at twice the rate as in the SSA medium mortality assumption variant.

What we see is that, even under the worst-case mortality assumptions, between 1985 and 2060 there will be significant growth (163%) in the disabled and institutionalized populations due to the much larger size of the birth cohorts passing ages 65 and 85 in 2010 and 2040. Under the most favorable mortality change assumptions the increase will be 237% (i.e., from 6.8 to 23.6 million persons). This suggests that, despite uncertainty in mortality assumptions, there will be extremely large increases in the need for LTC services in the future due simply to differences in birth cohort sizes.

More sensitive to the mortality assumptions is the number of oldest-old, highly disabled and institutionalized persons. However, even these groups will increase markedly. For example, if we examine only persons aged 85+ with 5 to 6 ADL impairments or who are aged 85+ and institutionalized we see that, under the worst-case mortality assumptions, there will be an increase of 281% (i.e., from 829 thousand to 3.2 million). Since these persons will be the most frail and require the greatest amounts of LTC services this increase alone signifies a large increase in the demand for LTC services. If we consider the "best case" mortality assumptions for this same group we find an increase of 503% (i.e., from 829 thousand to 5.7 million). What this variability

TABLE 1: Projections of the U.S. Long-Term Care Population in the Community and in Institutions, hy Age, Sex, and Level of Impairment for 1985, 2000, 2020 and 2040 (in thousands)

YEAR	COMMUNITY Level Of Impairment								INSTITUTIONALIZED		TOTAL	
	IADL Only		1-2 ADL		3-4 ADL		5-6 ADL					
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
1985												
Age 65-74	337	511	228	423	127	191	131	150	80	133	902	I.409
Age 75-84	274	562	218	550	99	237	126	194	141	364	858	I.903
Age 85t	a7	194	106	302	48	133	63	172	112	481	416	1,283
TOTAL	698	1,267	551	I.275	274	562	320	517	332	97x	2.176	4,599
2000												
Age 65-74	376	534	254	445	142	201	146	163	a9	135	1,007	1.478
Age 75-84	394	753	315	719	141	312	181	262	206	463	1,237	2.509
Age 85+	142	323	166	502	78	222	106	286	167	802	659	2.135
TOTAL	912	1,610	735	1.666	361	735	433	711	463	1,401	2.904	6.122
2020												
Age 65-74	668	869	447	726	254	329	255	267	174	219	1,799	2,409
Age 75-84	500	892	397	844	181	366	232	312	253	538	1,563	2,952
Age 85+	213	450	248	699	116	309	159	399	249	1,114	985	2.971
TOTAL	1.381	2,211	I.092	2,269	551	1.004	647	977	676	1.871	4.346	8,332
2040												
Agt 65-74	666	845	442	710	254	322	252	266	187	209	1.800	2,353
Age 75-84	894	1.484	725	1.395	316	606	402	520	502	822	2,839	4,887
Age 85+	427	789	496	1,222	233	542	321	701	497	I.925	1.975	5.179
TOTAL	1,987	3.120	1,663	3,327	804	1,471	975	1,487	I.187	3,016	6.616	12,419

Totals may reflect rounding error.

Source: Tabulations of 1982 and 1984 National Long Term Care Survey, and 1985 National Nursing Home Survey

TABLE 2

Projections of the Communily-Based Disabled, Institutionalized. and Non-Disabled Elderly Population, 1985-2060, by Disability Level Measured by Activities of Daily Living (ADL) and Instrumental Activities of Daily living (IADL) (numbers in thousands)

UPPER BOUND POPULATION PROJECTION (Rapid Mortality Rate Decline Assumptions)[1]

Year	Non-Disabled[3]	Community-Based Disabled[4]					Institutionalized[5]
		IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total	
Aged 65-74							
1985	14.692	848	651	319	281	2,098	212
2000	16.114	910	701	344	312	2,267	219
2020	27,789	1539	1.187	587	545	3,857	362
2060	27,744	1,497	1,163	580	561	3,800	339
Aged 75-84							
1985	6.061	836	768	336	321	2,261	505
2000	8,618	1.173	1,052	463	455	3,143	675
2020	11.103	1,482	1,296	579	587	3,945	796
2060	18,005	2,367	2.007	901	949	6,223	1,196
Aged 85+							
1985	1.008	282	407	181	236	1,106	593
2000	1,803	500	716	321	422	1,958	1,035
2020	2,788	803	1.136	513	677	3,128	1,611
2060	8,280	2,085	2,896	1,319	1,748	8,049	3,954
Aged 65+							
1985	21,761	1,965	1,826	836	837	5,465	1,310
2000	26,535	2,583	2,468	1,128	1,189	7,368	1,929
2020	41,881	2,824	3,619	1,679	1,808	1,093	2,770
2060	52,239	5,949	6.066	2,800	3,258	18.072	5,489

TABLE 2 **(continued)**

	LOWER ROUND POPULATION **PROJECTION** (Slow **Mortality Rate Decline Assumption**)[2]						
	Non-Disabled[1]	**Community-**Based **Disabled**[4]					Institutionalized[5]
Year		**IADL** Limitation	1-2 ADL Limitations	**3-4** ADL Limitations	**5-6** ADL Limitations	Total	
				Aged **65-74**			
1985	14,692	**848**	**651**	319	281	2,098	212
2000	15,834	**909**	697	**343**	**304**	2,253	229
2020	26,359	1,538	1.164	**581**	**504**	3,786	421
2060	28.58 **1**	1.712	1.278	646	541	4,176	514
				Aged **75-84**			
1985	6,061	836	768	336	321	2,261	505
2ooo	8,148	1.117	1,012	442	430	3,002	662
2020	9,629	1317	1.181	520	508	3,537	781
2060	14506	2.002	1,830	782	762	5,376	1,256
				Aged **85+**			
1985	1,088	282	407	181	236	1.106	593
2000	1,530	430	619	277	363	1.688	**901**
2020	1,952	551	792	**354**	463	2,160	**1,153**
2060	3,887	1,085	1,559	**695**	907	4,247	2,254
				Aged **65+**			
1985	21.761	1,965	1.826	836	837	5,465	1,310
2000	25.512	2,457	2,328	1,062	1.097	6,943	**1,792**
2020	39,940	3.406	2,147	1,455	1,475	9,483	2,356
2060	46,974	4,799	4,667	2,123	2,210	13,799	4,023

[1] Assumes that mortality rates will decline at double the rate **of current** best estimates of rate of mortality **decrease.**

[2] **Assumes** that mortality rates will decline at half the **rate** of current best estimates of rate of mortality decrease.

[3] **Source:** Social Security Administration, Office of the Actuary: Social Security Area Population Projections: 1987, Actuarial Study No. 99. SSA Pub. No. **11-**11546, 1987.

[4] **Source:** **1984** National Long Term Care Survey

[5] **Source:** 1985 National Nursing Home Survey

Totals may **reflect** rounding error.

in outcome shows is that we must carefully monitor the growth of this population to make long range plans for service for it is not simply enough to know that the increase will be great. There will be a dramatic difference in the levels of LTC service required (i.e., 281% versus 503% -- an absolute difference of 2.5 million cases) depending upon which set of assumptions proves most accurate.

A second major source of uncertainty in the projection of the growth of the population in need of LTC are possible changes in this group's functional and health status. Specifically, because of improvements in health services in the U.S., improvements in the standard of living and improvements in nutrition and lifestyle (e.g., reduced fat intake, reduced tobacco consumption), it is likely that cohorts aged **65+** and **85+** in the future will be in better health than current elderly cohorts. In or&r to illustrate this effect, in Table 3, we provide projections where the medical problem most frequently reported as causing disability in the 1984 NLTCS, arthritis, is assumed to be reduced 50%.

TABLE 3: Projections of the U.S. Long Term Care Population, by Age and Disability Level, Assuming 50% Reduction in the Presence of Arthritis; and Baseline Projections, 2000 and 2040

Age	**Assuming 50% Reduction in Prevalence of Arthritis**		**Baseline**	
	2000	**2040**	**2000**	**2040**
75-84	2,011	3,344	2,261	3,757
85+	2,753 1,647	5,679 4,277	3,076 1,826	4,733 6,342
TOTAL	6,411	13,300	7,163	14,832

Totals may reflect rounding error.
Source: Tabulations of 1982 and 1984 National Long Term Care Survey

We see that if a public health intervention could be introduced that would reduce the prevalence of arthritis by 50% it would have a considerable potential impact on the need for LTC services (about 11% or **752,000** fewer elderly disabled in **2000;** 10% or 456,000 fewer persons aged **85+** in 2040). The problem is that the diseases for which we know the most about **risk** factors and control (e.g., heart diseases, stroke, cancer) are lethal diseases that produce relatively little long-term disability. In contrast, the chronic degenerative diseases producing the most **long-**term disability (e.g., dementia, osteoporosis, rheumatoid and osteoarthritis) **are** now not as well studied and for which we have fewer effective controls. Thus, without considerable new research on these other disabling diseases, total life expectancy is likely to increase more rapidly than disability-free life expectancy. This will tend to increase the prevalence of disability and the need for LTC services.

A third source of uncertainty in these projections is the nature of the LTC services utilized. For example, there is considerable interest in determining if informal and formal care services delivered in the home can defer or eliminate the need for certain types of institutionalization. The effects of different rates of institutionalization on the growth of the community resident disabled population is represented in Table 4.

TABLE 4: Projections of the Community Resident U.S. Long Term Care Population Assuming Specified Limitations of Growth of Beds in Institutions, by Age, for 1985.2000, 2020 and 2040 (in thousands)

	Age Group 65-74	75-84	85+	TOTAL
		1985		
Baseline	**2,098**	2,261	1,106	5,465
Annual Percent Increase in Beds Assumed				
		2000		
0.0	2,328	3,275	**2,1**13	7,716
1.05%	**2,301**	**3,195**	1,998	7,494
2.2%	2,267	3,093	1,850	7,210
		2020		
0.0	4,006	4,107	3,255	11,368
1.05%	3,916	3,928	2,945	10,789
2.2%	3,815	3,724	2,593	10,131
		2040		
0.0	4,030	**7,295**	**6,399**	17,724
1.05%	**3,934**	**6,960**	**5,813**	**16,707**
2.2%	**3,757**	6,342	4,733	**14,832**

Source: Tabulations of the 1982 and 1984 National Long Term Care Survey.

In the table we see that different growth rates in the number of institutional beds can have a significant effect on the number of disabled persons resident in the community_ In the year 2000 the difference would be 506 thousand cases. In 2040 the difference is 2.9 **million** cases **with** the biggest changes occurring in the population aged 85 and over.

In the above we examined the various sources of uncertainty (i.e., mortality assumptions; changes in health; changes in institutional rates) in **the** future growth and residence of the functionally disabled elderly and oldest-old populations. Despite any plausible combination of those factors certain qualitative observations about the size and composition of the disabled elderly population are likely to hold: First, that there will be a large increase in the disabled elderly population driven largely by increases in the size of the oldest-old population--the population group with the highest level of need for LTC services; second, that the growth of demand for LTC services will be concentrated among women who, with their greater life expectancy, will tend to survive their spouses; and third, that institutional care, unless there is a dramatic reversal of current policy, is likely to cover a decreasing proportion of the total need for LTC care in the U.S (e.g., under baseline assumptions it would decline from 5.17% in 1985 to 4.38% in 2060 of the total U.S. elderly disabled population; Manton, 1988a).

B. Functional and Health Status Characteristics and Transitions of the U.S. Elderly Medicare Population

In evaluating the basic characteristics of the chronically disabled U.S. Medicare eligible population (the samples of the 1982 and 1984 NLTCS are drawn from lists of Medicare eligible populations) a number of descriptive and multivariate analyses were done. For example, GOM analyses were conducted of the 1982 (and 1984) NLTCS population in or&r to identify subgroups defined on multiple health and functional characteristics. These cross-sectional multivariate analyses were reported, for example, in Manton and Soldo (1988). Those analyses identified a number of distinctive health and functional status profiles. For example, the partly independent role of cognitive versus physical impairment in different subgroups was defined A subgroup of the "oldest-old" frail population could be distinguished from a much younger, acutely ill and morbid subgroups. Characterization of these subpopulations provided useful information for a number of focused policy analyses conducted later.

A fundamental factor in determining the future need for LTC services is the age related risk of functional disability for individuals. Thus, in addition to the descriptive, cross-sectional analyses described above, studies of functional and health changes were conducted. Previously, most national estimates of this risk were based on prevalence estimates derived from cross-sectional health surveys. The 1982 and 1984 NLTCS provide nationally representative, longitudinal data on health transitions in the U.S. elderly population. From these data true disability incidence data can be derived with specially developed prospective sample weights. Specifically, the longitudinal sample weights provided on the Census public use files provide weights for persons who were interviewed in both 1982 and 1984. Thus, they are useful to examine the 1982 status of persons interviewed in 1984. To assess changes from 1982 to 1984 new weights were calculated, based on the 1982 sample structure, that accounted for all persons who could have potentially fallen in the sample frame in 1984 (Manton, 1988b,c).

Two-year transition rates estimated from the 1982 and 1984 NLTCS are provided in Table 5, specific to sex and age.

From the table we see that male and female disability two-year incidence rates are very similar (e.g., 14% and 11.3% for males and females aged 65 to 74, respectively). However, the mortality risks for females are much lower at every age and disability level than for males. This means that once disability onsets, females are likely to live more years with disability than males. This explains why the prevalence of disability is higher for females in cross-sectional surveys.

From the table we also see that there is considerable reported long-term improvement in survival. In other analyses we found 23.6% of persons aged 65 and over with 3 to 4 ADLs and 22.8% of persons with 5-6 ADLs improving their functional status after two years (Manton, 1988b). Among two-year survivors, the number who improve after two years is even higher-- 31.1% and 35.4% with 3-4 and 5-6 ADLs, respectively.

In Table 5, in contrast, we see that 27.4% of males and 29.3% of females aged 65 to 74 with 5 to 6 ADLs have improved functional status two years later. For males and females aged 85 and over, the degree of improvement is still significant --12.8% and 13.9%, respectively. Adjusted for survival the male improvement at age 65 to 74 is 42.3%; at age 85 and above it is 27%. For

TABLE 5: Transition **Probabilities (%)** of 1982 Versus 1984 **Disability** Status for Males and Females by Three Age Groups

	1984 STATUS															
	Not Disabled		IADL Only		I-2 **ADLs**		3-4 **ADLs**		**5-6 ADLs**		Institutional		Deceased		**TOTAL**	
	Males	Females	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**	Females	**Males**	**Females**	**Males**	**Females**	Males	Females
1982 STATUS																
Not Disabled'																
65-74	as.99	88.73	2.48	3.54	1.39	2.13	0.72	0.77	0.55	0.55	0.62	**0.50**	8.24	3.79	87.56	86.37
75-84	72.87	73.74	4.77	6.39	3.66	5.01	0.71	1.66	**1.42**	1.06	1.63	3.08	14.93	9.06	75.14	68.95
85+	48.71	46.49	6.69	7.24	8.76	10.92	3.14	2.38	2.05	3.56	4.32	10.16	26.21	19.25	50.41	**39.65**
IADL Only																
65-74	14.62	13.09	48.62	45.56	12.49	20.48	0.95	5.71	4.87	2.84	1.90	4.13	16.54	8.19	3.63	4.02
75-84	11.00	4.90	36.64	37.60	13.93	25.87	6.54	5.74	7.15	2.87	6.69	7.72	18.05	15.29	6.17	6.61
85+	1.42	0.60	33.41	29.12	15.40	28.21	6.65	5.25	4.04	6.34	5.68	11.18	33.41	19.31 i	7.81	6.75
1-2 ADLs																
65-74	3.43	1.88	15.96	19.92	31.24	39.82	16.24	10.79	7.15	4.79	5.32	4.22	20.67	12.61	3.04	4.10
75-84	2.62	2.66	11.47	15.09	29.59	37.00	8.26	12.81	8.08	4.26	2.49	10.11	37.49	18.08	5.82	8.33
85+	0.00	0.67	6.58	8.81	20.86	32.39	10.97	16.07	13.79	8.51	15.68	12.32	32.13	21.18	12.57	12.15
3-l **ADLs**																
65-74	4.63	2.85	5.44	6.03	19.89	27.61	22.15	28.28	17.19	16.98	2.43	6.38	28.29	11.88	1.51	**1.62**
IS-84	3.09	0.41	3.09	3.68	8.55	20.14	18.54	23.70	18.17	20.50	10.46	12.26	38.10	19.32	2.34	3.53
85t	0.00	0.00	1.82	2.24	5.45	7.85	12.14	21.52	19.98	26.04	12.72	17.55	47.90	24.18	6.10	5.43
5-6 ADLs																
65-74	1.26	1.08	6.18	8.64	9.87	9.39	10.13	10.16	31.90	32.68	5.69	7.65	35.12	30.40	**1,87**	1.64
75-84	1.35	0.45	4.12	4.42	5.02	8.38	8.11	9.26	26.40	35.04	8.12	12.82	46.27	29.64	3.61	3 29
85+	0.00	0.00	0.00	1.10	4.28	6.27	8.56	6.45	27.14	27.36	6.42	14.34	53.60	44.49	**5** 18	7.30
Institutional as of 4-l-82																
65-74	1.68	2.14	0.84	0.61	2.53	1.07	0.84	2.29	1.68	1.24	57.34	68.95	35.08	23.71	1.45	1.54
75.84	0.54	0.38	1.64	0.97	0.54	0.60	1.63	0.60	0.56	1.09	49.83	61.78	45.25	34.58	4.14	6.90
85+	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.83	0.00	0.66	37.54	53.05	62.46	44.97	13.54	23.91
'82 **Detail Noncompleters**																
65-74	4.63	8.74	6.69	17.48	4.63	19.82	9.41	11.51	4.46	8.74	9.08	2.77	61.10	30.91	0.62	0.39
75-84	6.12	6.57	9.33	5.28	6.72	10.49	2.24	6.55	8.96	9.21	4.49	25.00	61.52	36.89	1.24	1.22
85t	0.00	0.00	**5.55**	2.33	5.55	4.67	0.00	7.01	0.00	9.34	16.67	34.65	72.22	42.02	2.00	1.86

TABLE 5 (cont'd.)

Institutional (after 4-1-82)																
65-74	1.77	5.80	3.88	6.18	0.00	5.42	7.77	3.09	2.89	0.00	38.84	43.54	38.85	35.95	0.31	0.32
75-84	0.00	5.16	0.00	5.95	5.12	6.06	0.00	2.69	2.59	3.60	35.84	41.11	56.45	35.44	0.93	1.17
85+	0.00	1.34	0.00	0.00	4.00	0.00	4.00	0.00	5.74	2.69	32.00	52.13	60.00	43.85	2.39	2.95
TOTAL																
65-74	76.27	77.80	4.67	5.98	3.15	4.95	1.76	2.03	1.77	1.64	1.92	2.22	10.46	5.38	100.00	100.00
75-84	56.25	51.70	6.95	8.58	5.89	9.38	2.25	3.85	3.52	3.36	4.83	9.47	20.30	13.67	100.00	100.00
85+	24.24	18.16	7.05	6.24	8.92	11.09	4.76	6.71	5.74	6.71	12.06	23.45	37.25	29.12	100.00	100.00

[a]Includes those nut disabled on screener or detailed interview.

SOURCE: Tabulations of 1982 and 1984 National Long Term Care Survey and 1985 National Nursing Home Survey.

females aged 65 to 74 the survival adjusted figure is 41% and, at ages 85 and above 25% . Thus, for both sexes, and even at advanced ages (85+) there is a considerable probability of improvement in individual functioning.

A third observation is the importance of disability as a mortality risk factor. There is nearly a five-fold increase in mortality risks for persons with 5-6 ADLs (37.2% over two years) impaired compared to those with no impairment (8.1%). Even for persons aged 85 and above, the mortality risk increases over two-fold for persons with 5 to 6 ADL impaired versus those with no reported impairment (for males from 26.3 to 53.6% and for females from 19.3 to 44.5%). The risk of disability increases, and the likelihood of functional improvement declines, with age though, even at age 85, there remains a significant likelihood of functional improvement.

One issue is the nature of the biomedical factors that generate the sex differential in male-female disability risks (Manton, 1988c). This is illustrated in Table 6.

In Table 6 we see that males are more likely to report acute, lethal diseases (e.g., cancer and heart disease, chronic and acute lung diseases) as causes of their disability than females who report more disabling conditions (e.g., senility, arthritis, diabetes).

C. Recalculation of the AAPCC Underwriting Factors

The AAPCC methodology is currently used to reimburse HMOs who have accepted at-risk contracts from Medicare (Kunkel and Powell, 1981). This methodology is based upon underwriting factors specific to age, sex, welfare and institutional status, which were calculated from three years (1974 to 1976) of the Current Medicare Survey (CMS). We recalculated these underwriting factors using the more recent (and more extensive, 22,000 person-years of experience for the elderly in the 1984 NLTCS versus 20,000 total person-years for all Medicare beneficiaries of the CMS) data from the 1984 NLTCS linked to Medicare Part A and Part B records for the year 1984. The age, sex, and institutional stratifications were based upon the sample information. Welfare status was based upon the existence of a Medicaid Buy-in indicator on the Medicare Master Third Party Buy-in file. An experimental stratification based upon disability status (as determined from the survey; an ADL or IADL impairment that had lasted or was expected to last 90 days or more) was also tried as well as a stratification for disability based upon the prior reason for enrollment. Adjustments had to be made for a 35day gap in the Part B records and for death during the year by calculating factors adjusted to total number of days of exposure to service use. These underwriting factors for total Medicare expenses (Part A and Part B decompositions were also conducted) stratified by disability level are presented in Table 7 (Manton, 1988d).

The underwriting factors, which represent the ratio of the average expenditure for the underwriting category relative to the national average expenditures (not stratified by any of the underwriting factors) show that disability as reported on the survey has a large effect on the underwriting factors for both males and females. For example, for males aged 65 to 69 the difference for community residents was 177% (i.e., 1.91 versus 0.69). Disability based on prior reason for entitlement did not perform satisfactorily. Thus, if additional underwriting factors are to be introduced into the AAPCC consideration should be paid to functional status.

D. Effects of Changes in Medicare Reimbursement Policy on Medicare Service Use Patterns, Mortality Risks and Rehospitalization Rates

An important set of questions emerged with the introduction of the Prospective Payment System (PPS) for reimbursing acute hospital episodes by Medicare. These questions involved whether the utilization of other Medicare services (i.e., home health care, SNF, out-patient care) or

TABLE 6: Weighted Percent of Disabled Sample Persons Reporting Disabling Medical Conditions by Condition, **1984 NLTCS, by Sex**

	IADL Disability		1-2 ADL Disabilities		3-4 ADL Disabilities		5-6 ADL Disabilities		TOTAL	
	Males	Females	‘Males	Females	Males	Females	Males	Females	Males	Females
				3.3						
Cancer	4.6	3.3	4.8	3.2	7.2	5.3	8.3	7.4	5.7	4.2
Ischemic Heart Dii	5.8	3.4	2.4	9.7	...5.1	4.4	8.0	4.5	5.0	3.6
Hypertension	1.4	10.2	6.0	24.0	34.16.2	13.7	5.9	11.6	6.6	10.8
Other Circulatory Disease	29.9	26.5	29.4			29.3	48.4	40.8	33.6	28.1
Senility	12.3	14.9	10.5	14.8	16.9	15.5	19.5	23.8	13.7	16.2
Mental Disorders	3.7	4.1	4.3		3.4	5.8	5.5	6.2	4.1	4.7
Parkinson’s Disease	4.3	6.9	8.7	4.2	8.9	9.6	20.4	13.5	9.1	7.8
Visual Disorders	17.4	16.5	17.8	13.3	14.3	14.5	13.3	13.0	16.4	14.6
Deafness	12.4	4.2	8.7	3.3	4.3	2.6	4.7	6.0	8.7	3.9
Ulcers	1.2	0.6	0.6	...1.1	2.1	0.7	0.9	0.5	1.2	0.8
Hernia	1.5	2.4	2.1	4.42.0	4.4 1.2	1.7	1.1	1.9	1.5	2.1
Other Digestive Disorder	4.4	3.9	3.4			4.0	4.9	4.9	4.2	4.2
Kidney & Bladder Dii	2.6	2.4	3.5	2.4	2.9	3.4	3.9	3.1	3.2	2.7
Genito-Urinary Disease	2.5	0.3	2:o	0.9	2.5	0.3	2.2	0.2	2.3	0.5
Emphysema & Bronchitis	10.8	3.6	8.4	2.8	5.5	2.1		2.1	9.2	2.9
Acute Respiratory Disease	7.9	5.0	7.1	4.3	5.0	3.8	10.2 5.3	2.5	6.8	4.2
Skin Disease	0.7	1.6	0.6	1.5	0.6	2.0	0.3	1.7	0.6	1.7
Arthritis	22.0	34.8	35.7	43.8	32.6	48.9	19.7	33.8	27.3	40.0
Other Skeletal Problems	17.8	19.8	26.8	25.7	35:o	27.5	22.3	19.7	23.8	23.1
Residual	4.1	15.5	8.4	17.8	12.7	21.4	6.1	20.2	7.0	17.9
Mean Number of Conditions	1.8	1.9	2.0	1.9	2.1	2.2	2.2	2.3	2.0	2.0

SOURCE: Tabulations of 1984 National Long Term Care Survey.

TABLE 7: Ratio of Program Expenditures for Medicare Covered Services' by Sex, Age, Disability* and Medicaid Buy-in Status Using the 1984 National Long Term Care Survey

	Institutional			Community Disabled			Community Non-Disabled		
	Buy-in	**Non-Buy-in**	**Total**	**Buy-in**	**Non-Buy-in**	**Total**	**Buy-in**	**Non-Buy-in**	**Total**
MALES					**PART A**				
85+	1.18	2.76	2.28	1.12	1.86	1.77	3.54	1.19	1.31
80-84	1.80	4.25	3.31	1.25	1.89	1.81	1.58	1.13	1.19
75-79	0.99	2.65	2.27	1.77	2.29	2.21	0.92	1.10	1.09
70-74	0.40	1.99	1.40	2.35	2.02	2.07	0.72	0.89	0.88
65-69	1.50	1.80	1.63	2.41	1.88	1.94	2.04	0.62	0.65
					PART B				
85+	1.11	1.63	1.47	1.23	1.38	1.36	3.03	1.27'	1.36
80-84	1.56	2.59	2.19	1.65	1.65	1.65	1.39	1.05'	1.07
75-79	1.16	2.74	2.38	1.66	1.61	1.61	0.81	1.00	0.99
70-74	2.02	1.70	1.82	2.96	1.91	2.06	0.95	0.91	0.91
65-69	1.99	2.11	2.04	2.05	1.82	1.85	1.26	0.74	0.75
					TOTAL				
85+	1.15	2.37	2.00	1.16	1.69	1.63	3.36	1.22	1.33
80-84	1.72	3.67	2.92	1.39	1.81	1.75	1.51	1.13	1.15
75-79	1.05	2.68	2.30	1.73	2.05	2.00	0.88	1.07	1.06
70-74	0.97	1.89	1.55	2.56	1.98	2.07	0.80	0.90	0.89
65-69	1.67	1.91	1.78	2.28	1.86	1.91	1.77	0.66	0.69
FEMALES					PART A				
85+	1.36	1.26	1.29	1.91	1.86	1.87	2.57	1.10	1.23
80-84	1.26	1.97	1.73	1.91	1.68	1.72	1.27	0.95	0.97
75-79	1.45	1.94	1.77	1.37	1.78	1.69	1.31	0.72	0.76
70-74	1.74	2.79	2.34	1.67	1.87	1.83	0.87	0.59	0.61
65-69	3.02	2.61	2.79	1.71	1.88	1.85	0.77	0.40	0.42

TABLE 7 **(cont'd.)**

					PART B				
85+	1.30	**1.15**	**1.20**	**1.28**	**1.16**	**1.19**	**1.49**	**0.88**	**0.93**
80-84	**1.61**	**2.24**	**2.03**	**1.49**	**1.51**	**1.51**	**1.11**	**0.87**	**0.89**
75-79	**2.26**	**2.71**	**2.55**	**1.82**	**1.42**	**1.51**	**1.93**	**0.80**	0.88
70-74	**1.57**	**1.97**	**1.80**	**1.88**	**1.75**	**1.78**	**1.37**	**0.70**	0.74
65-69	**2.82**	**2.36**	**2.56**	**1.72**	**1.80**	**1.79**	**0.95**	0.54	0.57
					TOTAL				
85+	**1.34**	**1.22**	**1.26**	**1.69**	**1.62**	**1.63**	**2.19**	**1.02**	1.13
80-84	**1.38**	**2.07**	**1.83**	**1.76**	**1.62**	**1.65**	**1.21**	**0.92**	0.94
75-79	**1.73**	**2.21**	**2.04**	**1.53**	**1.65**	**1.63**	**1.04**	**0.75**	0.80
70-74	**1.68**	**2.51**	**2.16**	**1.74**	**1.83**	**1.81**	**0.83**	**0.63**	0.66
65-69	**2.95**	**2.52**	**2.71**	**1.71**	**1.85**	**1.83**		**0.45**	0.47

***Base (i.e., 1 .O) is national average for relevant Medicare program expenditure.**

*Disability is based upon the presence **of a chronic (90-day) impairment in an** ADL or IADL as **reported in the 1984 National Long Term Care Survey.**

LTC was effected by changes in hospital utilization stimulated by PPS. There was also concern that the economic disciplines enforced by PPS might adversely affect the quality of care provided to Medicare beneficiaries. These questions were examined within certain data constraints by analyses of the 1982 and 1984 NLTCS linked to Medicare Part A service data.

Specifically, because PPS was introduced in the interval between the two NLTCS (i.e., from Oct. 1, 1983 to Sept. 30, 1984) one could examine the service use and outcomes of the respondents to the 1982 and 1984 surveys in terms of a pre-post experimental design with the introduction of PPS as the experimental condition. This was done by linking all Medicare Part A service in the 12 months after October 1982 and October 1984 to the corresponding 1982 and 1984 NLTC survey records. Then analyses of the chronic health and functional characteristics of persons in those two surveys could be used to identify subgroups who had particular sets of chronic functional and health problems using the GOM methodology. Life tables were then calculated for those subgroups which represented hospital, home health, SNF and community episodes that occurred to those people during the 12-month service use window. Since the GOM analysis was applied to health and functional data pooled for 1982 and 1984, the health and functional status subgroups were identically defined for the two periods. Since the survey samples in the two years were selected to be chronically disabled this meant that we could analyze changes in service use and health outcomes for the frailest subpopulations of the Medicare beneficiary population--persons who would possibly be particularly susceptible to adverse effects of PPS.

The results were quite clear. The data show there was little evidence of an increase in mortality for the frail subpopulations between the two service windows (i.e., October 1982 to September 1983 and October 1984 to September 1985). Since hospitalization rates declined due to PPS there did tend to be an increase in the severity of hospital case-mix but, in other studies, after controlling for case-mix at admission there was no evidence of increased hospital mortality. In addition the risk of hospital readmission declined. Thus on at least two measures, for the periods under study, there was little adverse effect demonstratable from PPS--even for these frail, susceptible subpopulations (Liu and Manton, 1988a; Manton and Liu, 1988).

In contrast there were significant effects of PPS on the pattern of Medicare service use. Home health service use increased. Hospital LOS &creased--even for the frail subpopulations who had initially longer LOS. It appears that from data from the 1985 NNHS, the case mix severity of nursing home residents increased. Many of these effects can be viewed as reasonable shifts in service use patterns given that the quality of care delivered is maintained.

The primary study limitations are that Medicare Part B services were not included and we had data only on Medicare SNF and not for other types of nursing homes.

E. The Development of Case-Mix Measures for Reimbursine Medicare Home Health Services

With the success of the PPS for reimbursing acute hospital services the possible development of case-mix adjusted reimbursement for LTC services was raised. A major type of LTC service for which these questions were posed was home health services. The linkage of the 1982 and 1984 NLTCS to the Medicare Part A service records provided an opportunity to investigate this possibility.

In one series of studies an evaluation was made of the health and functional status characteristics of all persons in the 1982 NLTCS sample who received home health services (Manton and Hausner, 1987). For the group receiving the detailed household interview-a GOM analyses was made of 56 health and functional status dimensions. This analysis identified six dimensions that described the health and functional status of those persons. The individual scores for these six dimensions were then regressed on measures of the use of Medicare home health, i.e., total expenditures and total number of home health visits. The six dimensions were found to explain a significant proportion of the variation in individual levels of home health service use and that the six different subgroups had very different levels of service use. This predictability was found to hold for service use within12 months of the survey data.

In addition, extended models were estimated which included regional variation in the use of other (i.e., non-home health) services and other demographic characteristics of the clients. Overall, even though the detailed case-mix measures were available for only a proportion of the sample, the extended models could explain up to 25.3% of the variance in home visits and expenses.

In addition case-mix measures were estimated with 58 variables where two indices of service use were introduced. This is consistent with the usual development of case-mix measures where service use is used to calibrate the differences between categories (e.g., in the RUGSII system the 16 categories were defined on the basis of the amount of nursing services delivered). These groups explained nearly 50% of the individual variation in home health service use.

The 56-variable groups were clinically interpretable and would be preferred on the basis that they were constructed independently of the service use measures. Thus, the definition of the 56 variable groups would not be altered by changes in payment levels for home health services. The advantage of the 58-variable groups is that, they are objectively determined, combine considerable clinical data with the service measures, and have very high levels of predictive power for home health service use.

In an additional series of analysis the case-mix groups were derived from the 1984 NLTCS survey population for the same 56 measures. Similar dimensions were extracted from the analyses of the 1984 data except that a mentally impaired group was less prominent and the level of prediction in the 1984 data was somewhat smaller. Part of the reduction in the ability to predict service use seemed to result from a tightening of home health regulations that reduced the number of persons with examely large amounts of service use.

F. Out-Of-Pocket Pavmenq

An important set of issues that emerged during consideration of the extension of catastrophic coverage for acute medical services was the patterns of expenditures made out-of-pocket for various types of medical and formal LTC services. These spending patterns were analyzed using data from the 1984 NLTCS and involved extension of analyses performed with the 1982 NLTCS (Liu et al., 1985; Manton and Liu, 1988). We examined the variation of these patterns of expenditures for persons with different income levels. We evaluated how much was spent for nursing versus other services. It was found that, among persons paying out-of-pocket, that the average monthly expenditure in 1982 was $164 with persons having lower levels. of disability paying between $88 to $117 and with 5 to 6 ADL's paying $439. For those receiving nursing services the average monthly expenditures were much higher-$424. It was found that the ability to pay for services influenced the ability of persons to stay out of nursing homes. It was found that even persons with 5-6 ADL impairments could stay in the community with adequate social, housing and economic resources--indeed the community resident population with 5 to 6 ADL's was nearly as large as the institutional population with that level of impairment. The out-of-pocket expenditure patterns for all payees and for payees using nursing services are presented in Table 8.

G. Medicaid Spend-Down and Institutionalization

An important set of issues that were addressed with the longitudinal files of the 1982 and

TABLE 8: Summary Statistics on Reported Out-of-Pocket Payments for a Month for Those Receiving Any Home Care and Those Receiving Home Nursing Care, by Activity of Daily Living (ADL) Limitation Level: United States, 1982

	Home Care Only			Home Nursing Care		
	All Payors With IADLs/ADLs	Up to 4 ADL Limitations	5-6 ADL Limitations	All Payors with IADLs/ADLs	up to4 ADL Limitations	5-6 ADL Limitations
Persons Paying Out-of-Pocket*	608.0	484.0	124.0	58.0	30.7	27.4
Average Monthly Payment	$164	$93	$439	$424	$156	$724
Payment at Selected Percentiles of Payors						
10th	$6	$6	$15	$9	$6	$24
25th	15	34	40	90	13	40
50th	40	85!14	140	400	74	100
75th	135		450		229	807
90th	400	237	1.260	880	400	1,922

*Number in thousands.

SOURCE: 1982 NLTCS

1984 NLTCS was the phenomenon of Medicaid "spenddown" and "spousal impoverishment." Specifically, it can be the case that institutional care exhausts the private financial resources of the patient until the person can no longer remain in the institution except with Medicaid reimbursement. The effects of such spenddown are particularly significant when they deplete the resources of a noninstitutionalized spouse. The institutional sample of the 1984 NLTCS was used to assess the process of spenddown and the likelihood of spousal impoverishment. Transitions of this process are presented in Figure 1 (Liu and Manton, 1988b).

The actual rates of spenddown varied nearly seven-fold from 6% for persons in the community to 41% for persons in nursing homes in 1984.

H. Nursing Home Transitions

One of the unique properties of the institutional sample of the 1984 NLTCS is that it is a true "admissions" cohort which can be used to study the risk of institutionalization between 1982 and 1984. The NNHS, in contrast, begins with persons who are already institutionalized. Thus, the 1987 follow-up NNHS covers only the next-of-kin of institutional residents in 1985 NNHS. The so-called "discharge" sample of the 1985 NNHS will reflect incidence patterns except for differences in the size of admission cohorts.

The institutional sample of the 1984 NLTCS was used to study the pattern of utilization of institutions. This was done by devising rules to discriminate between long- and short-term residents among the persons in institutions in 1984. This was done by contrasting persons who entered the institution during the inter-survey interval with those who were in the institution at the time of the 1982 survey. A variety of characteristics of the short- and long-term nursing home residents was analyzed using multinomial logistic regression procedures (Liu, DeVita, and Manton, 1988).

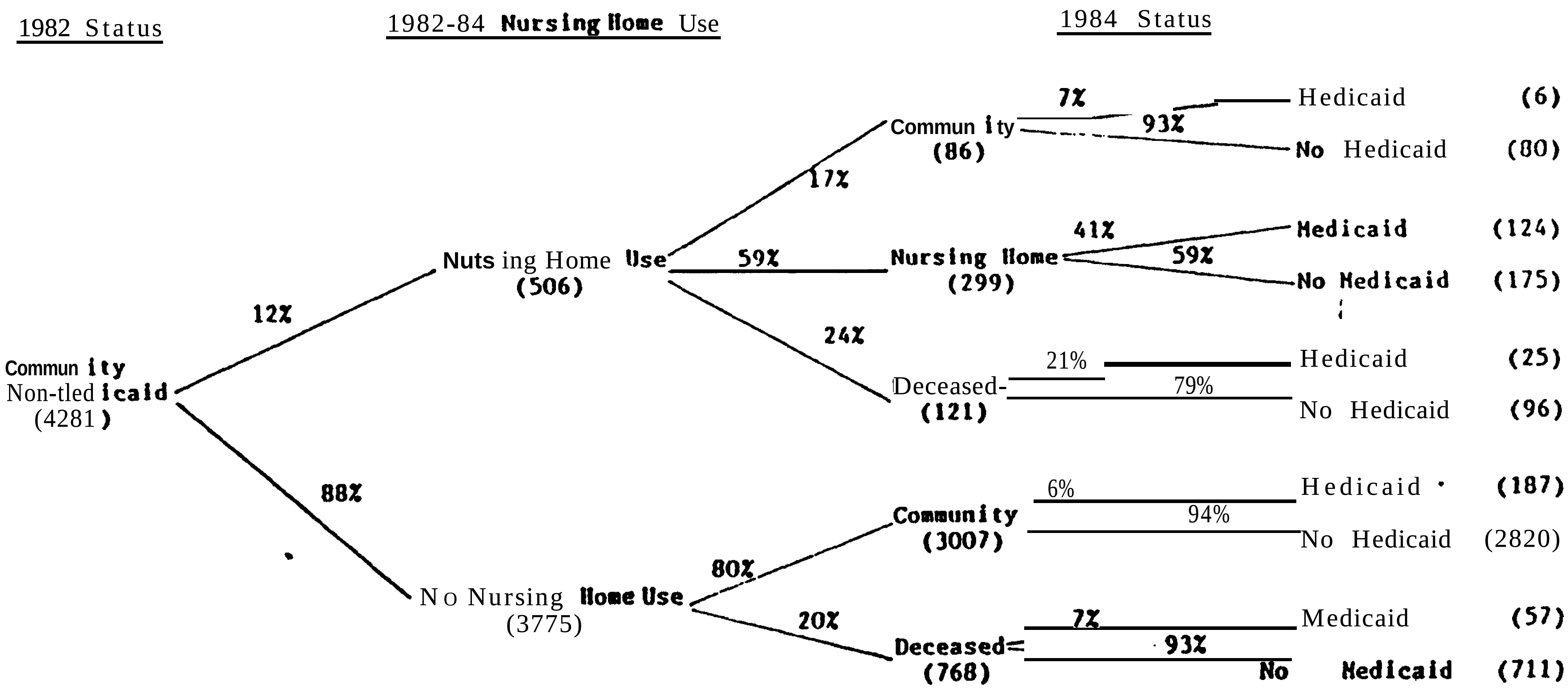
I. Transitions of Medicaid Nursing Home Residents

Analyses were conducted of the longitudinal (24 months) experience of two monthly cohorts of persons entering Type D (nursing home) Medicaid facilities who were SSI beneficiaries. These analyses addressed program utilization with regard to payment and residence characteristics and how those characteristics varied with institutional characteristics (Manton and Lowrimore, 1986). A grade of membership analysis was conducted of beneficiary characteristics and the characteristics of their residences and, conditional upon subgroups identified residential, program entitlement and mortality life tables calculated. In the analysis two elderly populations were identified--one resident in SNFs who was more likely to be active payment status and to change residence, and a second group resident in ICFs who were less likely to remain payment active but not to change residence until death. A third elderly group identified was resident primarily in institutions with high levels of rehabilitation services. The fourth group identified was a mixture of young and middle-aged mentally impaired persons resident in ICF-MRs. Durations of residence, payment and survival were calculated for all groups,

J. Long Term Care Insurance

A number of analyses were conducted of the characteristics of the disabled population who might represent a market for private LTC insurance. This involved investigation of three surveys: the NLTCS, the SOA-LSOA and the NNHS. It was found, for example, that, in addition to income restrictions, there would be significant numbers of persons who had disabilities and chronic medical problems. This, is illustrated in Table 9 (Liu, Manton, and Liu, 1989).

Figure **1:** Nursing **Home** and 'Hedicaid Status Transitions:
Non-Medicaid, Community Residents in 1902



Note: Number **in** parentheses is the number **of** cases.

SOURCE: 1982 NLTCS

kl.3719: 3719-f01

TABLE 9: Percent of Population With Any One ar More of Five Chronic Conditions by Income and Level of Disability

Income and Age	Population** (in 000s)	Presence of Condition With No ADL	Presence of Condition With < 3 ADL	Presence of Condition With 3+ ADL	Presence of Condition Total
Less than $7.000					
55-64	2,384	42.27%*	16.58%*	9.88%*	68 73%*
65-74	2,949	52.18	17.60	5.83	75.61
75-84	2,422	43.43	22.22	7.99	73.64
85+	617	24.38	28.39	15.85	68.63
Total	8,372				
$7.000 - $15.000					
55-64	4,664	44.26	11.63	3.83	59.72
65-74	5,936	51.44	11.56	4.70	67.70
75-84	3,087	45.15	16.29	7.25	68.69
85+	500	34.32	21.33	16.68	72.32
Total	14,187				
$15 000 - $25.000					
55-64	5,698	44.25	6.61	2.19	53.05
65-74	4,153	50.64	8.70	2.87	62.2 1
75-84	1,542	49.12	13.28	7.27	69.66
85+	284	23.11	25.46	19.99	68.57
Total	11,677				
Greater than $25,000					
5564	9,706	42.96	3.35	0.82	47.14
65-74	3,991	51.24	7.66	2.88	61.79
75-84	302	52.06	10.82	9.61	72.50
85+		30.55	15.49	30.39	76.44
Total	14,329				
Total	48,565				

*Percentage of cell population; e.g., 42.27% of group aged 55-64 with incomes less than $7,000.
**7.4 Million elderly who did not provide amount of income were distributed proportionately.
SOURCE: 1984 NHIS SOA

TABLE **10: Transitions Between 1982 and 1984 for Persons With Heart Disease, Stroke or Cancer in 1982***

	1984 Status								
	Higher Disability			**Died**			**Institutionalized**		
1982 Status	**Heart**	**Stroke**	**Cancer**	**Heart**	**Stroke**	**Cancer**	**Heart**	**Stroke**	**Cancer**
Non-disabled	**51.2%**	**59.2%**	**44.7%**	**9.2%**		**22.2%**	**0.7%**	**9.5%**	
IADL Only	30.6	28.1	19.9	14.5	22.2	37.5	5.6	5.0	4.9
ADL 1-2	19.3	21.8	19.8	21.8	3s.7	41.3	7.3	10.5	3.5
ADL 34	21.4	28.8	23.4	24.3	28.0	36.9	10.3	20.8	15.4
ADL 5-6	—	---	---	38.7	47.5	75.9	8.6	9.1	7.5

*Unweighted number of cases of heart disease (4,081), stroke (420), and cancer (361).

SOURCE: 1982 and 1984 National Long Term Care Surveys.

We see that, even for persons with incomes over $25,000, significant proportions had chronic medical problems even without disabilities. In Table 10 we show the different disability transition rates for persons with three major conditions.

K. Preparation of A Public Use-Pile for the 1982 and 1984 NLTCS and the Provision of Technical Assistance

Given the expertise developed with NLTCS a special public use derivative file was developed for the 1982 and 1984 NLTCS. Preparation of this file involved several steps.

First; it was found that the sample weights provided with the initial Census Bureau file were in error. Consequently, working with the Census Bureau the error was documented, identified and corrected. This involved intensive investigation of the file and the preparation of several new demographic variables as the basis for calculating the new series of sample weights.

Second, the file was organized into a series of different sub-files which required a series of programming steps in order to utilize variables from different files. The use of a "flat" file structure where all variables were organized on a case-basis had been found to be efficient in terms of programming efforts for our own analyses. Consequently a flat file was prepared for the public use tape.

Third, certain coding and editing steps had to be undertaken to a.) eliminate redundant variables; b.) suppress geographic detail because of privacy restrictions: and c.) move variables to certain positions to facilitate programming. Once the file was reformulated a series of tabular runs were made to ensure that the content of the original Census Bureau file was preserved.

Fourth, the Medicare Part A records were prepared in a second, independent file. These records were ordered and edited to be easily accessible and provided with an anonymous identification number so that they could be linked to the survey records.

Fifth, the documentation (-300 pages) for the original file was edited to reflect the new file structures and format.

Sixth, tapes and documentation (all questionnaires, interviewers' instructions and code books) were sent to NTIS.

Finally, technical assistance is being provided to users of the files. This involves consultation about the structure of the file, the design of the samples, and the characteristics of the data. When requests involve access to work files retained only by the Census Bureau those requests are identified and transmitted. For example, resolution of the characteristics of the institutional sample component in 1982 and 1984 was provided by the Census Bureau.

L. International Analyses

The interest in international patterns of LTC need and service use stem from the observation that much can be learned by studying how those needs are met in different so&-cultural and economic settings. One finds, for example, that in developed countries, there is wide variation in the amount of institutional care that is delivered. In contrast, it was found that there was considerable similarity in the physiological processes that generate disability at advanced ages, that the profile of disabilities was functionally similar though they were sometimes manifest in very different behaviors, and that the patterns of sex differentials in morbidity, mortality and disability risks were found in many countries (Manton, Myers and Andrews, 1987; Manton, Dowd and

Woodbury, 1986).

V. Summary

The 1982 and 1984 NLTCS, linked to Medicare Part A service use records for the period 1980 to 1987 and Medicare Part B records for 1984 to 1987, were found useful to respond to a wide range of basic epidemiological, health financing, quality assurance, and policy concerns for acute, post-acute and long-term care. Useful insights were gained into the impact of the PPS on frail elderly Medicare beneficiaries who used acute care hospitals in a pre- and post-PPS period. These insights involved consideration of both quality of care and Medicare service delivery issues. The data sets also proved valuable in assessing the contribution of out-of-pocket payments to catastrophic acute care expenditures. The data were useful in studying a wide range of LTC care issues such as the characteristics of Medicaid spend down, spousal impoverishment, differences in the utilization of institutional care, the use and reimbursement of home health services. In addition the data on basic disability and health transitions were helpful in characterizing the likely duration of LTC service use and to project future patterns of service use.

In addition to the substantive analyses a number of methodological advances were made in both analytic and data collection activities. Cenain analyses involved the development of multivariate classification procedures (i.e., the GOM model) and its extension to longitudinal analyses of service use and health changes. In addition, there has been relatively little experience in analyzing national representative longitudinal health surveys of this type. Thus, a wide range of new insights into data collection, analysis, and use (e.g., the calculation of longitudinal sample weights) emerged. It is anticipated that the value of these data will be greatly extended by the collection of a third longitudinal round with a similar sample structure to that of the 1984 survey in 1988. A number of lessons learned in estimating transitions from 1982 to 1984 will be introduced into the 1988 design. The longer-term follow-up will extend the ability to make analyses of cohort differences.

REFERENCES

Katz S, Akpom CA: A measure of primary sociobiological functions. ***International Journal of Health Services*** **6:493-508, 1976.**

Kunkel SA, Powell CK: The Adjusted Average per Capita Cost under risk contract with providers of health care. ***Transactions of the Society of Actuaries*** **33:221-230, 1981.**

Liu K, **Manton** KG: Effects of PPS on hospital readmissions and mortality of disabled Medicare beneficiaries. In review at Inquiry, **1988a.**

Liu K, **Manton** KG: The effect of transitions between community and nursing homes on Medicaid eligibility. ***The Gerontologist,*** 1988b.

Liu **K, Manton** KG, Liu B: Morbidity, disability and long-term care: Implications for public and private policies. In review at ***Milbank Memorial Fund Quarterly,*** 1988.

Liu K, **Manton** KG, Liu BM: Home care expenses for the disabled elderly. ***Health Care Financing Review*** **7(2):51-58, 1985.**

Liu K, **DeVita** C, **Manton** KG: Risks of entering nursing homes for long and short stays. In review at ***HCF Review,*** 1988.

Manton KG: Epidemiological, demographic, and social correlates of disability among the elderly. ***Milbank Memorial Fund Quarterly*** **67(suppl.** 1 on Disability Policy), forthcoming, 1988a.

Manton KG: A longitudinal study of functional change and mortality in the United States. ***Journal of Gerontology*** **43(5):153-161, 1988b.**

Manton KG: Planning **long-term** care for heterogeneous older populations. In ***Annual Review of Gerontology and Geriatrics,*** Vol. 8 (Maddox G, Ed). **Springer,** New York, forthcoming, **1988c.**

Manton KG: A report on alternative calculations of demographic underwriting factors for the AAPCC formula using data from the 1984 National Long Term Care Survey and linked Part A and B records. Report prepared for Health Care Financing Administration, 19886

Manton KG, Dowd **JE, Woodbury** MA: Conceptual and measurement issues in assessing disability cross-nationally: Analysis of a WHO-sponsored survey of the disablement process in Indonesia. ***Journal Cross-Cultural Gerontology*** **1:339-362, 1986.**

Manton KG, Hausner **T:** A multidimensional approach to case mix for home health services. ***HCF Review*** **8(4):37-54,** 1987.

Manton KG, Liu K: Recent changes in service use patterns of disabled Medicare beneficiaries. In **review** at ***HCF Review,*** 1988.

Manton KG, Lowrimore G: Patterns of utilization of type D living arrangement by four types of SSI beneficiaries: The relation of individual and facility characteristics to **24-month** changes in payment and residence characteristics. Report prepared for Health Care Financing Administration, 1986.

Manton KG, Myers GC and Andrews G: Morbidity and disabiiity patterns in four developing nations: Their implications for social and economic integration of the **elderly.** Journal *Cross-Cultural* Gerontology **2:115-129, 1987.**

Manton KG, **Soldo** BJ: Disability and-mortality among the oldest-old: Implications for long term care service needs. Chapter in ***Forecasting the Health of the Oldest Old*** **(Manton** KG, Singer B, **Suzman** R, **Eds.).** Oxford University Press, New York, forthcoming, **1988.**

Social Security Administration. Office of the Actuary: Social Security ***Area Population Projections: 1987.*** Actuarial Study No. 99, SSA Rub. No. **11-11546, 1987.**

Torrey BB: The visible costs of the invisible aged: The fiscal implications of **the** growth in the very old. Presented at the American Association for the Advancement of Science meetings, New York, 1984.

Woodbury MA, Clive J, and Garson A: Mathematical typology: A Grade of Membership technique for obtaining disease definition. ***Computers and Biomedical Research*** **11:227-**298, 1978.

Woodbury MA and **Manton** KG: A new procedure for analysis of medical classification. ***Methods of information in Medicine*** **21:210-220, 1982.**

I. STUDY OBJECTIVES

The objectives of this study are to assess the size, characteristics and future growth of the elderly long term care (LTC) population in the United States. Multivariate analyses of the micro-data records from the 1982 and 1984 National Long Term Care Surveys were used to develop multidimensional profiles of attributes which characterize distinct subgroups in the functionally disabled noninstitutionalized elderly LTC population and which can be used to target individuals at risk of institutionalization. Cross-sectional and longitudinal analyses were also performed using the 1982 and 1984 rectangularized file of the National Long Term Care Surveys (NLTCS); and comparative analyses were undertaken using similar cross-national surveys from other countries.

The original scope of the research plan was augmented by three supplements over the course of the research project. The first supplement analyzed utilization of Medicare home health services and temporal trends in the nature and frequency of Medicare hospital readmission. These tasks were accomplished using data from the 1982 and 1984 NLTCS linked to Medicare Part A record files for the period 1978 to 1985. Home health service utilization, trends in rehospitalization, and out-of-pocket expenditures were analyzed; and public use tapes and documentation of the 1984 cross-sectional and 1982-1984 longitudinal files were produced.

A second supplement addressed temporal trends and calibration of AAPCC underwriting factors using the 1982- 1984 NLTCS linked to Medicare Part A and Part B records over the same time period, Trends in Medicare service use patterns and institutionalization of different marital status, informal care, economic, and demographic groups were assessed and the ways in which marital status, income and assets, health and functional status and demographic factors affect the change in economic and housing status of spouses of institutionalized persons was identified and described. Underwriting factors of the AAPCC for cells from the 1982 and 1984 NLTCS were recalibrated and several additional underwriting factors were examined and their predictiveness assessed.

A third supplement provided additional funding for technical consultation on the 1982-1984 NLTCS public use tape and user documentation produced in the first supplement and provided for technical consultation and liaison with the Census Bureau regarding these files. Simple tabulations and marginals of the file were also produced.

Aspects of supplements two and three are currently still ongoing as are efforts to extend components of supplement one to include Medicare Part B sevices.

A. Multivariate Analysis of the 1982 NLTCS

The level and type of functional impairments and the LTC services and social context that support the disabled elderly in the community were assessed This was carried out using Grade of Membership (GOM) modeling techniques applied to both cross-sectional and longitudinal data from the 1982 NLTCS. From that survey 56 ADL, IADL, IADL2 and medical condition variables were analyzed (after analyses of much larger groups of variables) to identify subgroups in the community resident LTC population. The association of formal and informal care service use with the subgroups

Preceding page blank

was examined.

B. Cross-sectional and Longitudinal Analyses of the NLTCS

Cross-sectional multivariate analyses of the 1982 and 1984 NLTCS was conducted to determine if the profiles of- attributes that identified the subgroups of the noninstitutionalized LTC population had changed over that time period of if subgroup frequencies in the population had changed A longitudinal GOM analysis of data on persons observed in both the 1982 and 1984 surveys was performed to assess changes in the profiles of disability, medical, and other attributes for individuals and the association of the multivariate profiles identified in 1982 with the risk of institutionalization or death in the period between the two surveys. In addition, life table analyses of different types of Medicare Part A service use were conducted for each of the subgroups found in the GOM analyses.

C. Projections and Forecasts

Projections and forecasting of the LTC population by sex, age, marital status, disability level and type over the period 1980 to 2040 were made to quantify the growth of need for LTC services. In addition to providing baseline projections utilizing the middle variant of the population projections produced by the Social **Security** Actuaries a number of simulation exercises, involving alternative assumptions about the rate of growth of the national supply of institutional beds and about changes in future morbidity and disability rates were conducted. Outcome measures included the number of disabled persons, the number of informal caregivers needed to maintain current levels of informal 'care, the number of hours of care delivered and the need for different types of medical and LTC manpower.

D. International Cross-sectional Analysis

Cross-sectional analysis of disability patterns in the community-based elderly populations was done in a number of developed and developing countries in order to (a) describe international patterns in the need for and delivery of LTC services, and (b) contrast the current pattern of LTC services in the U.S. with activities in other countries. The analyses employed the cross-sectional GOM statistical methods used in the studies of the 1982-1984 NLTCS.

E. Health Need and Service Utilization Profiles

Profiles of health needs and service utilization among the elderly populations of a number of countries using the life table model of mortality, disability, and mortality were produced

II. METHODOLOGY

A. Transition Rates, Transition Probabilities, and other Types of Probabilities Used in Models of Disability and the Effects of Sample Design on their Estimation

General Principles and Definitions

In this section, we will discuss transition rates, transition probabilities and other types of probabilities used in models. To provide a familiar context for this discussion of probabilities and rates we will conduct our discussion in the context of age-period-cohort models, i.e., models in which independent multiplicative effects are estimated along the dimensions of age, period (i.e., calendar year), and cohort. Clearly, some of these analytic constraints will be generalized in the multivariate event history process models to be discussed. These definitions are important to our discussion of new evaluation method appropriate to deal with LTC service duration data where mortality and other transitions are competing risk affecting estimates of different types of service use. The fundamental concepts to these evaluation procedures are those of the life table and "active" life expectancy (see Manton and Soldo, 1987).

In order to calculate active and healthy life expectancy measures we need to identify age, period, and cohort components of variation in the activity limitation and morbidity prevalence rates calculated from surveys over time. Due to the fact that only two of the three values of age (a), period (y = year), and cohort (c) can be determined independently there is a problem of identifiability in specifying APC models that has received much recent attention (e.g., Fienberg and Mason, 1979). A formal analysis of this confounding can be conducted using Fourier transforms to see the exact nature of the "aliasing" or "biasing" that accrue between the effects (Woodbury et al., 1987). To nsolve this confounding of effects it is necessary to impose constraints on the parameter estimates. Fortunately, in the current sets of analyses our subject matter suggests certain constraints are substantively natural. Specifically, the life table model is a model of the age trajectory of the risks of various types of health events. Thus we can take the age effects as primary in our model and parameterize the model so that period and cohort effects are proportional to the underlying or marginal set of age specific hazard rates or probabilities. This is done by selecting a base period and base cohort where the effects of period and cohort are fixed at 1.0 in a multiplicative model (equivalently, in a loglinear form, the additive effects of period and cohort would be fixed at 0.0). Then, effects for subsequent periods and cohorts are taken as multipliers on the base cohort and period effect.

The actual fitting of the parameter estimates can be done in a variety of ways. In a multiplicative model we could use the iterative proportional fitting algorithm to produce Maximum Likelihood Estimates (e.g., Woodbury et al., 1987). The loglinear additive model might be fitted by weighted least squares. In the estimation procedure described below we will use a Newton Raphson approach to maximum likelihood estimation.

It should also be recognized that our data arise from complex sample designs and that the effects of the sample design will have to be taken into account both in the determination of specific point estimates of various rates and in the generation of confidence intervals around those point estimates. Although there is a substantial literature on the treatment of this aspect of the study, there also is a wide range of opinion as to the best way to proceed in any given situation (e.g., Royal and Cumberland, 1981). We will comment on this issue at various points of this subsection. For the purpose of simplifying the exposition, however, except for the use of case weights in counting each outcome or event, we will initially proceed as if we were dealing with survey data collected under simple random sampling methods.

There are two types of estimates we wish to obtain. The first is a prevalence rate estimate which gives the proportion of a given population group which exhibits a given disease, disability, or other attribute at the time of the survey. The second is an incidence rate estimate which gives the rate per person per unit time at which new events of disease, disability, or other signs or symptoms occur in a given group. Because of the nature of cross-sectional survey data, incidence rates derived from that type of data are necessarily retrospective in nature. For example, in the National Health Interview Survey (NHIS), the time period varies from as short as the two week period ending on the Sun&y prior to the interview to as long as the preceding one year period. In this case, the survey necessarily excludes those events which led to institutionalization or to death (Horvitz, 1966). This is in contrast to the longitudinal survey designs (e.g., the 1982-1984 NLTCS) which allow such events to be recorded prospectively.

Let a denote age, y denote year, and y-a denote cohort. Then the APC model expresses the prevalence or incidence rates in the product form.

$$P_{ay} = \alpha_a \cdot \beta_y \cdot \gamma_{y-a} \ . \qquad (1.1)$$

In the case of prevalence rates, we begin by assuming a binomial model, where the likelihood is given by

$$L_B = \prod_a \prod_y \binom{N_{ay}}{n_{ay}} p_{ay}^{\ n_{ay}} \left(1 - p_{ay}\right)^{N_{ay} - n_{ay}}. \qquad (1.2)$$

In this equation, n_{ay} is the prevalence count in a subpopulation of size N_{ay} and p_{ay} is the prevalence rate. Under a saturated model, one obtains the standard estimator:

$$\hat{p}_{ay} = n_{ay}/N_{ay} \ . \qquad (1.3)$$

Under the APC model, p_{ay} is replaced with (1.1) and (1.3) is replaced with.

$$\hat{p}_{ay} = \hat{\alpha}_a \ \hat{\beta}_y \ \hat{\gamma}_{y-a}, \qquad (1.4)$$

where the parameter sets $\{\alpha_a\}, \{\beta_y\}$, and $\{\gamma_{y-a})$ are estimated using the Newton-Raphson algorithm to maximize (1.2). Assessment of the goodness-of-fit can be conducted using standard likelihood ratio procedures which yield a test statistic which is asymptotically chi-squared distributed. Some adjustment of these tests will be required, however, due to the effects of complex sample design when the procedure is actually applied to the surveys in our study (see Fay, 1985).

The parameters in (1.4) are all assumed to be nonnegative. Note, however, that the products in (1.4) must also be not greater than 1.0 for the estimator to be admissible as a probability. While we would not anticipate that the predicted prevalence rates will be greater than 1.0, we can deal with values near 1.0 by using a function of the form:

$$P_{ay} = \frac{\alpha_a \beta_y \gamma_{y-a}}{\alpha_a \beta_y \gamma_{y-a} + 1}. \qquad (1.5)$$

Also note that if $\gamma_{y-a} \equiv 1$, then (1.4) reduces to a model of statistical independence of age and period, in which case adjustments of the type in (1.5) would be unnecessary.

In the case of incidence rates (and also for prevalence rates which are small, i.e., p c .05) we begin by assuming a Poisson probability model. To describe this incidence rate model, let n_{ay} be the number of events in a population group and let N_{ay} be the person-years (not persons) of exposure to those events. In the multiplicative form of the model, we write the likelihood as

$$L_p = \prod_a \prod_y (N, \lambda_{ay})^{n_{ay}} \exp\{-N_{ay} \lambda_{ay}\} / n_{ay}! , \qquad (1.6)$$

where λ_{ay} is the Poisson parameter. Under a saturated model, one obtains the standard estimator

$$\hat{\lambda}_{ay} = n_{ay}/N_{ay} . \qquad (1.7)$$

Under the APC model, λ_{ay} is replaced with the expression on the right hand side of (1 .1) and (1.7) is replaced with

$$\hat{\lambda}_{ay} = \hat{\alpha}_a \hat{\beta}_y \hat{\gamma}_{y-a} , \qquad (1.8)$$

where the parameter sets (a,), $\{\beta_y\}$, and $\{\gamma_{y-a}\}$ can be estimated using iterative proportional fitting to maximize (1.6) (Woodbury et al., 1987). As in the binomial case, cbi-squared tests based on the transformed likelihood ratio may be used to evaluate the fit of the various models.

If either APC model in (1.4) or (1.8) fails to fit the data, then additional steps could be required to produce acceptable rate estimates. Here it should be noted that the estimates from the saturated model, though fitting the data by definition, are not desirable due to the effects of uncontrolled systematic and random factors. This is serious because inappropriately modelling these systematic and stochastic factors means that the parameter estimates will not accurately describe experiences beyond those in the data set used to generate the estimates. Thus, two additional steps that can be taken are a.) to introduce covariates into (1.4) or (1.8) to control for systematic effects and b.) to respecify the likelihood in (1.2) or (1.6) to account for additional sources of stochasticity. Because the introduction of additional covariates is a standard response to the lack of fit of the model, we will consider only the second response in detail.

One approach is to use a parametric empirical Bayes procedure in which the parameter p_{ay} or λ_{ay} is specified to be independently distributed according to some member of a finite parameter family of probability distributions (Morris, 1983). The uses of Bayesian and empirical Bayes procedures for two-way tables are discussed in Leonard (1975) and Laird (1978), respectively. In the particular case of binomial proportions, Kleinman (1973) discusses the case of the beta distribution as the prior distribution on p_{ay} and Smith (1983) gives a computer program for obtaining MLE's for this model.

Empirical Bayes estimators may also be developed for the Poisson model. Tsutakawa (1985) and Tsutakawa et al. (1985) exhibit estimators based on normal prior distributions for transformations of the standard parameters. Manton et al. (1981) and Manton and Stallard (198 1) assume a gamma prior on the distribution of λ_{ay}, yielding the following negative binomial likelihood.

Another useful feature of the composite rate estimator is that it can be viewed as a compromise between the modelled rate (μ_{ay}) and the sample generated rate (n_{ay}/N_{ay}). Thus, it represents a compromise combining aspects of the two major approaches to dealing with complex sample survey design (Manton, Woodbury, et al., 1986). In this model the effects of within cluster correlations due to cluster sampling can be reflected in the estimate of s while the effects of stratification can be explicitly modelled.

The specific steps in model building would be similar for both the beta binomial and the negative binomial models. For example with the negative binomial model one could proceed with a sequential approach to the analysis of data. One could first introduce age specific constants in modelling rate estimates over time and for different population groups. The coefficients for those constants would reflect the average age specific morbidity or disability rates over all periods and cohorts. The estimate of s in this case would represent the degree of excess variation of the observed rates from that expected under a Poisson model. To the basic age model (whose parameters could be used to calculate an "average" life table over all periods) we would then add period specific parameters. The significance of these parameters would he tested by standard likelihood ratio procedures. If significant this would suggest that the life tables were different over time. After introducing the period effects, cohort effects would be introduced to determine if there were different age trajectories of disability change across cohorts. Subsequent tests would be constructed for other relevant covariates. At the point at which one stops adding in effects (or selects only those that are significant) the composite rate estimates would be calculated and employed in the life table computations to be presented in the next section.

Since much of our data is derived from complex sample surveys we will need to consider how design effects will affect hypothesis testing. Fay (1985) discusses this in the context of contingency tables and presents two options. One is to use classical likelihood procedures with parameters estimated for specific sample strata. This produces appropriate test statistics but has the disadvantage of requiring the estimation of large numbers of parameters. On the other hand, for analyses conducted using the Grade of Membership model described in Section 4 (below) this approach is readily implemented since each individual is in effect treated as a sample stratum of size = one person. A second approach is to use some form of jackknife or bootstrap procedure. Fay (1982) presents a program for this for jackknifed tests for contingency table analysis for complex sample designs. Fay (1983) presents documentation for this program (both are in the public domain and have been used by us in analyses of complex survey data from the Epidemiological Catchment Area Study) and comments and gives examples of specific strategies that could be used in implementing the approach. The disadvantage with this approach is its heavy computational burden. A third approach is exemplified by the models of Cohen (1976) and Rao and Scott (1981) in which an overall correction factor to the chi-squared statistic is based on weights related to the measures of design effects (deffs) used by survey samplers to assess the efficiency of the complex design vis a vis the efficiency of a simple random sample of the same size. In each series of cross-sectional survey analyses we will select from among these three approaches based upon an assessment of their relative performance in a small set of "test" cases.

B. Description of Grade of Membership (GOM) Model

In the prior subsection we described a range of statistical procedures that were employed to model disability and mortality prevalence and incidence rates. However, functional status is a complex, multidimensional phenomena that may require a multivarlate analytic approach. Because of this complexity, our analyses of cross-sectional and longitudinal surveys requires that we can model multivariate event history processes, adjust for unobserved heterogeneity, deal with complex samples, and not require strong assumptions about either the distribution of unobserved risk covariates or the hazard function. Currently, among the most advanced procedures for analyzing event history data are the multivariate event history models described by Heckman and Singer (1984a, b). Though useful in many applications these procedures do not satisfy our requirements for a multivariate analytic procedure because a.) it is not clear how to adjust these models for complex sample design effects, b.) there are few examples when they are applied to multi-episode event history data, and c.) they require assumptions about the form of the hazard function, which, in lieu of strong ancillary evidence about the form of the hazard functions, can lead to difficulties because results can be, in certain types of data, strongly determined by the selection of alternative forms (i.e., Trussell and Richards, 1985).

An alternative model that is often used in the analysis of panel data is the LISREL procedure. That procedure may be useful in describing change on a number of continuously distributed variables. It is not appropriate for our studies of extreme elderly populations where there is a strong interaction between the processes guiding changes in the continuous variables and the effects of systematic mortality selection.

The procedure we did select fulfills our basic requirements for an analytic procedure. This procedure is the Grade of Membership model and is based upon a "fuzzy" set classification procedure where we have altered the state description to appropriately represent the time domain. Specifically, we can define the basic model by a simple fractional bilinear equation. If we define each data element as a binary variable, x_{ijl} which is either 0 or 1 for the lth response ($l=1, \ldots, L_j$) to the jth variable ($j=1, \ldots, J$) for the ith person ($i=1, \ldots, I$), then we can predict each element as a function of two types of coefficients. The first coefficient is g_{ik}, again where i refers to the person and $k = 1, \ldots, K$ refers to the number of basic response profiles necessary to explain the variation of the x_{ijl}. This coefficient is estimated under the constraints that $\Sigma_k g_{ik} = 1.0$ and $0 \leq g_{ik} \leq 1.0$. This parameter is a score (not a probability) describing how much of the $\{x_{ijl}\}$ for a person can be explained by one of K sets of profiles. The profiles are described by the second set of coefficients. These coefficients, λ_{kjl}, are the probabilities that a person exactly of the kth type (i.e., $g_{ik} = 1.0$) has the lth response to the jth variable). Because the g_{ik} coefficients vary continuously between 0 and 1 this makes the model much more general than usual crisp classification procedures where a person has to be in one and only one of the K groups (i.e., g_{ik} must be 1.0 for only one class and 0.0 for all others). With these definitions the basic (cross-sectional) model can be written:

$$\Pr(x_{ijl} = 1) = \sum_k g_{ik} \lambda_{kjl} . \qquad (2.3.1)$$

To relate the definitions of the $\{g_{ik}\}$ and $\{\lambda_{kjl}\}$ to a more standard multivariate procedure we note the logical similarity of the $\{g_{ik}\}$ to factor scores, and the $\{\lambda_{kjl}\}$ to factor loadings, in factor analysis. The analogy to factor analysis should not be taken too far, however, since factor scores can vary from minus to plus infinity while the g_{ik}'s are bounded between 0 and 1.0, inclusive--a restriction that yields special properties to substantive interpretations of the Grade of Membership model results (especially in describing stochastic processes which, for GOM, are constrained to operate in a K-l dimensional simplex) and which is a constraint that is important in estimation. The g_{ik}'s must also be clearly distinguished from the posterior probabilities of being exactly classified in a discrete mixture model. These latter probabilities are different parameters that really represent $\{\Pr(g_{ik}=1)\}$. The λ_{kjl}'s are also different from factor loadings since the Grade of Membership model is a discrete response model, so that the λ_{kjl}'s are probabilities while, in the factor analysis model, the factor loadings are correlations between the measured variables and the analytically determined factors.

The Grade of Membership **model has several** other useful statistical properties that distinguish it from other multivariate procedures. Estimation is conducted using MLE procedures by applying Newton-Raphson procedures to the following conditional multinomial likelihood function:

$$L = \prod_{i} \prod_{j} \prod_{l} \left(\sum_{k} g_{ik} \lambda_{kjl} \right)^{x_{ijl}} \qquad (2.3.2)$$

This likelihood function (or an equivalent unconditional Poisson form) involves the simultaneous estimation of the $\{g_{ik}\}$ and the $\{\lambda_{kjl}\}$. In the standard factor analysis model, the two sets of coefficients are not jointly estimated, i.e., the factor loadings **are** first estimated and then the factor **scores** are calculated Thus, in standard factor analysis some assumption regarding the distribution of responses over persons (e.g., multivariate normality) is necessary. In the Grade of Membership model the $\{g_{ik}\}$ and $\{\lambda_{kjl}\}$ are jointly estimated using (2.3.2) and no parametric distributional assumptions about responses over cases are made. Nonetheless, the $\{\lambda_{kjl}\}$ can be proven to be consistently estimated by appropriate modification of the five conditions presented in Kiefer and **Wolfowitz** (1956). **These** five conditions (i.e., **existence** of the density f(x) of $\{x_{ijl}\}$ with respect to an appropriate **σ-finite** measure; continuity of the density; measurability; **identifiability;** and integrability) **require** that we examine the metric of the likelihood function to see how implicit, nonparametric constraints operate in the likelihood function to ensure the consistency of the structural **parameters,** i.e., the $\{\lambda_{kjl}\}$. **In** Tolley et al. **(1987a)** Consistency Of the $\{\lambda_{kjl}\}$ **follows** from **"packaging"** the observable data into sets of R replicates where each replicate has a sufficient number of cases to algebraically calculate all $\{g_{ik}\}$ and $\{\lambda_{kjl}\}$ for that subsample. Specifically, by assuming that the density f(g) of $\{g_{ik}\}$ has compact support, **Tolley** et **al.** (1987a) replace the Kiefer-Wolfowitz metric $\delta_0(\gamma_1, \gamma_2)$, where $\gamma = (\{\lambda_{kjl}\}, f(g))$, with a sequence of metrics $\{\delta_R(\gamma_1,\gamma_2)\}$ based on differences of moments of $f_1(g)$ and $f_2(g)$ up to order R. This generates an equivalence class of distribution functions that have their **first** R moments equal, and all Cross product moments up to order R-l equal also. The identifiability assumption of Kiefer-Wolfowitx is restated and then proven in terms of the identifiability of the equivalence class for which $\delta_R(\gamma_1, \gamma_2) = 0$. Within this class, however, further identification of the mixing distribution density f(g) is not possible. This means that the $\{\lambda_{kjl}\}$ **are** consistently estimated for all distributions of the $\{g_{ik}\}$ which are unique up to the first R moments. Furthermore, the moments of the distribution of the $\{g_{ik}\}$ are consistently estimated up to order R. Thus consistency can be proven with no specific parametric distributional assumption of individual responses.

It should also be noted that the Grade of Membership model implies constrained maximum likelihood estimation because of the constraints on the range of g_{ik}'s and λ_{kj}'s to the interval (0, 1). Tolley et al. (1987) show that the standard chi-squared approximation to the change in the log likelihood function between nested models holds approximately even under such constraints.

Another useful statistical property of the Grade of Membership model is the way that it reflects the effects of complex sample designs on inferences. Specifically, since each person can be viewed as a sample of size one with a unique vector of g_{ik} values, all possible design effects are incorporated in the standard **MLE's** obtained from (2.3.2). Thus, except for post-weightings to reflect the population distribution of characteristics (e.g., see eqns. (2.3.20) and **(2.3.21),** below), the ML procedure adjusts for all sample design effects. Having discussed the basic GOM model and the life table concepts necessary to examine the incidence and prevalence of disability **are** now used to **specialize** the GOM model for implementation of those life table measures for different types of data.'

C. Cross-Sectional GOM Analysis

Application of single and multistate life table methodologies to the analysis of active and healthy life expectancy requires selection of some strategy to deal with the fact that "active life" and "healthy life" may be multidimensional constructs. For example, one strategy is simply to define several categories of disease and label **a** person as healthy or morbid according to whether he or she has been diagnosed as having any of the selected diseases. A second strategy is to &fine classes of disability (e.g., IADL, **ADL, IADL2)** and then to assign a person a disability score according to the number of categories that apply to him or her. The basic active life expectancy model and estimates of active life expectancy and different patterns of LTC service use are illustrated in Figures 1 and 2a and b where a continuum from any one IADL limitation, through 1 to 6 ADL limitations, to nursing home residence use is treated as a continuous gradation.

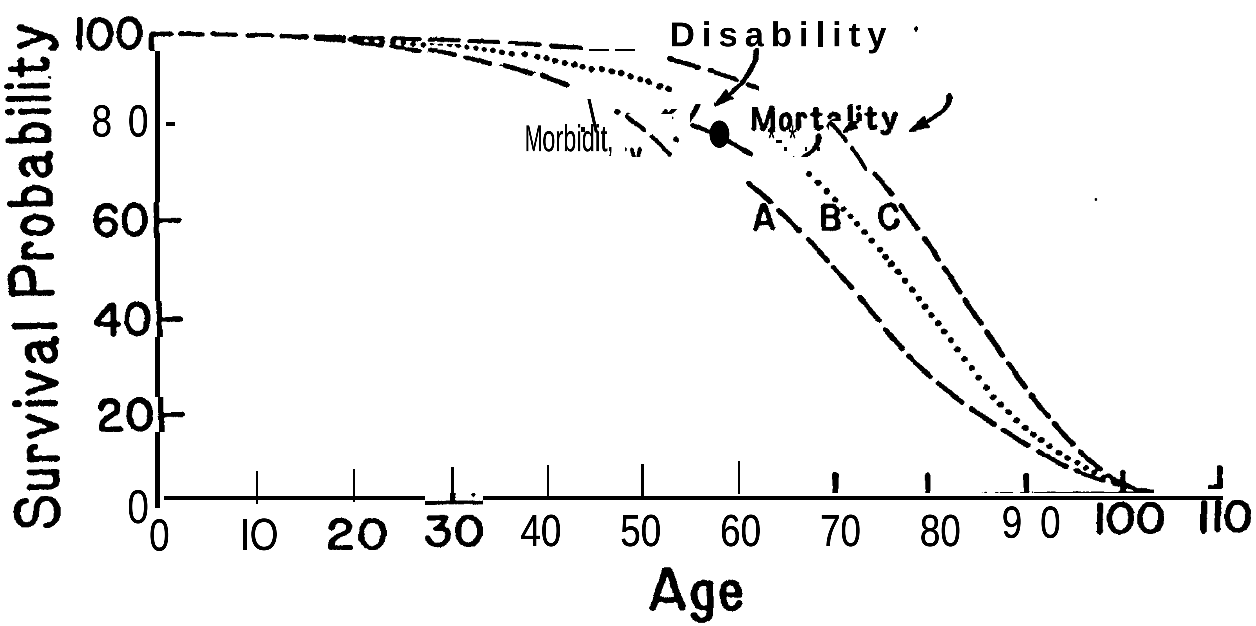
Figures 1, 2a, 2b, & **2c** About Here

When 2a and 2b are compared **with** the model in Figure **2c,** however, it is clear that other, alternative gradation systems (for other types of questions) can be equally compelling. In the case of Figure **2c** the alternative is based on gradations of the type and level of care required by the various population subgroups. A third strategy is to combine the first two. This requires that we can deal simultaneously with both categorical and continuous gradations of disease and disability along one or more dimensions of a multidimensional classification system The advantages of this strategy are that a.) one does not have to ***a priori*** choose one or the other of a broad range of alternative unidimensional strategies; and b.) one can allow the final selection of a single or a small number of relevant dimensions to be based on the characteristics of the survey population. To implement this strategy, however, requires the appropriate modification of the GOM model for complex sample survey data.

An useful property of the GOM model is the way in which the effects of complex sample design can be represented. Specifically, because unique g_{ik} coefficients are estimated that describe the variation of the $\{x_{ijl}\}$ for each individual, each person may be viewed as his own sample stratum, with a stratum size equal to one person. As a consequence, the GOM model automatically produces stratum specific parameter

Figure 1

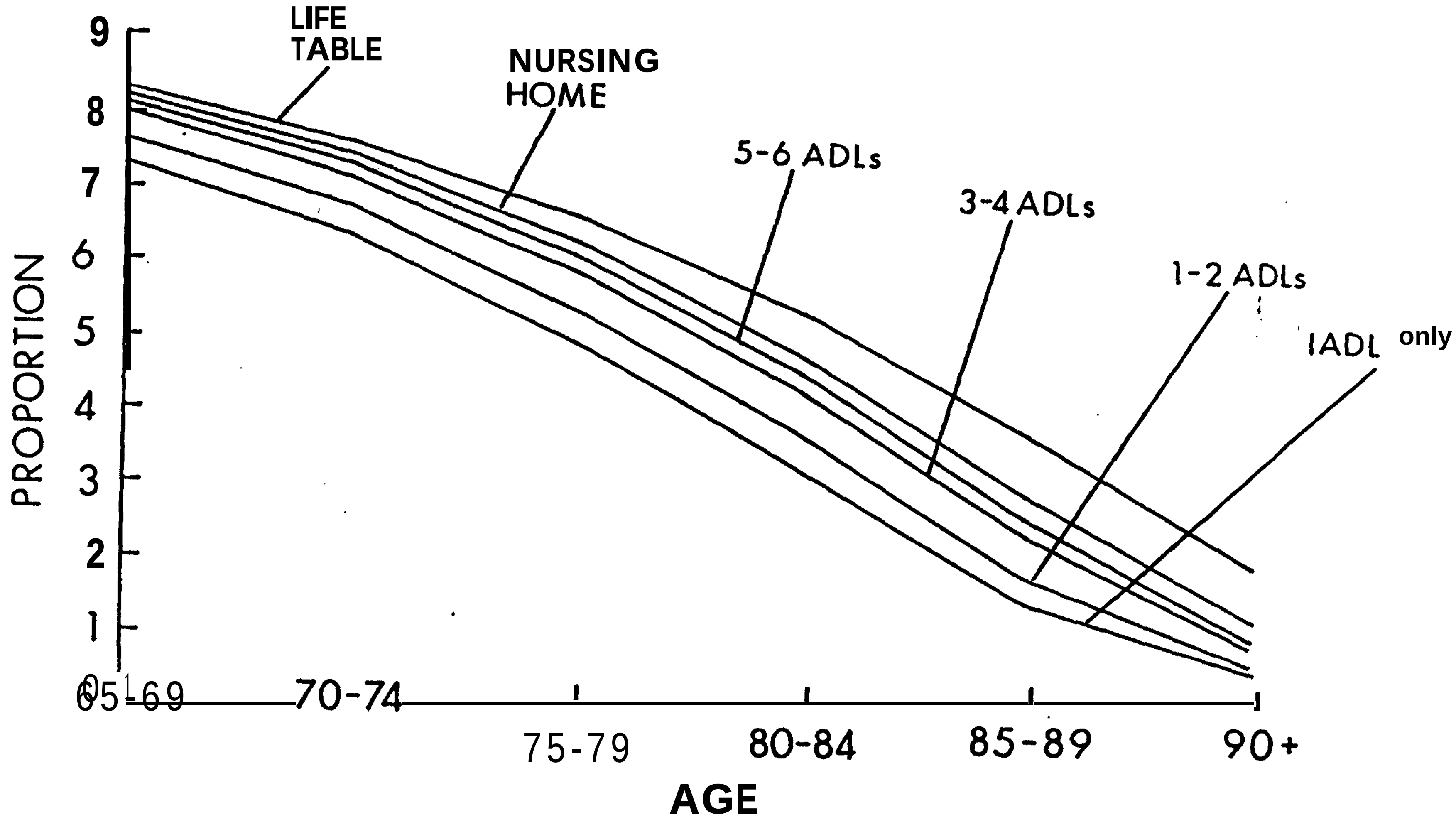
The mortality (observed), morbidity (hypothetical), and disability (hypothetical) survival curves for U.S. females in 1980



Source: **Manton & Soldo,** 1985, p. 210

Figure 2A

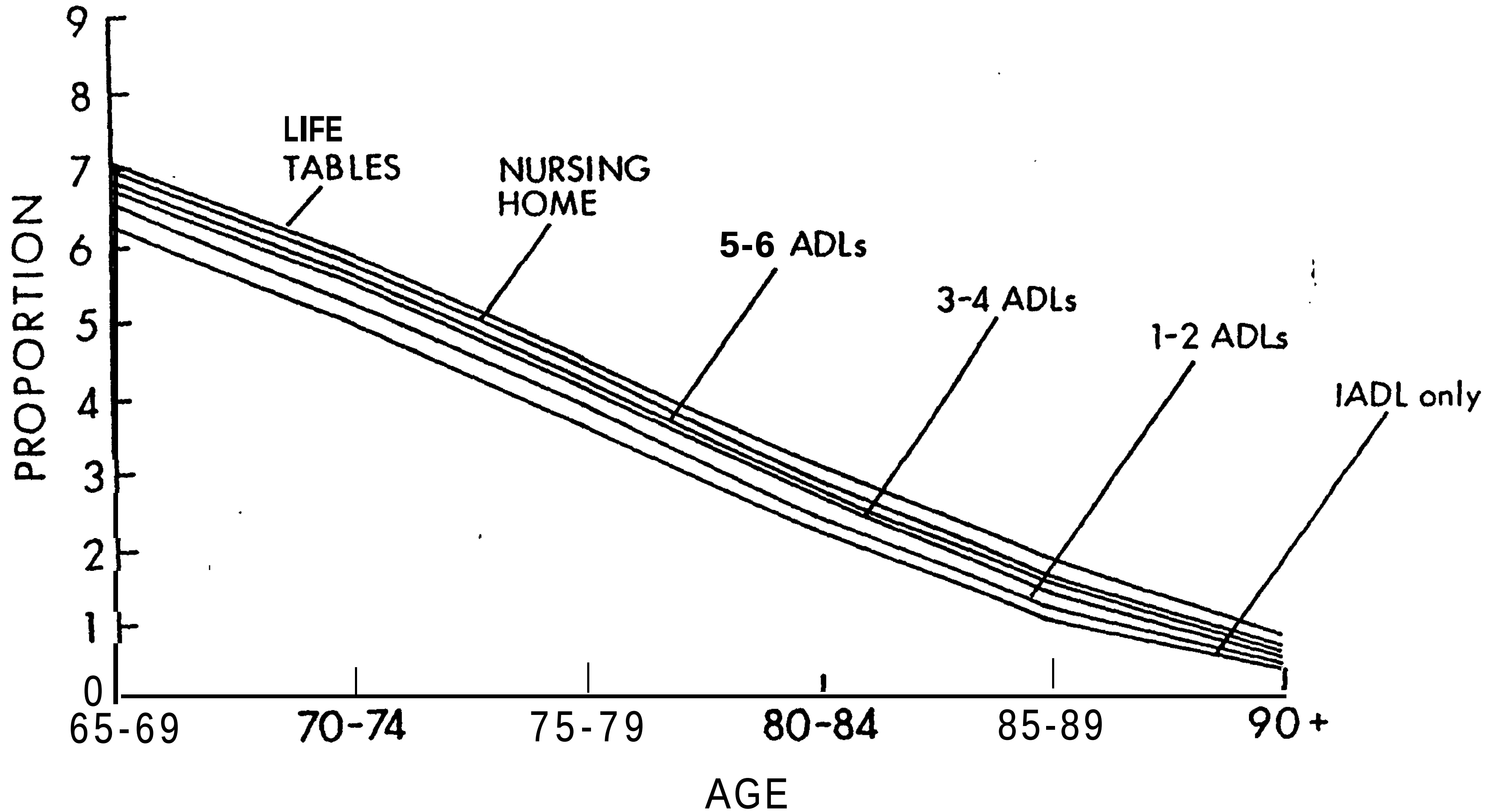
The observed mortality and hypothetical morbidity, disability and long-term care service use survival curves for U.S. females, 1980



Source: *NNHS* data tapes; U.S. Census Bureau, ***Current Population Reports,* P25,** *No.* 917, table **2, 1982;** NLTCS data tapes; Social **Security** Administration, 1982

Figure **2B**

The observed mortality and hypothetical morbidity, disability and long-term cafe service use survival curves for U.S. males, 1980



Source: NNHS data tapes; U.S. Census Bureau, *Current Population Reports*, P25, No. 917, table 2, 1982; NLTCS data tapes; Social Security Administration, 1982 estimates and all of the effects of sampling are represented in the $\{g_{ik}\}$ so that the classical MLE's are not biased. To represent the effects for a given population it is necessary only to use the $\{g_{ik}\}$ with the sample weights.

To verify this property, Woodbury and Manton (1985) investigated the conventional weighting approach in the context in the GOM model. Specifically, weights $\{w_i\}$ were assumed for each individual (i) which were proportional to the inverse of the his or her selection probabilities. The proportionality constant was arbitrarily selected to fix the sum of the weights equal to the sample size. These weights were then applied to the individual components of the logarithm of the GOM likelihood yielding an expression of the form

$$\ln L(\{w_i\}) = \sum_i w_i \{\sum_j \sum_l x_{ijl} \ln [\sum_k g_{ik} \lambda_{kjl}]\} \quad (4.3)$$

assuming the multinomial form of the model in (4.2). The asymptotic properties of $L(\{w_i\})$ were evaluated vis-a-vis the unweighted likelihood, $L(\{1\})$, and it was shown that although both estimators were consistent, the unweighted likelihood yielded smaller variance estimates and, hence, more precise estimates. This suggests that if the sampling mechanism is noninformative, then the use of the weights yields unnecessary large variances of the parameter estimates for GOM.

On the other hand, if the sampling mechanism is informative, then values of the design variables could be included in the analysis to reflect this information directly in a unweighted analysis. Furthermore, as shown in equation (4.1), the GOM model produces additional sets of parameter estimates $\{\lambda_{ijl}\}$ specific to each individual in the sample. Thus, estimates of the response probabilities in a complex sample could be obtained by applying conventional weighting procedures to the $\{\lambda_{ijl}\}$, after an unweighted GOM analysis.

Such an approach would closely follow the principles identified by Hoem (1985). Specifically, Hoem (1985) gives a detailed account of the arguments both pro and con for weighted estimators based on life history data. The essential point made in the case against weighting is that the sampling mechanism is (usually) noninformative in the sense that it is stochastically independent of the outcome of the life histories. On the other hand, if the sampling mechanism is infomiative (i.e., sample depends on life histories) then Hoem argues that some type of weighting should be used, though the precise method of weighting should depend on the model.

Once these issues have been resolved for a specific estimation problem it is then relatively straightforward to translate the resulting GOM parameter estimates into population prevalence rates using conventional weighting. For example, let x_{ijl} be a response whose prevalence rate we wish to estimate and assume that estimates of the $\{g_{ik}\}$ and $\{\lambda_{ijl}\}$ are already obtained using one of the alternatives just described. The prevalence rate p_{jl} of x_{ijl} can then be obtained from

$$p_{jl} = \sum_i \lambda_{ijl} \cdot w_i / \sum_i w_i \quad (4.4a)$$

$$= \sum_i w_i \left(\sum_k g_{ik} \lambda_{kjl}\right) / \sum_i w_i \quad (4.4b)$$

$$= \sum_k \left(\sum_i w_i g_{ik} / \sum_i w_i\right) \lambda_{kjl} \quad (4.4c)$$

$$= \sum_k \bar{g}_k \lambda_{kjl}, \quad (4.4d)$$

where $\bar{g}_{ik}$ is the weighted average of the GOM scores in the sample. Thus the question of weighted estimation of population parameters can be separated from the question of weighted estimation of the individual subjects' parameters, i.e., the $\{g_{ik}\}$ and $\{\lambda_{ijl}\}$. Such separation does not occur with other multivariate procedures such as factor analysis or principal components analysis, as noted above, because individual specific parameters are not estimated simultaneously with the structural parameters of these models.

The primary use of the GOM model in cross-sectional studies is to generate sets of K scores that will describe each individual's functional and health characteristics in a more parsimonious way than the J observed measures. This is accomplished by introducing functional and health measures from the relevant data set and extracting a sequence of sets of profiles with increasing K until the (K+1)th profile is no longer significant. The $\{g_{ik}\}$ obtained from the Kth set can be used in a number of ways in subsequent analyses.

One way they may be used is to extrapolate from the experience from one study to that of another. For example, in the National Channeling Study we could determine the probability of certain health outcomes for a person with a given set of g_{ik}'s. It would be possible to test if, for the same set of g_{ik}'s, the probability of that outcome were the same in the experimental and control populations. Once the probabilities are determined one can see what the distribution of outcomes would be like in the national population by applying the probabilities of the event estimated in the community population for a person with a given $\{g_{ik}\}$ by the probability that the $\{g_{ik}\}$ would occur in the national population. Indeed, such a use was the primary rationale for the National LTC survey.

A second use of the $\{g_{ik}\}$ is to generate life tables for different types of outcomes and show how they vary as a function of different types of morbid conditions. Specifically, suppose measures of functional ability are assessed in a GOM analysis and a set of K profiles generated (e.g., in Manton (1987), 27 ADL, IADL and IADL2 measurements were analyzed and five profiles were identified). Every person has a score on each of the K profiles. Each score may be introduced into a regression analysis as a dependent variable where the independent variables represent the presence or absence of a given condition. Linear effects of age may be represented by interaction of the indicator variables with age . In this case, the coefficient for each variable represents the age variable effect of a given medical-eondition on a given dimension of disability. In symbolic terms this may be written,

$$g_{ik} = \sum_{m} \beta_{km} \left[Age_i \; D_{im} \right] + e_{ik} \qquad (4.5)$$

where g_{ik} is the kth functional score for the ith person generated from the disability and functional impairment measures introduced into the GOM analysis, the $\{\beta_{km}\}$ are the regression coefficients describing the change in the g_{ik} score due to the presence of the mth condition, Age_i is the age of the individual in years, and D_{im} is a dummy variable indicating whether (D_{im} = 1) or not (D_{im} = 0) the ith person has the mth condition. The results of such an analysis (presented at The Workshop on Prevention as a Way to Improve Work Capacity in Older People sponsored by ASPE at the Brookings Institute, May 8-9, 1986), based upon data from the 1982 NLTC survey, are presented in Table 1.

Table 1 About Here

We see that there are five sets of profiles (the columns that are headed by a descriptive label derived from an analysis of the $\{\lambda_{kjl}\}$ profiles) and that the age specific effects (in this table age = 67 in order to evaluate the implications of recent changes in the social security entitlement age) of each of twelve medical conditions is presented Notice that the sum of the coefficients $\{\beta_{km}\}$ across the five columns equals zero so that the change in disability for a given condition is consistently reflected by compensating changes for all five types of profiles.

These "influence" functions, being explicit functions of age, can be plotted against age. Furthermore, since there are K regression functions we can determine the changes in prevalence with age of each type of disability. Furthermore, one can calculate these curves under assumptions about different changes in morbidity or, alternately, use them to assess the different effects of different types of morbidity and disability in different types of populations.

As written, the set of K equations in (4.5) represents a many-to-many mapping from the set of chronic disease indicators to the set of K disability profiles determined by the GOM analysis. Because these mappings are age specific we can consider three different ways that they may be used to provide the age specific prevalence rates underlying the survival model depicted in Figures 2a, b andc used to generate the cross sectional estimates of active and healthy life expectancy.

Table 1
Estimates for a specific age (67 years) of the effects of 12 medical conditions on the weighted prevalence of five types of disability profiles

	Proportion in Total Sample with Medical Conditions	Type 1 "Healthy"	Type 2 Mobility Limited	Type 3 Circulatory and Respiratory Impaired	Type 4 Cognitive Impaired	Type 5 Acute Medical Problems
				Regression Coefficients		
Rheumatism	73.2	-8.04	**1.97**	6.69	**-2.69**	2.01
Diabetes	16.6	-7.01	**-1.47**	I:88	0.61	**6.03**
Cancer	6.4	-3.62	**-0.21**	-1.74	-0.61	6.23
Arteriosclerosis	31.4	-6.63	**-2.41**	1.21	2.68	5.16
Senility	9.12	-15.41	**-10.72**	-7.84	10.18	i3.85
Heart Attack	6.2	-7.37	**0.72**	4.29	0.29	2.08
Hypertension	47.1	-1.34	**0.64**	3.35	-1.41	-1.22
Stroke	6.6	-10.39	**-0.87**	-2.55	-0.35	14.07
Bronchitis	12.9	-5.23	**-3.28**	7.34	-1.34	2.35
Emphysema	9.9	-1.81	**-1.76**	1.27	0.01	2.28
Hip Fracture	2.3	-13.67	**14.74**	-5.16	-4.76	8.84
Other Fractures	5.5	-6.50	**0.88**	3.75	-2.88	4.71
Prevalence of **Disability Profile with No Change** in **Medical** Conditions		31.4%	20.7%	19.3%	11.4%	17.2%
Prevalence of Disability Types if Medical Conditions are **Eliminated**		**47.6**	**21.2**	**10.7**	**12.6**	7.8

SOURCE: **1982 NLTCS**

First, we can use the prevalence of the conditions in place of the indicator variables in (4.5) to generate estimates of the average GOM scores. These average GOM scores may then be used in (4.4d) to generate the prevalence of disability or any other attribute which is associated with the chronic diseases used in (4.5). At the bottom of the table we show a.) the prevalence in the community disabled population of the five types of disability at age 67, anb b.) the estimated prevalence of the five disability types if selected the medical condition were eliminated. These may in turn be used to generate the cross sectional life table values required for computing active life expectancy.

Second, we may use any of the dimensions established in the GOM analyses as pure indexes of disability and treat the associated GOM scores for the selected dimension as continuous measures. For example, we saw in Figure 2a how ADL scores could be used to classify cases in the NLTCS on level of disability. In a similar way, the first pure type profile identified in Table 1 is a healthy type so that the associated set $\{g_{i1}\}$ may be treated as a continuous index of the dimension disabled-healthy defined on the range 0 to 1 with $(1-g_{i1})$ indicating the disability score for the ith individual. These scores may be recoded to a suitable number of categories for use in generating functions of the form in Figure 2a and the associated active life expectancy measures.

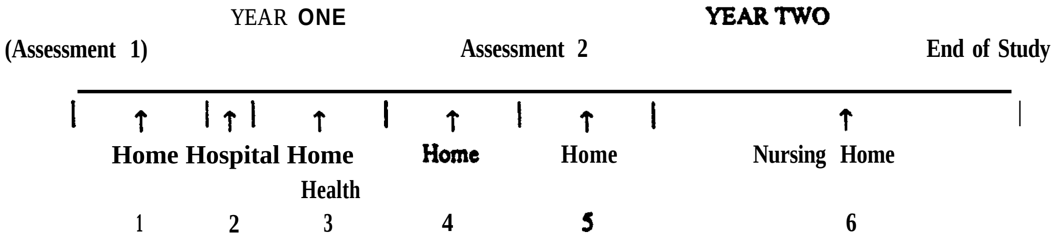
Third, the dimensions identified by the GOM model are typically few in number (i.e., K values in the range 3 to 6 are common). Hence, with only a small number of profiles to be identified and described, it may be the case that there is a natural ordering of the profiles along the range of least to most disabling conditions. In this case, the prevalence of each profile could be meaningfully defined in terms of the average GOM score on that dimension. These prevalence rates could then be handled as an ordered set in a manner similar to the service utilization scales in Figure 2c.

D. Longitudinal GOM Analysis

The utility of the Grade of Membership model for the appropriate life table analyses may be greatly extended by considering its use for multivariate, multi-episode event history analysis. The GOM model can be used for such event history modelling by making two modifications. The first involves redefining the metric of the likelihood function to reflect the assumptions made about the nature of the underlying stochastic process generating the study phenomena. The second involves the parameterization of the transitions that one wishes to evaluate.

We developed the longitudinal form of the GOM model because the available multivariate procedures that could be adopted to deal with longitudinal data were not appropriate for the type of longitudinal data that had to be dealt with in evaluating changes in the health and functional status of the old and oldest-old populations. One major factor that must be dealt with in such studies is that mortality rates for disabled elderly are high and are systematically related to the health and functional status measures whose changes one wishes to examine. Thus whatever longitudinal model is used it must explicitly represent the interaction of the dynamics of health factors with systematic mortality. LISREL, for example, provides no device to do this. Second, the data we wish to analyze are often discrete responses, making the assumptions of multivariate normality generally made in multivariate procedures invalid. Even in factor analytic schemes to analyze discrete response data the assumption is still made that the unobserved factors determined by the analysis are normally distributed (e.g., **Muthen and Christoffersson,** 1981). Because the g_{ik} **scores arc** estimated simultaneously with the λ_{kjl}'s in the GOM model, no specific parametric assumption is made about the distribution of responses over persons (see Tolley et al., 1987a). Third, there are frequently measurement problems, like right censoring and extreme variability of assessment times (i.e., in the California MSSP the "six" month assessments were made generally over a six month range from 3 to 9 months after the assessment), that could be handled by the GOM model. Fourth, the GOM model is able to describe multiple linked episodes--a facility available with few other procedures. Finally, the model could represent the effects of unobserved variables on the episodes (e.g., like **Heckman** and Singer, 1984) but without specific parametric assumptions about either the distribution of the unobserved variables or functional form of the hazard rate.

The change in the metric of the likelihood function is actually relatively straightforward One starts by considering an event time line for an individual as in the following figure.



In the figure we represent a hypothetical time line for a person in a study (of the type generally represented by our data--specifics of other surveys or demonstration data sets may vary such as assessment being every six months like the California MSSP, or their being assessments only at the beginning and end of the study). This particular person has six episodes during his period of observation defined by six transitions (including the end of study). In redefining the metric of our likelihood function we need to a) transform this person based record into episode based records, and b.) include the information on each of the episodes that reflects dependency across episodes (i.e., depending upon the nature of the process that is assumed one might, for example, need to identify what the immediately prior episode was).

We also see that, in the middle of the observation interval the person is reassessed, i.e., that all of the functional and health status measurements are retaken. In the case that the time of assessment is variable (and not at a fixed point for every person) we need to treat this as a type of episode termination to adjust for changes in the overall period of observation and, more specifically, for the censoring of any observations that could have occurred in episode 4. Naturally, one type of episode termination that could have occurred is "death" which would have permanently terminated the observation period. Thus, this record would have generated six episodes which we would create by noting the exact beginning and end **dates** of each episode and by noting the reason for termination.

The first problem for GOM, once the episode is created, is to classify those episodes into groups or types based upon the functional and health status characteristics associated with each episode (i.e., the $\{x_{ijle}\}$, where e indicates the episode sequence number, an additional subscript t maybe added to represent time within episode for use in duration dependent models). The first type of data are covariates. These have to be derived from the time of assessment. There are two such assessments in the above record. The values at these two assessment times have to be associated with each episode. To make these associations one can proceed in different ways depending upon what one assumes about how the changes between the two assessments occurred. The first assumption, which is the most basic, presumes that the attributes at the earlier assessment hold for all episodes occurring until the next assessment. At the start of the new assessment interval (i.e., beginning in episode 5) the covariates associated with the episode are the new (assessment 2) values. This type of model (i.e., with a "jump" in information at the second assessment) is fairly standard (e.g., similar type of assumption about hazard rates is made even in simple life table modelling) and is based upon the assumption that the attributes measured change reasonably slowly relative to the length of the observation window (Yashin et al., 1985). Actually such assumptions are frequently made in event history modelling and in epidemiological assessments when the risk factors at baseline are often used to predict subsequent risks over periods that are sometimes as lengthy as 20 years. Our intervals are much shorter and less likely to produce serious bias.

One could also examine alternative models for setting the values of covariates. For example, one could posit a linear model for changes between the two assessment times. This is perhaps appropriate for continuous variables but not for discrete variables (i.e., if one has no problem toileting at time one, but does have a problem at time two, what does one assign to an episode that began one-third of the way through the interval?). For discrete variables what one could is to assume that the probability of the event changes **linearily** and that, when the value of the event probability is **≥0.5** that any episodes after that point in time receive the value 1.0 (i.e.. the event occurred)--before that time the person received the value 0.0 (i.e., the event has not yet occurred).

To present these results more formally we need to present and describe the likelihood function for the time series data. This can be written as,

$$L = \prod_i \prod_e \prod_t \prod_j \prod_l \left(\sum_k g_{ike} \lambda_{kjl} \right)^{x_{ijlet}} \qquad (5.1)$$

where the index t will be suppressed for t $\equiv$ 1 in the following.

In addition to defining the episodes, and linking the episodes to covariates that **will** group the episodes according to the health and functional characteristics of people who enter them, it is necessary to estimate the transition parameters of the processes generating the episode. This is done by defining sets of transition variables based upon the amount of time (t), and mode of termination for each episode.

To be more specific, in the figure above we see that four types of episodes are defined (i.e., hospital stay; home health service episode; nursing home episode and community residence). For each of these types of episodes we can identify six modes of termination (i.e., one can move to a different one of the three remaining states, one can die, be reassessed, or the study can end). Thus, for each of the four episode types we can identify a variable when, for each of a set of time intervals, it can be determined if a person experienced each of the six termination modes. Clearly, for any given episode only one termination can occur (i.e., for the T [time intervals] by E [termination types] possible responses any person can have only one non-zero response--the remaining experience of the individual must be coded into other episodes). From these transition variables the $\{\lambda_{kjle}\}$ can be calculated, i.e., for each of the **K** analytic types defined on functional and health status variables we will have four transition variables. The $\{\lambda_{kjle}\}$ for these transition variables are identical to the d_x's in a life table so that any life table function could be calculated from the $\{\lambda_{kjle}\}$ estimates. In some analyses it will be useful to calculate multiple decrement life tables and in other cases one may wish to adjust for competing risks by using Chiang type adjustments to the probability estimates. Note that these multiple decrement life tables are state specific so that with information on multiple communicating states we will have the necessary information for calculating duration dependent multistate life tables of the type discussed in Section 2.

Actually, the transition variables may be defined in two ways. First, in the case described, the GOM profiles are calculated using the information only in the health and functional variables, i.e., though we calculate the $\{\lambda_{kjle}\}$ for each pure type, information on the transition variables is not allowed to influence the definition of the pure types. In the second case the transition variables are used, along with the health and functional status variables, to define the pure types. This second type of analysis is useful because it can be used to identify the effects of unobserved variables on the episode processes. Specifically, in the first case where the transition variables are not allowed to affect the definition of the **K** profiles the predicted single and multistate life tables reflect only individual health and functional differences. In the second the independent information in the transition variables is used to modify the pure types and improve the prediction of the life tables. If this improvement in prediction is significant (i.e., the change in the likelihood function terms associated with a given transition variable is significant) then we have evidence of influential variables that are not measured (Manton et al., 1987).

One additional use that can be made of the transition variables is to determine the effect of an experimental condition (e.g., the introduction of FPS). Specifically, it is clear that an episode can be associated with either an experimental or control group person. As a consequence we can code separate transition variables for experimentals (for this variable all controls represent missing data) and controls (for this variable all experimentals are missing data). Since the pure types can be defined for experimental and control episodes pooled, .the $\{\lambda_{kjle}\}$ can be forced to be the same for both experimental and control groups. Thus, the experimental and control life groups will have associated life tables that may be directly compared, with a statistical control on all variables used in their calculation. Thus, both the pure type life tables and the life tables associated with any given vector of g_{ik}-scores will be comparable.

A second use of the $\{g_{ik}\}$ is to examine changes in health and functional status profiles over time. Specifically, in a longitudinal study, measurements on an individual at different times may be treated as independent episodes and the episodes included in a GOM analysis as the basic units of observation, i.e., i is redefined to index episodes rather than individual persons. This means that the same $\{\lambda_{kjl}\}$ will be associated with the outcomes $\{x_{kjle}\}$ from different episodes but that the $\{g_{ike}\}$ for each episode could change. With the $\{g_{ike}\}$ so estimated, a variety of linear autoregressive modelling strategies (Yashin et al., 1985) Could be used to evaluate the cross-temporal change of the $\{g_{ike}\}$. Since the $\{g_{ike}\}$ can summarize a large number of variables, and can continuously vary, this considerably generalizes the life table model describing health and functional changes as simple one step discrete changes. As noted in Yashin et al. (1985), such linear autoregressive models can be viewed as special cases of the Kalman filter (Duncan and Horn, 1972). In complementing these regression models the two major conditions that need to be dealt with are the constraints on the $\{g_{ike}\}$ to lie in the interval (0,1) and the requirement that the g_{ike}-values for each person sum to one. The first condition will be satisfied in most empirical applications because the predicted values tend to regress toward admissible values. The second condition may require the use of LaGrange constraints on the estimation equation. Both of these issues will be investigated. The obvious advantage of such a simple linear autoregressive prediction scheme is that it allows for rapid updating and forecasting of the empirical distribution of the $\{g_{ike}\}$ without having to make strong parametric assumptions.

E. Life Table Analysis

After generating various probability estimates (whether directly estimated from prevalence or incidence data or derived from GOM analyses) we need to use those parameters to construct life tables or survival curves for different types of health outcomes. Such life table models can be generated using the standard life table functions. Examples of the integrated survival curves in such life table models are presented-in Figures 2a, b and c. In describing the methodology for constructing these functions we take the aggregate or total mortality life table as given. These are available on a race and sex specific basis from NCHS for three year periods centered on each census year, and from SSA (e.g., Wilkin, 1982) for the elderly on a sex specific basis for each calendar year. Furthermore, it should be stressed that such tables are available to us on a race by sex by year basis both for the entire nation and for geographic subdivisions down to the county level.

Basic Life Table Functions

The life table model is a tabular representation of the aggregate mortality survival function S(t). Below we review the basic life table functions for simple survival and then generalize these functions for multiple health endpoints. In a complete life table, function values are presented for each integer value of age or time since entry to state c_0. In an abridged life table, function values are presented for less frequent intervals of time, usually five years of age in mortality tables. For both types of life tables, the assumption that S(t) is a continuous nonincreasing function of time is basic. However, the precise continuous time form of S(t) is not identifiable from the standard sources of vital statistics data, namely, periodic follow-up on well-defined cohorts or cross sectional age specific mortality rates based on the ratios of the calendar year number of deaths to the midyear population count. Thus, different methods of constructing life tables from empirical data differ in their assumptions concerning the form of S(t) within age or time intervals. Furthermore, for cross sectional life tables additional assumptions are required about the rate of increase of the population over calendar time. For simplicity, in this section we assume that S(t) is known.

These assumptions allow us to define the life table for an initial population of size l_0 in state c_0 at time $t_0 = 0$ in terms of the following seven functions:

$$l_t = l_0 \, S(t) \tag{2.1}$$

$$_n d_t = l_t - l_{t+n} \tag{2.2}$$

$$_n q_t = {_n d_t}/l_t \tag{2.3}$$

$$_n h_t = -\ln\left(1 - {_n q_t}\right) \tag{2.4}$$

$$_n L_t = \int_t^{t+n} l_s \, ds \tag{2.5}$$

$$T_t = \int_t^{\infty} l_s \, ds \tag{2.6}$$

$$e_t = T_t/l_t \, . \tag{2.7}$$

Because l_0 and S(t) are assumed known, l_t is the expected number of survivors at time t in the cohort; $_n d_t$ is the expected number who die in the interval (t, t+n). The subscript n in (2.2) to (2.5) is suppressed for n = 1, by convention. Thus q_t is the conditional mortality probability for the interval (t, t+1), given survival to time t. From (2.1) and (2.4), it follows that,

$$ {}_nh_t = \int_t^{t+n} \mu (s)\, ds, \qquad (2.8) $$

so that $\mu(t)$ is the instantaneous force of mortality at time t and h_t is the cumulative mortality rate for the interval (t, t+l). Equations (2.1) to (2.4) do not require assumptions about the form of S(t) within unit time intervals; Eqs. (2.5) to (2.8) do. The functions ${}_nL_t$ and T_t denote the expected number of person years lived by the cohort in the intervals (t, t+n) and (t, ∞), respectively, while e_t denotes the expected average number of years per survivor to time t. This latter function is frequently referred to as the residual life expectancy at time t, as the age specific life expectancy at age t, or as the mean time to failure beyond time t.

A related function is the life table mortality rate, defined as the ratio of the number of deaths per time interval to the number of person years of exposure to death in that interval. From the above definitions, it follows that the age specific life table mortality rate can be defined as

$$ {}_nm_t = {}_nd_t/{}_nL_t \qquad (2.9a) $$

$$ = \int_t^{t+n} \mu(s) l_s \, ds \Big/ \int_t^{t+n} l_s \, ds \, . \qquad (2.9b) $$

Clearly, if $\mu(s)$ is constant on the interval (t, t+n), then ${}_nm_t = \mu(t)$, and, in view of (2.8), ${}_nm_t = {}_nh_t/n$. Hoem (1984) considers the implications of the constant force of mortality assumption and advocates it over the other two standard alternatives--the uniform distribution of deaths assumption; and the "Balducci hypothesis" of linearity of ${}_{1-s}q_{t+s}$ on the interval $0 \le s \le 1$. Fergany (1971) argues that even without the constant force of mortality assumption, the approximation $m_t = h_t$ will be usually good enough to use the observed age specific death rate as an estimator of h_t in empirical life table construction from vital statistics data.

The complement of the life table age specific probability of death ${}_nq_t$ is

$$ {}_n\bar{q}_t = \left(1 - {}_nq_t\right) \qquad (2.10a) $$

$$ = l_{t+n}/l_t \, . \qquad (2.10b) $$

This function is useful in developing discrete time forecasting formulas.

The above life table description applies equally well to cohorts and cross-sectional populations. We use l_{ay} to denote the life table survival function at exact age a and calendar time y. The sequence $l_{(a+t)(y+t)}$, t = 0, 1,..., denotes the cohort life table while $l_{a+t,y}$, t = 0,1,..., denotes the period life table.

Generalization of Life Table Functions for Multiple Health Endpoints: Static And Dynamic Models

The integrated survival model is composed of a series of life table survival curves distinguished by the different endpoints used in their construction, e.g., morbidity, disability, and mortality (see Figure 1). In presenting such models, we distinguish between survival curves generated from prevalence rates and those generated from incidence rates. In using the prevalence method, the age specific survival curve, l_{ay}, for all-cause mortality in year y is generated first; then, under an assumption of stationary population. dynamics, the morbidity, l_{May}, or disability survival curve, l_{Day}, for a specific chronic disease is generated by multiplying the survival probability l_{ay} by the complement of the corresponding prevalence rate, p_{May} or p_{Day}, with each computation performed on an age specific basis, i.e.,

$$l_{May} = l_{ay}\left(1 - p_{May}\right) \tag{2.11}$$

$$l_{Day} = l_{ay}\left(1 - p_{Day}\right). \tag{2.12}$$

In these models, l_{May} and l_{Day} depend on l_{ay} through the rates, p_{May} and p_{Day}; hence changes in l_{ay} in the interval (y, y + Ay) are in no way dependent on prior values of l_{May} or l_{Day}

In the incidence method, one replaces the assumption of stationary population dynamics with a multistate life table model which generates l_{May}, l_{Day}, and l_{ay} in such a way that all three curves depend on the morbidity, disability, and mortality processes at younger ages in each cohort Thus, by using the appropriate stochastic process models, the incidence method permits evaluation of cohort and temporal changes in population risk factor distributions and their relation to recent declines in national age specific morbidity and mortality rates. This provides a basis for projecting the consequences of continued declines in those rates on future morbidity and mortality levels.

Active And Healthy Life Expectancy

Active and healthy life expectancy are computed in an analogous way to total life expectancy. Whereas (2.7) shows that total life expectancy is obtained by integrating the total survival curve l_t over the right hand infinite interval, active life expectancy is computed by integrating the disability survival curve l_{Dt} over the same interval and healthy life expectancy by integrating l_{Mt}. Fort >0, the normalization factor in each case is l_t. Hence, we obtain the following expressions for active and healthy life expectancy at time t,

$$e_{Dt} = \int_t^{\infty} l_{Ds}\, ds/l_t \qquad (2.13)$$

$$e_{Mt} = \int_t^{\infty} l_{Ms}\, ds/l_t\,. \qquad (2.14)$$

Referring to Figure 1, one can see that area A = e_{M0}, area B = $e_{D0} - e_{M0}$, and area C = $e_0 - e_{D0}$. Figures 2a and b show how additional refinements to the model may be introduced by further classification of the disability category.

The above comparisons are "single year comparisons." This means that we can identify, say, what the period effect parameter β_{1985} implies for the estimate of active life expectancy in 1985 as measured by the life table parameter $e_{D0,1985}$.

A second form of comparison of the life expectancy measures from the life tables for two years or from the life table for one year with the life expectancy from a modified life table for the same year, but under some assumed intervention effect, can be developed using the method described by Pollard (1982). This method was modified by Manton and Stallard (1987) for the specific application to the comparison of two life tables, one of which is specifically designated as a baseline table. In cross-temporal comparisons, this would imply that the life table for the final data year (1985, say) was designated as the baseline and all other years were comparison years. In analysis of the effects of simulated interventions such as described above for the APC model or for simulated cause elimination interventions under the Chiang model of independent competing risks, the unmodified table forms the baseline and the table derived from implementation of the specific intervention is the comparison table. If we use asterisk (*) to denote the modified life expectancy and hazard rates in the comparison table, then the modified Pollard formula is:

$$\Delta e_t = e_t^* - e_t \qquad (2.15a)$$

$$= \sum_{s=t}^{\infty} \sum_{j=1}^{K} {}_s|P_{tj} \qquad (2.15b)$$

where

$${}_s|P_{tj} = \int_s^{s+1} \left(\mu_j(r) - \mu_j^*(r)\right) l_r^* e_r\, dr/l_t^*, \qquad (2.16)$$

where $\mu_j(t)$ is the cause specific mortality hazard at age (time) t due to cause j, j = 1,...,K. Thus (2.15b) represents an additive decomposition by age and cause of the change in life expectancy between the comparison and baseline tables. By modifying these equations to reflect the changes in active and healthy life expectancy, similar types of decompositions of these two measures could be conducted to identify the ages and causes (i.e., types of mortality or disability) which are the most influential in determining these changes.

Multistate Life Table And Compartment Modelling Strategies

In the prior section we discussed methods for generating measures of active and healthy life expectancy by linking prevalence estimates from cross-sectional surveys with cross-sectional life tables for the same calendar period. We referred to this procedure as a static model because the prevalence rates which underlie the computation of the morbidity and disability survival curves are independent from one period to the next. In fact, if cohort effects are modelled and are significant then the prevalence rates for adjoining years will exhibit a complex correlation structure which depends on the time series structure of the cohort effect parameters. If cohort effects are nonsignificant in the APC model, a cross-temporal correlation structure may still be induced if period effect parameters are systematic. The APC model thus permits greater insight into the static model than would be obtained using only the observed prevalence rates. In particular the detection of systematic period or cohort effect parameters for specific classes of morbidity and disability might be indicative of changing dynamics of health processes as functions of age, lifestyle, medical care, and social support systems. For example, increases up to 1982 in the age adjusted lung cancer incidence and mortality rates in the United States may be modelled as a consequence of cohort differentials in the prevalence of cigarette smoking (Manton et al., 1982).

The alternative to static modelling is dynamic modelling. Whereas the static models are based solely on the use of prevalence rates of various types of morbidity and disability, the dynamic models are based on the use of incidence rates for the onset of various types of morbidity and disability. The dynamic models also &scribe processes for which recovery rates from specific diseases, disabilities, or other transient health status can be specified. Note that dynamic models are required whenever the focus of interest is on the rates of occurrence of events within any subgroup of the population whose membership is not constant. Thus, the analysis of length of stay patterns in nursing homes, for example, requires the use of dynamic models.

Furthermore, such analyses are best conducted using the longitudinal follow-up study design such as in the NLTCS longitudinal components. For example, we commented earlier that the estimates of incidence rates from retrospective recall questions in cross-sectional surveys is subject to a selection bias in which the most serious (e.g., lethal) events are missing because the sample person is systematically excluded from the survey by the very event of interest.

The use of incidence rates'to describe transitions between various health and disability states leads to a multistate life table model in which the population at-risk to a given set of transitions is in general a subset of the total population. For any given state of the model, this then implies that the conditions for a stationary subpopulation are that the frequencies of input and output are in equilibrium. However, whereas the output frequency depends on the number of persons in the specific state, the frequency of input depends on the number of persons in the states that feed the specific state. This means that in a complex multistate life table, a change in any one rate can produce ripple effects throughout the whole system as a new equilibrium is established. On the other hand, if the system is in approximate equilibrium, then the output frequency from a given state will be close in value to the input frequency. This relationship was exploited in Woodbury and Manton (1982) to evaluate the rate of incidence of nursing home entry and the distribution of length of stay using data on the discharge sample of the 1977 NNHS.

The general form of a multistate life table is that of a stochastic process that evolves over time. A typical example of the types of processes that can be modelled with this methodology is represented by the states and transition rates of the component subpopulations of the NLTCS in Figure 3 for period 1982 to 1984. These states and transitions refer to the same type of loss of functional capability as described by the prevalence rates used to generate Figures 2a and b. Three subpopulations are defined, each with changing membership over time: (1) institutionalized persons; (2) community residents with limitation in IADL or ADL, and (3) community residents with no limitations in IADL or ADL or with limitations of only temporary duration (e.g., less than 3 months).

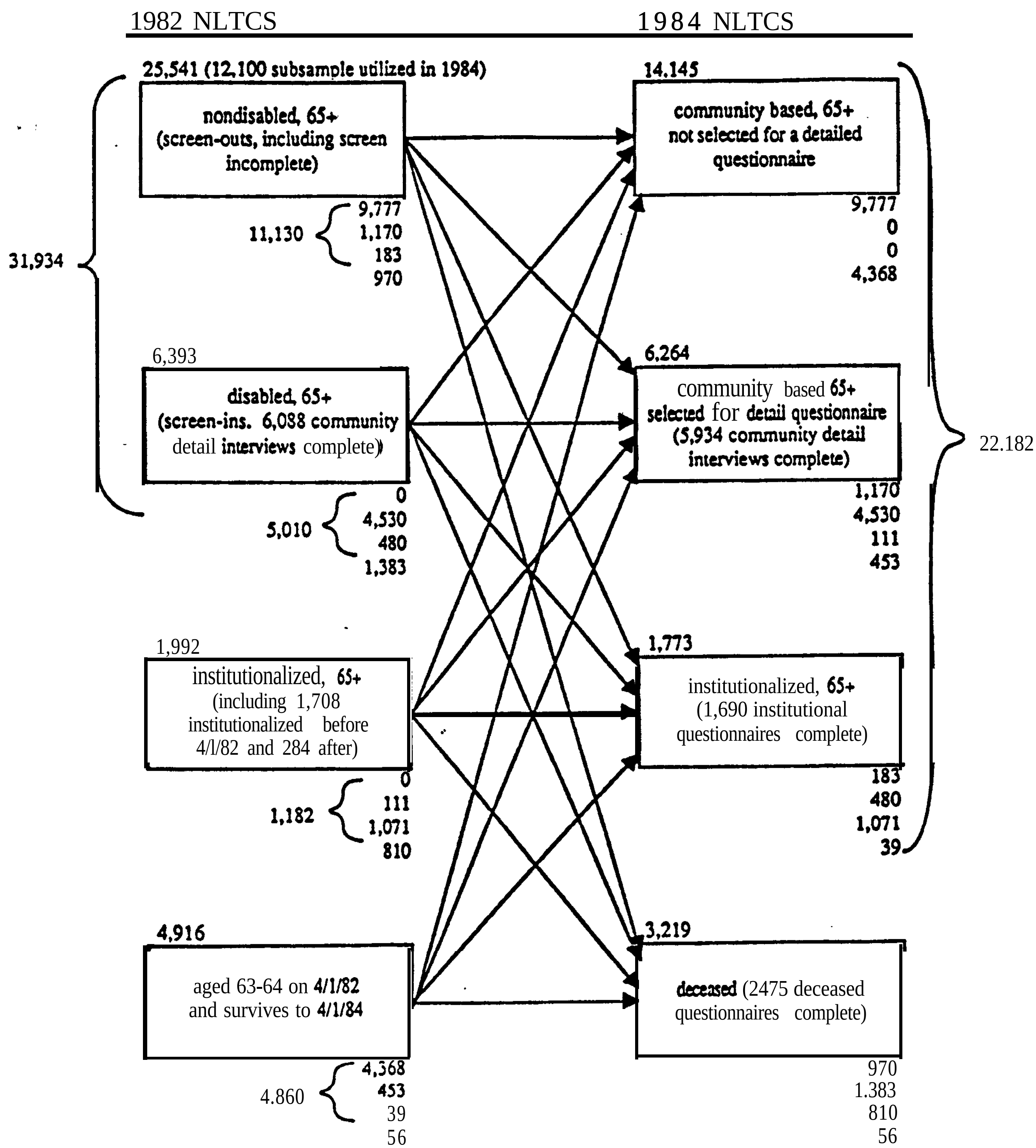
<u>Figure 3 About Here</u>

Because the NLTCS was restricted to persons age 65 years and over, a fourth subpopulation was defined for the 1984 survey comprising those persons who were aged 63 or 64 years old in 1982 and, hence, ineligible for inclusion in that survey. This subpopulation may be regarded as exogeneous inputs into the 3-state system defined above with the deceased cases (1984) forming the outputs of the system. Further insight into the nature of the transitions in Figure 3 can be obtained by decomposing the community disabled subpopulation according to level of disability. An example of such a decomposition is presented later in Table 29. The percentages in that table may be interpreted as transition probabilities which are generated by a continuous time Markov process (Kalbfleisch and Lawless, 1985).

These examples clearly show that if one wishes to fully describe the complex interactions of disease processes and the related morbidities, disabilities, and mortality they cause, it is necessary to expand the single state life table model to include additional states. Multistate life table models permit both increments and decrements to each state. Thus, for some chronic disease and disability processes where the transition is irreversible the methodology is more general than necessary. On the other hand, where states are defined to include attributes that are of temporary duration such as marital status, capacity for independent living, and temporary institutionalization then the general methodology is needed. The usual formulation of this model (e.g., Schoen and Land, 1979; Hoem and Funck-Jensen, 1982; Rogers, 1975, 1986) is as a time inhomogeneous finite state Markov process, with age as the time variable. With time treated as discrete in the survival updating equation this implies a finite state Markov chain.

Figure 3

Changes in the Status of Component Sub-populations of 1982 and 1984 NLTC Surveys



The practical implementation of this form of multistate life table model involves a number of technical details in the area of numerical analysis, not demography (Hoem and Funck-Jensen, 1982). In particular there are questions regarding the adequacy of various "integration hypotheses" used in calculating the multistate $\mathbf{L_a}$ values (see eq. (2.5.)). Krishnamoorthy (1979, p. 143) shows that the so-called linear hypothesis and the constant intensity hypothesis both yield age specific survival probability matrices which are the same up to the second order terms.

If we omit the details of the integration hypotheses, then the multistate life table model can be described as a straightforward generalization of the cohort life table in Section 2. We assume J states and an initial population at age a_0 of size $\boldsymbol{l}_0 = \boldsymbol{l}(a_0)$ as square matrix of order J. For simplicity we will write $\boldsymbol{l}_a$ as $\boldsymbol{l}$ (a), and the (i,j)th element as $l_{ij}(a)$, where $l_{ij}(a)/l_{jj}(a_0)$ denotes the probability that a person starting out in state j at age a_0 is in state i at age a.

The dynamic character of the multistate life table model is completely specified in terms of the Kolmogorov diffenntial equation governing the change in $\boldsymbol{l}$ (a) over time:

$$\frac{d}{da}\boldsymbol{l}(a) = -\boldsymbol{\mu}(a)\boldsymbol{l}(a), \qquad (3.1)$$

where $\boldsymbol{\mu}(a)$ is the J by J transition intensity matrix governing the process at age a, i.e.,

$$\mu_{ij}(a) = \begin{cases} \nu_{oj}(a) + \sum_{k \neq j} \nu_{kj}(a) & (i=j) \\ -\nu_{ij}(a) & (i \neq j), \end{cases} \qquad (3.2)$$

where $\nu_{ij}(a)$ is the transition intensity from state j to state i at time a, with i = 0 representing the death transition, by convention. More formally,

$$\nu_{ij}(a) = \lim_{\Delta a \downarrow 0} \left\{ \frac{1}{\Delta a} \Pr\left[C(a + \Delta a) = c_i \mid C(a) = c_j \right] \right\}, \qquad (3.3)$$

where $\{c_j\}$ denotes the set of J states plus c_0, the death state. In view of (3.3) it is apparent that various occurrence-exposure formulas may be derived for empirical estimation Of $\nu_{ij}(a)$.

Direct solution of (3.1) yields the two standard forms (Willekens et al., 1982):

$$l(a) = l(a_0) - \int_{a_0}^{a} \mu(s)\, l(s)\, ds$$

$$= l(a_0) \exp\left\{ -\int_{a_0}^{a} \mu(s)\, ds \right\} . \qquad (3.4)$$

The matrix analogue to (2. 10b) is obtained as

$$\mathbf{P}(a) = \mathbf{I} - \mathbf{h}(a) + \frac{1}{2}\left[\mathbf{h}(a)\right]^2 \ldots . \qquad (3.5)$$

where h(a) is the cumulative hazard matrix:

$$\mathbf{h}(a) = \int_{a}^{a+1} \mu(s)\, ds . \qquad (3.6)$$

This yields the life table updating function

$$l(a + 1) = \mathbf{P}(a)\, l(a) . \qquad (3.7)$$

Similarly, the person years **matrix** L(a) can be defied as

$$\mathbf{L}(a) = \int_{a}^{a+1} l(s)\, ds . \qquad (3.8)$$

This function can be used to define a variety of life expectancy formulas giving the average time to specified changes in state or to mortality (see Willekens et al., 1982, for examples).

These life expectancy calculations can be viewed as generalizations of (2.6) and (2.7). For example, let

$$T(a) = \int_{a}^{\infty} l(s) ds \qquad (3.9)$$

and

$$e(a) = T(a)\left[l(a)\right]^{-1}, \qquad (3.10)$$

where the inverse is assumed to exist. This will be the case if all states in the model have nonzero probability in l (a). The columns of e(a) reflect the life expectancy of a person in each of the J states given that the state of residence at age a is known. Thus, $e_{jj}(a)$ gives the active life expectancy for a person initially in the nondisabled community population (state j) at age a and $e_{+j}(a)$ gives the total life expectancy for such a person, where

$$e_{+j}(a) = \sum_{i-1}^{J} e_{ij}(a), \qquad (3.119$$

i.e., "+" implies summation over the indicated subscript.

Similarly, the total life expectancy in this population is a weighted average of the state specific life expectancies:

$$e_{++}(a) = \sum_{j=1}^{J} e_{+j}(a)\, l_{jj}(a)/l_{++}(a)\,. \qquad (3.12)$$

These calculations relate directly to the measures e_{Ma} and e_{Da} defined in Section 2, and explained in terms of the areas A, B, and C in Figure 1. To see this, let (A, B, C) be coordinated with the states (1, 2, 3). In this case, area A is given by $e_{1+}(0)$, where et+(O) is the healthy life expectancy at age a = 0. More generally, we have

$$e_{i+}(a) = \sum_{j=1}^{J} e_{ij}(a)\, l_{jj}(a)/l_{++}(a)\,. \qquad (3.13)$$

Thus we obtain the correspondence between the two types of models:

$$e_{Ma} = e_{1+}(a) \qquad (3.14)$$

$$e_{Da} = e_{1+}(a) + e_{2+}(a) \qquad (3.15)$$

$$e_{a} = e_{1+}(a) + e_{2+}(a) + e_{3+}(a)\,. \qquad (3.16)$$

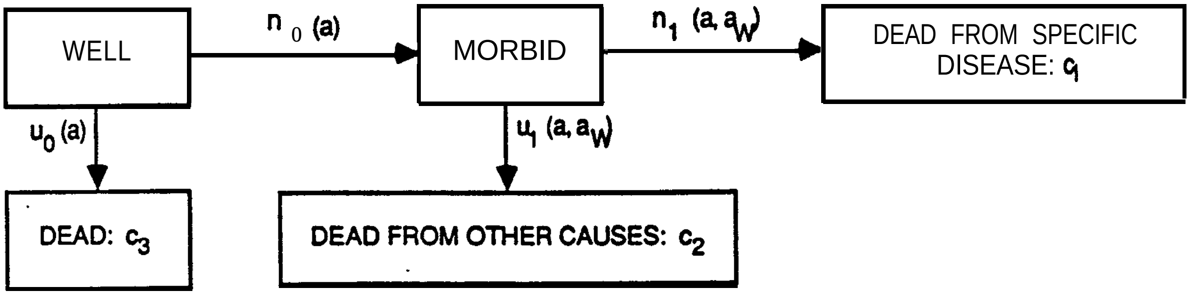
These equivalences clearly demonstrate that the multistate life table generalizes the single state life table to include transitions to nonabsorbing states. If the transition rates depend only on age then the model can be described as a time inhomogeneous Markov process with a finite number of states. This form of multistate life table model has been proposed for analyses of labor force participation (Hoem and Fong, 1976), marital status patterns (Schoen and Land, 1979; Krishanmoorthy, 1979), and multiregional migration patterns (Rogers, 1975, 1986). It had not previously been extensively applied to modelling health states (see Manton and Stallard, 1982 as an example).

For modelling chronic disease morbidity and disability processes, however, the risks of impairment, disability, handicap, and mortality are typically described in terms of the duration of the disease, not the patient's age, although in certain cases the patient's age may be an influential factor due to age differentials in overall vitality, the duration of risk factor exposures or the presence of co-morbidities. This suggests that multistate life tables for K chronic diseases must be at least K+1 dimensional in time. This form of multistate life table can be described as a time inhomogeneous semi-Markov process with a finite number of states. Unfortunately, without some very restrictive assumptions on the number K of diseases, the order of onset of these diseases, and the dependence of subsequent disease hazard rates on the manifest diseases, these models are difficult to implement. On the other hand, these models are important to consider whenever there is the possibility of duration dependence in the transition rates governing transfer between health states or service utilization categories. For example, we have found such a model useful in describing the latent development of solid tumors and have used it as a basis of a lung cancer forecasting model (Manton and Stallard, 1982, 1984, 1987). In this case it was biologically plausible that the risk of tumor diagnosis would be related to the size of the tumor, and hence, to the duration of the preclinical development period. A similar model structure could also be used in studying other diseases with progressive development and increasing severity over time since onset or diagnosis. We have studied such life table strategies in the case of complex morbidity, disability, and mortality transitions in longitudinally followed populations using a multivariate description of state (Manton et al., 1986). Examples of such life tables derived for a Gaussian stochastic process model of total mortality are presented in Yashin et al. (1986). Examples developed for functional and health dependence using a general nonparametric multivariate state description are provided in Clive et al. (1983). Woodbury et al. (1986a), Manton et al. (1986).

To be concrete, consider Figure 4. Two states are defined for the alive population: a "well" state, c_W, which is the initial state of the model which is exited at age aw; and a morbid state, c_M, which is entered from the well state at age aw. There are three causes of death in the model: (1) death from the specific disease, c_1; (2) death from other causes for persons in the morbid disease state, c_2; and (3) death from other causes for persons not in the morbid state, c_3. Thus c_1 denotes the cause under study, c_3 denotes other causes, and c_2 denotes the interaction of c_3 and c_M.

Figure 4

States and transitions of a two-state stochastic process



Each state for the alive population has two exits: One is governed by progression or mortality due to the disease (c_M or c_1); the other is governed by mortality due to other causes (c_2 or c_3). The model can be generalized to denote **K** stages of morbidity by replacing the c_1 state with a second stage of morbidity and defining two additional exits, with the first exit to either cause specific mortality (K=3) or to a third stage of morbidity (K>3), and the second to mortality due to other causes. This form of disease staging is discussed in Chiang (1979, 1984) for a time inhomogeneous Markov process with proportional hazards--a modelling assumption with potentially strong substantive implications. In particular, Chiang's model not only does not allow duration dependence but it also does not allow age dependence except for the special case that the relative increases in disease transition rates over age are all identical to the corresponding relative increases for the aggregate mortality hazard rates. Since the model provides no way to test these assumptions it is clear that a more general model, such as presented here, is needed for empirical analyses and model building for forecasting.

The procedure investigated in Manton and Stallard (1984, 1987) for models of this type is based on application of stochastic compartmental modelling techniques (Jacquez, 1972, Matis and Wehrly, 1979, 1981). In the usual statement of these models, the compartments are simply unobserved states of a multistate life table. For example, the preclinical phase of disease development is unobserved, by definition. The identification of such unobserved states, and of the functional forms of the transition rates into and out of those states is the main issue in compartment modelling. That is, once the compartments are defined and estimates of the transition rates obtained, one can then proceed as in a standard multistate life table model, modified to account for any duration dependence in the transition rates (Manton and Stallard, 1987). These strategies have been developed primarily for the analysis of a single disease process, where the specification of multiple compartments and the use of both theoretical and empirical transition rates have been investigated (e.g., Manton and Stallard, 1982).

More generally, however, we would consider the disability resulting from multiple types of disease as well as different types of disabilities affecting to varying degrees the capacity of very elderly persons to perform various activities of daily living both within institutional settings and in the community. This will require that we generalize our models to include multiple disease states, multiple disability states, both duration and age dependent transition rates, and both increments and decrements to the various states. The Grade of Membership model provides strategies for using alternative parameterizations of the individual's health and functional status "state" which may be a useful parsimonous (i.e., lower dimensional) description of such states and their transitions.

F. Tests and Application of the GOM Life Table Strategies

In the above, we described statistical methodologies for implementing the life table constructs in Figure 1 to our studies of functional impairment and service use. Those methods have been tested, validated and applied to a number of our analyses and have resulted in a number of policy paper and peer reviewed papers. For example, the basic prevalence and incidence rates measures were used in Manton 1988a,b. The basic life table measures are presented in Manton and Soldo 1987 and were presented at the recent quality of care are conference sponsored by HCFA in Baltimore (Manton, 1988). The use of GOM generated scores to examine the impact of specific diseases on age specific disability patterns was presented at the ASPE sponsored Workshop on Prevention as a Way to Improve Work Capacity in Older People at the Brookings InstituteMay 8-9, 1986. The cross-sectional GOM analysis was used in the development of case-mix indicators for home health services (Manton and Hausner, 1987). The dynamic GOM model was used to examine the impact of PPS on Medicare service use and mortality -- both in a recent DHHS report (Liu and Manton, 1988) and in articles submitted to peer-reviewed journals (Manton and Liu, 1988; Liu and Manton, 1988). Thus these two methods have been well tried and produced useful results. Many other analyses (e.g., such as in the Channeling and MSSP evaluations) have less successfully dealt with the duration data.

G. Projections and Forecasts, 1980-2040

Using data from the 1982 NLTCS, we generated projections of the long term care population by age (6574, 75-84, 85+) sex, marital status (married and nonmarried including widows, separated, divorced, and never marrieds) and disability level (IADL only, 1-2 ADL, 3-4 ADL, and 5-6 ADL limitations) specific rates to Social Security projections (SSA, 1980) of the U.S. elderly population (specific to age, sex and marital status) after the population had been adjusted for nursing home residence rates estimated from the 1977 NNHS. This produced age, sex, marital status and disability level specific projections of the noninstitutionalized elderly population for 1980, 1990, 2000, and 2040 which are reported in Section IV.E.

Similar projections were performed for the institutionalized population under the assumption that the annual nursing home utilization rate is about 2.1 percent. These results are also reported in Section. IV.E.

The above described projections assume that the current rate structure is stable through time. However, changes in health status at later ages will have significant effects on the growth of the long term care community and institutionalized populations. To represent this effect, we have produced another set of projections under the assumption that disability rates will be reduced proportionally as fast as the mortality rate declines assumed in the Social Security population projections. The effects of such reductions in disability on the long term care population are reported in Section IV.E. for both the noninstitutionalized long term care and nursing home populations.

In addition to the U.S. projections a number of projections were prepared for an international study sponsored by the HCFA administrator and coordinated by the HCPA Office of Legislation and Policy. In those analyses rates of disability from the 1982 NLTCS and the 1977 NNHS were applied to age and sex specific population counts from U.N. estimates and projections. This was done for all countries of the world. Those estimates were compared with the available data from specific countries to determine international differences in the epidemiology of disability and in institutionalization policies after population studies was controlled.

III. DATA BASES

A. The 1982 and 1984 National Long Term Care Survey

The 1982 and 1984 National Long Term Care Sweys (NLTCS) were designed to provide a database describing the chronically disabled, elderly population residing in the community. The survey covered five major areas of interest of that population, namely:

1. Medical status (diagnoses);
2. Functional status (ADL, IADL or other functional impairments, equipment utilized, caregivers);
3. **Income** and assets;
4. Use of health care services and sources of payment;
5. Housing and living arrangements.

The Center for Demographic Studies has prepared the public use data tape for this survey under Cooperative Agreement 18-C-98641 and relevant documentation (CDS, 1988) which are both available through the National Technical Information Service, and is providing technical assistance under a continuation of this project.

The 1982 National Long Term Survey

The 1982 survey is a nationally representative survey of the Medicare population over age 65 needing assistance with one or **more Activities of Daily Living (ADL) or** Instrumental **Activities** of Daily Living (IADL) on a long-term basis. A sample of 36,000 Medicare eligibles was drawn and interviewed by telephone to identify those with assistance needs. Persons identified as requiring assistance with **ADLs** or **IADLs** for a period of three months or longer were interviewed personally in the second phase of the survey. Persons residing in institutions were excluded from the interviews, and no attempt was made to obtain information on deceased persons. The final sample size for the second phase was 6,400 persons. In addition to the interviews conducted with the persons requiring assistance, all informal caregivers providing cam to those individuals were interviewed. Three surveys will thus be described here: the screening survey, the **long** term. care survey (of which the screener is a part) and a survey of informal caregivers.

For all 36,000 sampled individuals, the **screener** asked age, race, sex and birth date. For each of nine ADL and seven IADL items, the person was asked if he or she had problems performing that activity and the duration of the difficulty. If the individual responded that the actual or expected duration had been or was expected to be more than three months, he or she was given the detailed interview.

The detailed portion of the long term care survey was administered to all

Preceding page blank

noninstitutionalized persons with chronic (90 days +) difficulty performing one or more ADL or IADL functions as indicated by the screener--6,393 persons. The questionnaire was divided into seven sections: (1) Functional status; (2) Other functioning; (3) Housing and Neighborhood Characteristics; (4) Health Insurance; (5) Medical Providers and Prescription Medicine; (6) Cognitive 'Functioning; and (7) Military Service, Ethnicity, Income and Assets.

The functional status questionnaire asked about the presence of seventeen medical conditions, and whether in the last twelve months any of twelve medical events had occurred (such as heart attack, stroke, broken hip, etc.). A series of detailed questions were asked with regard to each function included in the ADL scale: eating, transferring, walking, dressing, bathing, and toileting. For those respondents who did not receive either personal help or help from specialized equipment for any of the functions, there were questions concerning whether or not someone was standing by to render assistance if help was needed. A similarly detailed set of questions was included on ability to perform the instrumental activities of daily living. Those individuals reporting problems with ADLs or IADLs were asked how long health had prevented them from engaging in those activities and what condition caused the problem. The caregiver was identified by name. Individuals were also asked if they regularly visited a senior center or adult day care center, and if so, whether they received any health services or therapy at the center, whether they received transportation to the center, and whether they ate meals there or in some other place with a meal program.

A series of questions was also asked about the caregivers, including the identity of each, the number of days in the previous week that he or she provided assistance, and the duration of time that the person had been helping. It also asked the relationship of the caregiver to the elderly person, whether the person was paid to help, how much the elderly person would have to pay, and who or what insurance program (public or private) would pay for the care. The final segment of the functional status questionnaire asked about range of motion and impairment.

The "other functioning" section dealt mainly with emotional and mental status, social contacts, and activities. A series of questions addressed whether the person used doctors or counselors for mental or emotional problems, whether they felt they needed such help, and whether they had ever been hospitalized for an emotional or mental problem. The elderly person was asked about frequency of contact with relatives and whether the frequency was adequate. A series of questions was asked about television viewing, listening to a radio, presence of.pets, attendance at religious services, reading habits, hobbies and games played. The respondent was asked to provide a general assessment of his or her overall satisfaction with life.

The section on health insurance asked whether the respondent was covered by Medicaid, CHAMPUS, other public assistance program, or private health insurance. Private plans were identified and described in terms of whether they provided coverage for hospitalization or other medical services.

The respondent was asked a series of questions concerning stays in a nursing home or hospital. He or she was also asked about any visits in the past month to a therapist, mental health professional, dentist, optometrist, chiropractor, or foot doctor. The number of prescription medicines bought in the last month and how much would be paid by the functionally impaired person out of pocket, whether another person or program would pay for the drugs, and whether the person was currently taking medication to relieve depression or as a tranquilizer were all included questions.

One brief section tested the cognitive function of the elderly individual using the SPMSQ. This test was not asked of persons for whom "senility" was noted in the earlier questions on medical condition. Income questions concerned receipt by any family member in the past month from various sources (e.g., Social Security or Railroad Retirement benefits, Supplemental Security Income, wages, salaries).

A survey of informal caregivers was administered to those still providing care to the sample person (N=1,626), and a similarly structured questionnaire given to 299 persons who had stopped giving care. Questions asked included: reiationship to sample person,, various ways in which the person's health had improved or deteriorated, time period for the deterioration, whether the sample person currently required more or less care than previously required, types of activities for which the caregiver provided assistance, and attitude toward various caregiving functions. The respondent was asked if the sample person could be left in the home alone, whether sleep was interrupted because of the need to provide care, whether the caregiver was inconvenienced in some other way by the necessity to give care, and the caregiver's assessment of the sample person's health relative to his or her peers. The name, relationship, marital status, and education level of all persons residing in the household with the sample person were asked The survey queried whether anyone other than the respondent provided care to the sample person, who had main responsibility for providing care, and if anyone else would provide care if the primary caregiver were unable to provide that care. The caregiver was also asked about problems that he or she had with the sample person, and whether they resulted in any added costs in providing care. Responses were provided for the items for which the caregiver spent money and the amount of extra money spent in the last month and last week..

Caregivers who resided with the sample person were asked if they would reside there if the person did not require assistance. Those who did not reside in the same household were asked about travel time to the sample person's home, and whether they had evermoved their place of residence to be nearer to the sample person. The caregiver was questioned about work outside the home, whether he or she was precluded from such work or worked fewer hours than desired because of the need to provide care. The caregiver was asked about his or her attitude toward nursing homes. The caregiver was also asked about the relative distastefulness of performing various tasks with regard to the sample person. General questions were also included about the caregiver's health, income, marital status, race and ethnicity.

Interviews were also conducted with caregivers who were no longer providing care. The caregiver was asked why she or he stopped providing care. A series of responses were possible for those who ceased caregiving because the sample person's health either improved or deteriorated. The respondent was asked about the time period over which the sample person's health improved/deteriorated. The remaining questions followed the same pattern as those asked to the caregivers who were still providing care.

The 1984 National Long Term-Survey

The follow-up survey for 1984 had both a longitudinal and a cross-sectional component. The survey was intended to provide insights into the factors contributing to or inhibiting change in functional and health status and institutionalization. The 1984 survey design included four groups:

1. All of the persons alive in 1984 who had functional limitations and were eligible for the full questionnaire in 1982 (**N** = 5,010).

2. All of the persons alive in 1984 not eligible for interview in 1982 who were in institutions (**N** = 1,182).

3. A subsample of the persons alive in 1984 who were screened and were not eligible for the detailed questionnaire in 1982 (**N** = 11,130).

4. A sample of persons alive in 1984 who had their 65th birthday since the 1982 survey (N = 4,860).

The first two groups were administered a detailed questionnaire without screening. The latter two groups were screened for arty functional limitations in 1984. Using components one and three, data were obtained on many of the factors contributing to later institutionalization together with those factors that deter residence in institutions. The total number of detailed interviews administered was about 10,000.

Three types of survey instruments were used in addition to the screener and control card. A questionnaire similar to the 1982 survey instrument was used for all functionally limited persons found in the community. A modification of that instrument containing ADL questions in addition to source of payment and selected demographic information was used for residents of long term care institutions. For persons who were deceased there was an instrument which ascertained from a proxy the residence at the time of death and other pertinent data No survey of informal caregivers is available for 1984.

The <u>screener</u> asked age, race, marital status, sex, whether the sample person was deceased, the type of residence of living persons, and ADL status. As in 1982, the questions on ADL status asked whether duration was actually or expected to be at least 3 months. There was also an indication of whether the individual was interviewed directly or, if a proxy answered, the reason for that proxy. Finally, questions were also asked about prior admissions to nursing homes and number of living children.

The <u>community</u> instrument was administered to all those residing in the community in 1984 and was similar to the detailed questionnaire described for 1982. The seven sections were the same as the 1982 survey. The first section of the questionnaire asked about specific conditions of the sample person. That was followed by questions on ADL and IADL problems. Specific questions were included about others who provided help. That section of the questionnaire concluded by asking about impairments and range of motion.

The second section surveyed "other functioning," which mainly included questions about mental and emotional problems, social contacts and activities. Housing and neighborhood characteristics were covered in the third section. Specific questions included suitability of the housing for the elderly, availability of grocery stores and pharmacies, problems with crime and the respondent's opinions about nursing homes.

Health insurance, the topic of section 4, asked about Medicare, Medicaid, CHAMPUS, CHAMPVA and private insurance (including what was covered). Section 5 covered medical providers and prescription medicines used by the sample person. The questions on hospitalization asked about number of times hospitalized in the last 12 months and lengths of stay each time. The last two sections were on cognitive functioning, and military service, ethnicity, income and assets.

The &ceased questionnaire was unique to 1984. They had two sections: health care and personal information. The health care section asked about nursing home, convalescent home and hospital stays if that was where the patient died. Questions included the source of payment for those stays. For patients who did not die in such institutions, the questionnaire asked about stays just prior to death. There were also questions about earlier periods of institutionalization. A specific question about hospice care was included. Finally, there were questions about others who provided care to the decedent, both paid and unpaid. Personal information surveyed included marital status, race, ethnic origin and income.

The institutional questionnaire was also quite short. Four sections were included: (1) cognitive functioning, (2) ADL, (3) admission, who pays and health insurance, and (4) certified beds. As with the other questionnaires, there was an indicator for whether the sample person or a proxy answered the questions.

The cognitive functioning section was asked only of the sample person and established the individual's ability to answer 10 simple questions (the Short Portable Mental Health Status Questionnaire). The ADL section was an abbreviated version of that administered in the community questionnaire. The categories were generally the same (focusing on help with eating, remaining bedfast, getting around, dressing, bathing, toileting), but within each category the questions were less detailed

The third section asks questions about admission to the facility and periods of institutionalization prior to admission. There was also a question on hospital stays in the last 12 months. Finally, the section also asked about who paid for the care at admission and who was paying on the date of the survey.

A fourth section on certified beds was asked of a staff member in the admissions or billing office of the institution. Questions included total bed size, Medicare and Medicaid certifications and number of beds affected.

Temporal Organization of the 1982 and 1984 National Long Term Care Surveys

Figure 5 below provides a systematic review of the cross-sectional and longitudinal components of the 1982-1984 NLTCS in the form of a time line for the 1982-1984 (and a planned 1988) NLTCS. Dates of the surveys, the dates for which Medicare service use data are to be collected and the survey instruments applied at each date are identified. A 1988 survey is currently in a planning phase and will be designed to replicate most features of the 1984 survey. The 'base sample frame will be the 22,182 alive persons involved in the 1984 survey. The 1988 survey will also have an "aged-in" sample of persons aged 61 to 64 in 1984 who passed their 65th birthday by the date of the 1988 survey. These persons will be screened for chronic disability as in the 1984 survey to ascertain if they qualify for the detailed household survey in 1988. In addition persons who received detailed surveys in 1982 and 1984, and who survive to 1988, will automatically receive the detailed household and institutional surveys. As in 1984 institutionalized persons will receive a special questionnaire. There will be no "next-of-kin" survey for persons who died during the 1984 to 1988 interval (as there was in the 1984 survey) but deaths will be determined from Medicare records. New in 1988 will be six-month telephone follow-ups of subsamples of caregivers and institutionalized persons. Finally, death certificates will be collected and coded for all decedents from 1982 to 1989.

<u>**Figure 5 About Here**</u>

In 1982 a core sample of the survey of 35,789 persons was drawn from the Medicare Health Insurance Skeleton Eligibility Write-Off **(HISKEW)** file. These records were selected by drawing "reduction sets" from a master sample of 55,000 records. Basically, reduction sets were drawn and screened until approximately 6,000 candidates (actually 6,393) for the detailed household survey (i.e., persons with chronic disability according to the survey criterion) were identified

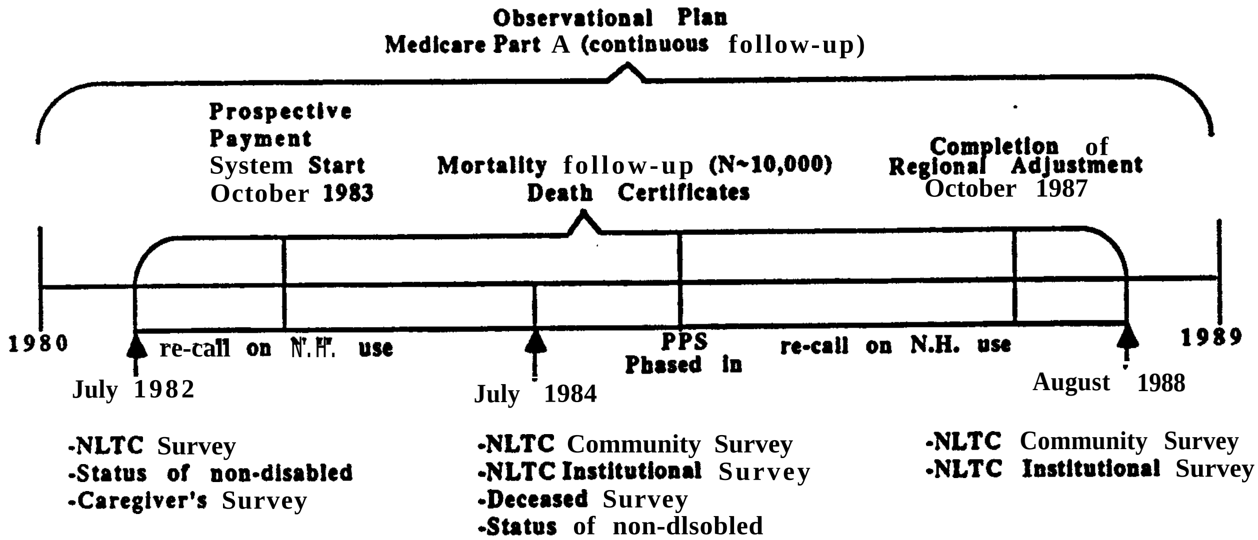
1.) Data on "state" of person at the three waves are multidimensional and involves both multiple, functional and medical conditions.

2.) Data on service use and mortality are continuous with exact dates and with associated diagnostic data (e.g.,. hospital diagnoses -post October, 1983; multiple medical conditions and service use).

3.) State can be expanded to include prior state characteristics (e.g., hospitalization or N.H. use in prior 12 months; Short Portable Mental Status Questionnaire).

4.) There are special one. time surveys (e.g., caregiver's help with cognitive assessments; deceased survey).

Figure 5



Observational Plan
Medicare Part A (continuous follow-up)
Prospective Payment System Start October 1983
Mortality follow-up (N~10,000) Death Certificates
Completion of Regional Adjustment October 1987
1980
re-call on N.H. use
PPS Phased in
re-call on N.H. use
1989
July 1982
July 1984
August 1988
-NLTC Survey
-Status of non-disabled
-Caregiver's Survey
-NLTC Community Survey
-NLTC Institutional Survey
-Deceased Survey
-Status of non-dlsobled
-NLTC Community Survey
-NLTC Institutional Survey

Survey work for round 1 began in June and continued to October, 1982 and produced 6,088 responses from the 6,393 persons identified as chronically disabled (based on the results of the detailed survey, only 5,580 of the 6,088 actually turned out to have been disabled for the reference 3-month period). In addition to the 6,393 community dwelling elderly disabled, 1,992 persons were found to be in institutions, either before April 1 (N = 1708) or who became institutionalized between April 1 and the screening date (N = 284). Thus, though no interviews in 1982 were conducted of institutionalized persons, we can identify the total set (N=1992) of institutionalized persons from the screen.

On April 1, 1984, the sample components of the 1984 survey were fixed and field work again was conducted between June and October, 1984. At this time, three survey instruments were applied to 10,099 persons (5,934 completed detailed household surveys; 1,690 completed institutional survey; 2,475 completed next-of-kin surveys). One instrument was essentially the same questionnaire as was applied to the 1982 community dwelling, disabled elderly population. This was administered to 5,934 persons. As for 1982, differing estimates of the numbers of disabled persons can be obtained from different questions on the survey each implying slightly different criteria. One important design difference between 1982 and 1984 is that all persons disabled or institutionalized in 1982 are given detailed household interviews <u>without</u> screening. This has the advantage of providing data on elderly persons who become non-disabled over the two-year interval. It has the disadvantage that one cannot obtain a set of persons exactly comparable to the 1982 "screen-in" population of 6,393 persons. Thus, to get a comparably defined disabled population in 1982 and 1984 one must use a criterion based on questions from the detailed household survey. A second instrument was the institutional questionnaire which allowed us to examine the retrospective reports of the institutional histories and sources of payment of all persons institutionalized on April 1. This questionnaire was administered to 1,773 persons with 1,690 complete responses. The third type of survey was the "next of kin" questionnaire on health services received during the terminal phase of the illness for deceased persons who were reported as disabled in 1982 and who died in the two-year intervening period. This questionnaire was administered to 2,475 persons. From the Medicare records all deaths occurring over the two-year interval could be identified. The total number of deaths was 3,219. Medicare Part A service use data are available for bills processed January 1978 thru June 1986.

To get a better understanding of the relation of the 1982 and 1984 sample components and changes in sample status between 1982 and 1984, examine Figure 3 on p. 62. In this figure are several different types of numbers. First, above each block is a single number which represents the number of persons in that state at that time. Thus, there were 25,541 persons (of the 31,934 from the 35,789 who responded to at least the telephone screen) who were determined to be non-disabled, community dwellers in 1982. In 1984 there were 14,145 such persons--9,777 derived from the 47% sample of the 25,541 persons who were non-disabled in 1982 and 4,368 derived from the sample of 4,916 persons who were aged 63 and 64 in 1982 (i.e., the "aged-in" sample).

Under each block is a set of numbers. For 1982 these describe the number of persons in that state who ended up in one of the four receiving states in 1984. For example, in the top block in 1982 there are a total of 25,541 persons. This is the number of persons who were screened and found **not** to be chronically disabled or institutionalized. We see that only 12,100 of the 25,541 were designated to be re-screened in 1984. Thus, the numbers under the block sum to the 12,100 who were sampled and re-screened in 1984. Of the 12,100, 970 persons were found to have died in the two-year period. Of the 11,130 survivors to 1984, 9,777 persons were found to be nondisabled (according to the screen criterion) in 1984. These 9,777 persons thus contribute to the 14,145 persons in the top block of the 1984 sample. In addition, 1,170 persons were found to be chronically disabled according to the screen criterion so that a detailed household survey was attempted (i.e., the 1,170 contribute to the 6,264 persons for whom a household survey was attempted--5,934 interviews were completed). Of the 12,100, 183 were found to be institutionalized and thus contributed to the 1,773 persons for whom an institutional interview was attempted in 1984.

On the right hand side of Figure 3 we see the mirror image of the 1982 sample status, i.e., the corresponding numbers for 1984 tell us where persons in those states came from. Thus, of the 6,264 persons for whom household interviews were deemed appropriate in 1984, 1,170 persons were drawn from the screening of the 11,130 survivors to 1984 of the 12,100 persons sampled from persons who screened as non-disabled in 1982. In addition, 4,530 persons were designated as candidates for the household survey in 1984 by virtue of being one of the 6,393 persons who screened as chronically disabled in 1982 and by surviving to 1984. Of the 6,393 persons, 1383 died in the two-year interval and end up as one of the 3,219 deceased persons in 1984. Note that these persons were **not** re-screened in 1984 and could have been functionally intact prior to death. In addition there were 111 persons (of the total of 1,992) who had been institutionalized in 1982, who survived to 1984 and who were no longer in institutions. Again this group was **not** screened but qualified on the categorical basis of their 1982 sample status. Of the 1,992 institutionalized persons in 1982,810 died in the two-year interval. The final contribution to the 6,264 persons were 453 persons who were screened and found to be chronically disabled from the 4,916 persons in the age-in sample. Thus, of the 6,264 candidates for the 1984 household survey, 4,641 (4,530 + 111) qualified because of the 1982 sample status and 1,623 screened in. Thus, the 6,264 is not exactly comparable to the 6,393 persons in 1982--all of whom were screened. Of the 6,264 candidates, 5,934 completed interviews. Of the 5,934 who completed interviews, 5,256 were disabled according to certain check questions on the detailed survey. On the same check questions in 1982, 5,580 persons were disabled in 1982. Thus, because of the different sample qualification procedures in 1982 and 1984 we must be very careful on how to define changes in functional status.

The deceased block shows that a total of 3,219 persons died from the four sample components over the two years. In addition, 1,773 persons were identified as institutionalized in 1984 from whom 1,690 completed surveys were derived. The 1,773 persons represents a cross-sectional or "prevalence" sample of persons in institutions as of a specific date (April 1) in 1984. This corresponds to the 1,708 persons in institutions on April 1 in 1982. The largest contributor to this population (1,071) comes from persons who were institutionalized in 1982 and who survived to 1984. Only 480 persons came from the 6,393 persons who were identified as chronically disabled and living in the community in 1982.

Linkage of the 1982 and 1984 NLTCS to Medicare Bill Data

To fully exploit the surveys conducted in 1982 and 1984 one must consider their linkage to another important data source--Medicare Part A bill files from 1978 to 1986 on Medicare reimbursed hospitalization, home health services and skilled nursing facility use. These records are contained on a separate tape which may be linked to the survey records using a specially constructed linkage variable (SEQNUM) which is given the same value for a given person in both records (i.e., the same value is assigned to the survey record and to all bill records on the Part A file for that person). The Medicare service use files contain bills for individual service episodes and provide a continuous history of the exact date of service use and the amounts reimbursed by Medicare for those services. Each bill in this interval is linked to the corresponding sample person who participated in the 1984 survey (25,401 persons total).

B. International Data

Indonesia

In Indonesia WHO sponsored a survey focusing upon disability, impairments and handicaps in or&r to evaluate concepts for the 1980 classification of the Disability, Impairments and Handicaps (WHO, 1980). This survey was WHO-sponsored, and consequently had the sample and survey design carefully reviewed by WHO consultants, all interviewing was done by physicians.

The disability survey was conceived as a method of measuring the prevalence of impairments, disabilities, and handicaps in a general population and examining factors which might either prevent or enable transitions from impairment to disability and/or handicap. In Indonesia, this study was carried out during 1976-1977 by the Institute of Health Research and Development (IHRD), Department of Health in Jakarta with WHO financial support and technical collaboration. A similar WHO-supported study was also initiated in two states in India about the same time.

IHRD used local physicians as interviewers instead of lay health workers because of their ability to select an International Classification of Disease (ICD) category for the reported or observed impairments. Small groups of local physicians were recruited rather than a single team of traveling physicians since the local physicians enjoyed a better rapport with sample respondents. Approximately 70 physicians were used to conduct the surveys. Epidemiologists from IHRD conducted two-week training courses for interviewers in each area, including pretests of the questionnaire.

The sample was selected by IHRD and Indonesian Central Bureau of Statistics and included the major Indonesian. land masses containing 18 of 24 provinces. The six provinces excluded were outlying islands where travel conditions were difficult. After a sample of 5,000 households had been selected, it was decided for logistical reasons to exclude the islands of Sulawesi, consisting of four provinces. The final sample consisted of 4,604 households in 14 provinces from Sumatra, Java, and Bali.

Each province was divided into an urban and rural domain which, along with the provinces, defined 27 strata (the province of Jakarta consists of only a single urban domain). Within each stratum there was a five-stage sample design based on data from the 1971 Indonesian Census of Population. Districts, subdistricts, and villages constituted the first three stages of sampling and were selected with probability proportionate to their 1971 population size. One census enumeration unit was selected with equal probability from within each selected village, and from within each selected enumeration unit, a systematic random sample of households was selected to give a self-weighting sample of approximately 1/4600 on a household basis.

The occupants of each household were listed and information was obtained from each person in the household. The interviewer was required to see everybody listed in the household roster. From 4,604 households, information from 22,468 persons of all ages was obtained

Since the study was carried out during 1976-1977, the WHO International Classification of Impairments, Disability, and Handicaps (WHO, 1980) was not available. The list of impairments, disabilities, and handicaps used was derived from an early draft of the WHO Classification. Disabilities and handicaps were selected to represent conditions common in Indonesian daily life and work experiences. Similarly, questions on socioeconomic status of household, education, occupation, welfare payments and available medical facilities are tailored to the Indonesian situation.

Korea, Philippines, Malaysia, Fiji

A group of WHO-sponsored surveys was conducted in 1984 in the Western Pacific region (Andrews et al., 1986). These surveys were carried out in four countries (Korea, Malaysia, Philippines and the Fiji Islands) using WHO consultants for the study and sample design and common instrumentation. The surveys were only of the elderly over 60 and were stratified on age so that adequate numbers of the very elderly were available. The total completed sample size was 3,504 persons. The samples in Korea and Fiji were representative of the total population; in Malaysia, only Peninsular Malaysia was covered; and in the Philippines, only the Taglog region of Luzon was covered (21% of the total population of the Philippines). The surveys are representative of the coveted population for persons 60+, by sex, and by urban/rural status. As seen in the documentation specific information was collected on health status, limitations in both ADL and IADL, equipment used to deal with those limitations, health service use, living arrangements and informal care and social support. Of the 3,504 persons, 26.8% were over 75 with 28.2% of the respondents in Malaysia, 23.4% in the Philippines, 27.7% in Korea and 20.7% in Fiji.

IV. FINDINGS

In this section we report on a series of multivariate and life table analyses of data from the NLTCS and a variety of International Data Bases.

A. GOM Analyses of the 1982 and 1984 NLTCS

A series of cross-sectional and dynamic **GOM** analyses were conducted of the NLTCS community disabled population. A number of those analyses were reported in the peer reviewed literature. These papers are contained in Appendix A. In this section we briefly review the findings of those specific studies and present highlights of the findings.

Cross-sectional Analysis of the 1982 NLTCS

This analysis was presented in Manton and Soldo (1987) and in Soldo and Manton (1985, 1986). Grade of Membership analysis of both the 1982 and 1984 NLTCS population were performed.

Four subgroups were identified in the analysis of the 1982 survey which were based on broad criteria involving chronic health problems, functional limitations, sociodemographic information, utilization of caregivers, medical history, payment source, and self-assessment of health. In this analysis the variation of individuals on a wide battery of functional and health status measures is predicted as a function of-two types of coefficients.

The first type of coefficient describes each of K analytically defined profiles in terms of the battery of measures introduced to the analysis. These coefficients, of which there are K sets, represent the probability that a person characterized by the Kth profile will have one of the attributes entered into the analysis. The substantive content of each of the K profiles can be determined by identifying which of the attributes have high probabilities of occurring in a given profile nlative to the probability that the attribute occurs in the total sample (column marked "Sample Proportion"). These coefficients are presented in Table 2 which should be read by column. This characterization of each of the analytically generated profiles proceeds much in the same way that one examines patterns of factor loadings to label factors in factor analysis. The GOM profiles have the advantage that the model used to generate them makes no assumption about the distribution of cases while factor analysis assumes multivariate normality.

Table 2 About Here

The second set of coefficients relates each person to the attributes defined by each of the K profiles. In this model a person can be "like" or "partially resemble" more than a single profile so that he or she may have scores, which sum to 1.0, which define how closely the person resembles each of the analytic profiles. Since no assumption is made about the distribution of these scores the model is more general than most forms of factor analysis. There are as many of these coefficients as there are persons in the analysis time

Table 2
So&demographic and functional limitation response **profiles**
(medical variables not included)

Internal variables	Sample proportion	Pure type 1	2	3	4
SOCIODEMOGRAPHIC					
Sex					
Male	0.341	0.636	0.272	**0.0**	0.471
Female	0.659	0.364	**0.728**	1.0	0.529
Age					
65-69	0.189	0.344	0.0	0.146	0.192
70-74	0.217	0.302	0.0	0.307	0.211
75-79	0.219	0.262	0.054	0.3 14	0.217
80-84	0.186	0.092	0.310	0.233	0.153
85-89	0.127	0.0	0.459	0.0	0.122
90+	0.062	0.0	0.177	0.0	0.106
Marital Status					
Married	0.4 14	0.778	0.0	0.0	0.652
Non married	0.586	0.222	1.0	1.0	-0.348
Education					
Never attended school	0.055	**0.0**	0.226	0.0	0.068
Grades 1 through 8	0.216	0.132	0.410	0.211	0.188
Junior high school	0.332	0.298	0.164	0.495	0.311
Senior high school	0.278	0.385	0.149	0.222	0.297
College	0.102	0.154	0.050	0.065	0.113
Graduate school	0.017	0.03 1	**0.001**	**.0.007**	0.023
Employed ≥ 30 **hours/week** **(binary)**	0.014	0.043	0.0	0.0	0.0
Income					
≤ $4999	0.185	**0.0**	0.0	0.567	0.061
$ 5000 - $6999	0.145	0.175	0.124	0.171	0.080
$ 7000 - $9999	0.161	0.221	0.067	0.104	0.222
$10.000 - $14999	0.151	0.291	0.0	0.0	0.271
$15,000 - $29999	0.125	0.151	0.190	0.0	0.212
$30,000 +	0.044	0.028	**0.148**	0.0	0.05 1
Refused to answer	0.059	0.061	0.089	0.054	0.041
Do not know	0.130	0.073	0.382	0.104	0.062
FUNCTIONAL STATUS					
IADL or ADL respondent needs help **with** (individual binary variables):					
Eating	0.073	**0.0**	0.0	0.0	0.392
Getting in/out of bed	0.296	**0.0**	0.0	0.247	1.0

Table 2 (cont'd)

Getting around indoors	0.442	0.092	0.0	0.636	1.0
Dressing	0.229	0.0	0.0	0.0	1.0
Bathing	0.474	0.101	0.347	0.476	1.0
Getting to or using toilet	0.229	0.0	0.0	0.0	1.0
Bedfast	0.012	0.0	0.0	0.0	0.056
Did not get around inside at all	0.018	0.0	0.0	0.0	0.085
Wheelchairfast	0.036	0.0	0.0	0.0	0.173
Doing heavy work	0.829	0.490	1.0	1.0	1.0
Doing light work	0.278	0.0	0.0	0.0	1.0
Doing laundry	0.513	0.0	1.0	0.506	1.0
Preparing meals	0.370	**0.0**	1.0	0.0	1.0
Shopping for groceries	0.691	0.0	1.0	1.0	1.0
Getting around outside	0.686	0.266	0.618	1.0	1.0
Going places outside of walking distance	0.636	**0.0**	1.0	1.0	1.0
Managing money	0.312	0.0	1.0	0.0	0.819
Taking medicine	0.275	0.0	0.7 14	0.0	1.0
Making phone calls	0.206	0.0	0.646	0.0	0.652
Difficulty Climbing Stairs					
No difficulty	0.126	0.321	0.274	**0.0**	**0.0**
Some difficulty	0.288	0.679	0.726	**0.0**	**0.0**
Very difficult	0.342	0.0	0.0	0.806	0.132
Unable at all	0.244	0.0	0.0	0.194	0.868
Diificulty Bending for Socks					
No difficulty	0.370	**0.769**	0.775	**0.0**	**0.0**
Some difficulty	0.304	0.231	0.225	0.547	**0.084**
very **difficult**	0.208	0.0	0.0	0.453	0.310
Unable at all	0.118	0.0	0.0	0.0	0.606
Diificulty **Lifting** and Holding **10-lb.** package					
No difficulty	0.223	0.665	0.260	**0.0**	**0.0**
Some difficulty	0.177	0.335	0.522	0.057	**0.0**
very **difficult**	0.183	0.0	0.218	0.426	**0.0**
Unable at all	0.417	0.0	0.0	0.517	1.0
Difficulty Reaching Above Head					
No difficulty	0.494	1.0	1.0	**0.0**	**0.0**
Some difficulty	0.229	0.0	0.0	0.550	0.262
Very difficult	0.170	0.0	0.0	0.343	**0.324**
Unable at all	0.107	0.0	0.0	0.107	0.414
Difficulty Brushing or Combing Hair					
No difficulty	0.666	1.0	1.0	0.158	**0.0**
Some difficulty	0.183	0.0	0.0	0.643	0.301
Very difficult	0.085	0.0	0.0	0.199	0.275
Unable at **all**	0.066	0.0	0.0	0.0	0.424
Difficulty Washing Hair					
No difficulty	**0.490**	1.0	0.951	**0.0**	**0.0**
Some difficulty	0.161	0.0	0.049	**0.596**	**0.0**

Table 2 (cont'd)

Very difficult	0.114	0.0	0.0	0.404	0.038
Unable at all	0.235	0.0	0.0	0.0	0.962
Difficulty Grasping and Handling Small Objects					
No difficult	0.630	1.0	1.0	0.204	0.328
Some difficulty	0.202	0.0	0.0	0.556	0.197
Very difficult	0.126	0.0	0.0	0.239	0.274
Unable at all	0.042	0.0	0.0	0.0	0.201
Can See Well Enough to Read Newsprint With Glasses	0.707	1.0	0.0	1.0	0.533

Source: 1982 National Long-Term Care Survey the number (K) of profiles. As a consequence we did not present tables for these coefficients. The effects of the second type of coefficient are manifest, however, in the coefficients presented in Table 2 since they allowed these coefficients to be estimated without making assumptions about the distribution of cases.

In addition, it is possible to calculate the probability that persons in one of the K groups will have an attribute that was not used in the analysis to define the groups. This was done in subsequent analyses for demographic (e.g., age, sex). and service use variables.

The GOM analysis was also applied to cases from the pooled 1982 and 1984 NLTCS (with appropriate weight adjustment) so that the profiles generated are representative of both survey dates. The study was done for an ASPE and HCFA sponsored analysis of the effects of PPS on Medicare service use and mortality in a highly vulnerable subset of the U.S. elderly population (Liu and Manton, 1988a,b; Manton and Liu, 1988). The value of K was determined by running analyses with different numbers of profiles and selecting a value of K (i.e., a number of profiles) that reproduced the data within acceptable statistical error, The probabiities for each of the 17 ADL, IADL, IADL2 (i.e., direct measures of functional loss such as problems in holding packages) impairments and 29 medical condition measures employed in the analysis are presented in Table 3 for each of the four analytically defined profiles. The size of these probabilities may be compared with the frequency of occurrence of the attribute in the total population. These probabilities are presented in the column marked "Sample Proportion". In describing each group below we also report certain patient attributes that were found to be strongly discriminating of each type (e.g., age and sex) even though not employed in the multivariate analysis to identify the profiles. The most significant characteristics of these four groups are listed in Table 3 and a detailed description of probabilities is contained in Table 4.

Tables 3 And 4 About Here

The four analytically defined profiles may be roughly characterized as those who are "mildly disabled," the "oldest-old," those with acute "heart and lung" problems and those with "severe ADL dependency" (Liu and Manton, 1987; Manton, 1988a). A previous analysis of the 1982 NLTCS population identified similar grouping characteristics (Manton and Woodbury, 1984).

The mild disability group is characterized by rheumatism and arthritis and little IADL or ADL impairment. On the demographic variables not used to define these profiles the group was found to be relatively young with only 10% of this group over age 85; 50% were married; 54% were males; 67% had good to excellent health; only 3% had prior institutionalization, and 47% required no informal care.

In contrast the oldest-old group had 47% over age 85 (19.4% over age 90), significant IADL problems, mobility, toileting and bathing limitations. This group had significant risk of hip and other fractures and the highest risks of cancer but fewer reported medical conditions than the first group. In this group 70% are not married; 69%

Table 3

Highlights of GOM group profiles*

Type I: Mild Disability

Rheumatism and arthritis **(58%)**
"Young-Olds" (10% over 85)
50% married
53% **male**
67% good-excellent health on subjective scale
3% with prior nursing home stay
47% with no helper days

Type II: Oldest-Old

Problems with transfer (72%). mobility, **toileting** and bathing
All IADLs
Hip fractures (8%: **RR=3:1),** other breaks (14%: **RR=2:1)**
Glaucoma
Cancer
50% over 85 years old
70% not married
70% female
22% prior nursing home stay **(RR=2:1)**
Home nursing service **(.25)** and therapist **(.06)**

Type III: Heart and Lung Problems

Bathing dependent and **IADLs**
100% arthritis, 62% permanent stiffness
45% diabetes, 50% obese
Highest risks of cardiovascular and lung diseases
95% female
95% under 85

Type IV: Severe ADL Dependency

60% with ADL for eating, 100% all other **ADLs**
Bedfast (11%); chairfast (32%)
70% incontinent (27% with catheter or colostomy)
Parkinsons, mental retardation (10%)
Senile (60%)
Stroke, some heart and lung
48% male, 58% married, 25% over **85, 20%** Black
80% with poor subjective health
19% with prior nursing home use

*Probabilities of group membership converted to percentages.

Table 4
Probabilities for ADL, IADL and IADL2 limitations and medical conditions for community disabled persons

	Sample Proportion	"Mildly Disabled"	"Oldest-Old"	"Heart-Lung" Problems	"Severe ADL' Dependency
ADL LIMITATIONS					
Respondent Needs Help With:					
Rating	10.8	0.0	0.0	0.0	59.8
Getting In/Out of Bed	38.7	0.0	. 71.8	0.0	100.0
Getting About Inside	52.2	0.0	100.0	0.0	100.0
Dressing	32.3	0.0	0.0	0.0	100.0
Bathing	57.9	0.0	100.0	35.7	100.0
Using Toilet	33.5	0.0	49.6	0.0	100.0
Bedfast	2.3	0.0	0.0	0.0	10.6
No Inside Activity	3.7	0.0	0.0	0.0	17.1
Wheelchair Fast	7.2	0.0	0.0	0.0	32.8
IADL LIMITATIONS					
Respondent Needs Help With:					
Heavy Work	84.5	33.3	100.0	loo.0	100.0
Light Work	38.3	0.0	100.0	0.0	100.0
Laundry	60.4	0.0	100.0	50.6	100.0
cooking	47.6	0.0	100.0	0.0	100.0
Grocery Shopping	75.2	0.0	100.0	100.0	100.0
Getting About Outside	74.9	3.3	100.0	100.0	100.0
Traveling	74.1	0.0	100.0	100.0	100.0
Managing Money	38.8	0.0	41.8	3.7	100.0
Taking Medicine	36.3	0.0	0.0	0.0	100.0
Telephoning	24.0	0.0	0.0	0.0	100.0
IADL2 LIMITATIONS					
How Much Difficulty Does Respondent Have:					
Climbing 1 Flight of Stairs					
No Difficulty	10.7	31.8	0.0	0.0	0.0
Some Difficulty	24.9	68.2	0.0	0.0	11.0
Very Difficult	34.1	0.0	44.7	88.0	0.0
Cannot	30.3	0.0	55.3	12.0	89.1
Bending for Socks					
No Difficulty	33.8	92.5	0.0	0.0	0.0
Some Difficulty	26.6	7.5	53.1	56.5	0.0
Very Difficult	20.9	0.0	46.9	43.5	8.4
Cannot	18.8	0.0	0.0	0.0	91.6
Holding 10 lb. Package					
No Difficulty	17.6	58.7	0.0	0.0	0.0
Some Difficulty	14.4	37.5	4.5	9.0	0.0
Very Difficult	16.5	3.8	20.9	43.0	0.0
Cannot	51.5	0.0	74.7	48.1	100.0

Table 4 (cont'd)

Reaching Over Head					
No Difficulty	45.8	96.4	77.4	0.0	0.0
Some Difficulty	22.9	3.6	22.6	47.4	18.5
Very Difficult	17.5	0.0	0.0	39.6	32.8
cannot	13.8	0.0	0.0	12.9	48.7
Combing Hair					
No Difficulty	60.3	100.0	100.0	0.0	0.0
Some Difficulty	18.0	0.0	0.0	75.5	17.7
Very Difficult	10.8	0.0	0.0	24.5	29.9
Cannot	10.8	0.0	0.0	0.0	52.4
washing Hair					
No Difficulty	39.8	100.0	31.9	0.0	0.0
Some Difficulty	14.5	0.0	8.2	61.9	0.0
Very Difficult	11.0	0.0	12.3	38.1	3.2
cannot	34.7	0.0	47.6	0.0	96.8
Grasping Small Objects					
No Difficulty	59.4	100.0	100.0	0.0	0.0
Some Difficulty	21.7	0.0	0.0	73.0	31.1
Very Difficult	12.0	0.0	0.0	27.0	32.1
cannot	7.0	0.0	0.0	0.0	36.8
Respondent Can See Well Enough To Read Newsprint	67.5	89.8	77.6	64.9	28.9
MEDICAL CONDITIONS					
Rheumatism/Arthritis	71.8	57.7	47.2	100.0	76.0
Paralysis	12.3	0.0	0.0	0.0	54.0
Penn. Stiffness	26.5	5.4	0.0	61.5	47.2
Multiple Sclerosis	1.3	0.0	0.0	0.0	5.5
Cerebral Palsy	0.6	0.0	0.0	0.0	2.4
Epilepsy	1.1	0.8	0.0	0.7	3.0
Parkinson's Disease	4.4	1.9	0.0	0.0	16.3
Glaucoma	9.2	6.4	14.8	3.9	11.9
Diabetes	21.2	11.9	0.8	45.4	30.5
cancer	8.2	6.0	10.8	8.9	7.6
Constipation	36.7	14.2	0.0	84.4	62.2
Insomnia	41.9	19.2	0.0	loo.0	54.3
Headache	18.9	0.0	0.0	63.9	26.4
Obesity	17.7	13.5	4.0	51.6	5.5
Arteriosclerosis	36.5	12.4	0.0	80.5	71.8
Mental Retardation	2.3	0.0	0.0	0.0	10.2
Senility	13.2	0.0	0.0	0.0	59.5
Heart Attack	9.1	0.0	0.0	31.4	9.7
Other Heart Problems	33.8	8.9	0.0	100.0	41.6
Hypertension	44.0	33.4	2.9	100.0	47.6
Stroke	11.4	4.2	0.0	7.6	38.6

Table 4 (cont'd)

Circulation Trouble	56.2	23.1	0.0	100.0	100.0
Pneumonia	7.5	0.0	0.0	21.9	10.9
Bronchitis	12.8	0.0	0.0	43.6	13.5
Influenza	15.0	6.8	0.0	41.4	15.8
Emphysema	12.9	6.1	5.0	29.6	12.9
Asthma	7.9	1.7	0.0	25.2	8.1
Broken Hip	2.5	0.0	8.8	0.0	1.4
Other Broken Bones	6.1	2.8	13.4	2.6	6.0

SOURCE: 1982 and 1984 NLTCS.

ate females, and 22% had a prior nursing home stay.

The group with heart and lung problems has IADL and IADL2 problems and trouble bathing. This group is predominantly female, with a 45% prevalence of diabetes, a 50% prevalence of obesity and very high levels of impairment due to arthritis. It has the highest risks of cardiovascular and lung disease and is predominantly (84.3%) under age 80.

The severe ADL dependency group has a 60% prevalence of limitation in eating and is impaired on all other ADLs, IADLs and IADL2s. This group is 11% bedfast, 33% chairfast, 70% incontinent with 27% with catheter or colostomy. This group is strongly characterized by some form of neurological disorder (e.g., senility 60% and paralysis 54%). It has significant circulatory problems with 80% reporting poor subjective health. This group is 48% male and 58% married--probably because any Person with this level of impairment requires large amounts of informal care resources in order to stay out of an institution.

In addition, we employed the second output of GOM analysis, the degree to which individual cases resemble each of the GOM profiles to determine if a shift occurred in the case-mix of episodes of Medicate hospital, SNF and HI-IA care between the pre- and post-PPS periods. By summing the individual case weights per GOM profile per case, it was possible for us to determine whether there was a shift in the cases that resembled each of the GOM subgroups (shift in the distribution of GOM scores between 1982 and 1984).

Table 5 shows a shift in the proportion of cases by service episodes of each of the four types between 1982 and 1984.

<u>Table 5 About Here</u>

The shifts are generally in the expected direction. For example, for hospital episodes them was a large decline in the highly functionally disabled (i.e., from 20.3% to 16.9%) but increases in the oldest-old and acutely ill categories (i.e., types II and III) suggest an increase in the medical acuity of the population with a significant reduction in seriously impaired persons with less medical acuity. In the SNF group we also see declines in the severely ADL impaired population with increases in the less impaired and oldest-old populations-again suggesting a change in case mix representing increased acuity of a specific type. HHA services show moderate changes with the oldest-old and severely ADL dependent types increasing in prevalence and the less disabled decreasing. Thus the HHA population has, in contrast to the SNF population, become more chronically disabled and even older. This HI-IA pattern reflects similar changes in the community population which becomes older and has more severely disabled persons. Thus the whole distribution by case-mix type has been altered by the sorting out of service venues due to the impact of PPS.

Another GOM analysis of the 1982 NLTCS was conducted to develop case-mix indicators (based on the g_{ik} scores from the GOM analysis) for Medicare reimbursement

Table 5
Percent distribution of disabled elderly in different service settings by Grade of Membership Type pre- and post-PPS

	Total	Mildly Disabled	Oldest-Old	Heart & Lung Problems	Severely ADL Dependent
Hospital					
1982	100.0	30.0	25.1	24.5	20.3
1984	100.0	29.7	27.2	26.2	16.9
SNF					
1982	loo.0	27.2	28.1	21.5	23.2
1984	100.0	30.1	30.8	20.4	18.7
HHA					
1982	100.0	22.6	27.1	21.7	28.5
1984	100.0	21.4	28.2	21.4	29.0
Other*					
1982	100.0	32.2	24.0	23.6	20.2
1984	100.0	31.5	26.4	21.0	21.1

* These are episodes when no Medicare hospital, skilled nursing facility or home health services are used. They could include, for example, no services, Medicaid nursing home stays and Medicare outpatient care.

Source: 1982 and 1984 NLTCS

of home health services. Since the purpose of this analysis was to identify case mix measures that best predicted home health sevice use (i.e., reimbursement amount and number of visits) a larger number of pure types was accepted_ These results (i.e., both the GOM analysis and the analysis of the ability of the g_{ik}'s to predict service use) are presented in Manton and Hausner (1987). Table 6 shows that we were able to give case-mix measures that predicted both visits and reimbursements well.

<u>Table 6 About Here</u>

A validation of these findings in the 1984 NLTCS is currently being completed.

B. GOM Pure Type Subgroups of the Institutionalized Population

Nursing homes are used for different purposes ranging from short-term rehabilitative care to long-term care for persons with chronic disabilities that preclude their residency in the community. The fact that short- and long-stay patients both occupy nursing homes suggests that different types of patients need to be differentiated in estimating the risks of nursing home entry and the costs of nursing home care over time. To date, the identification and measurement of long- versus short-stay nursing home episodes have been based primarily on surveys of persons already in nursing homes. Several studies of the 1977 National Nursing Home Survey (NNHS) described the admission characteristics and utilization patterns of nursing home patients after they were in institutions (Keeler et al., 1981; Liu and Manton, 1983, 1984). Generally, data have not been available to explore the risk of nursing home admission by reasons for nursing home use and circumstances preceding admission. Studies of nursing home risks have also generally not distinguished between the various types of nursing home admissions (Branch and Jette, 1982).

Because the 1984 NLTCS elicited detailed information on the nursing home use in the two years since the 1982 NLTCS total incidence of nursing home admissions in this period, can be estimated, as well as whether admissions were long or short stay. In this initial analysis we identified persons who entered nursing homes during the interval and who were no longer in nursing homes in 1984 as "short-stay" patients. The assumption underlying this distinction is the observation that institutionalized persons captured in a cross-sectional sample (e.g., persons in nursing homes at the time of the 1984 survey) tended to have much longer lengths of stay on average than persons in an admission or discharge sample (Manton, Woodbury and Liu, 1984). For example, the median length of completed stays in the 1977 NNHS discharge sample was 75 days while the average length of stay in the 1977 NNHS current resident sample was 597 days (NCHS, 1979).

With the assumption noted above, we began to estimate the patterns of nursing home use by long- and short-stay patients. We first examined the status in 1984 of the 1982 sample. All persons who received the detailed second stage instrument in 1982 were disabled and residents in the community. By 1984, most of these same individuals were found either in the community or in nursing homes. A third possibility was that individuals in the 1982 sample died between 1982 and 1984. Results of this analyses are presented in Tables 7 and 8 (Liu and Manton, 1988).

Table 6

Percent of variance explained for different home health service regression models with different periods of service definitions, health measures, and levels of control for other covariates

Variables used in constructing case-mix dimensions	Period type	Case-mix dimensions only	Case-mix dimensions and other covariates
Health, function (56)	Capitation	16.8	25.3
Health, function, services (58)	Capitation	40.7	44.8
Health, function, services (58)	Episode	30.4	43.2

Source: 1982 NLTCS

Table 7 & 8 About Here

Table 7 presents the distributions of the 1982 sample by their 1984 status. About 72 percent of the 1982 community disabled persons were still community residents in 1984. Only 7 percent were in nursing-homes in 1984 while almost 21 percent died in the intervening two years. The mortality rate of this sample is consistent with estimates from other studies of this age group (Manton, 1987). The two-year nursing home prevalence rate of 7.1 is consistent with other studies which found that 5 percent of the population over age 65 enter nursing homes in a year (e.g., Liu and Manton, 1983).

Table 7 also contains the 1984 status of subgroups of the 1982 community residents by their demographic and functional characteristics in 1982. As expected, the risk of being a nursing home resident increased with age, rising from 4 percent for those 65-74 to 12 percent for persons over age 85. Higher rates of nursing home use were found for females and whites, results consistent with other research (Manton and Soldo, 1987). Nursing home use risks were also strongly related to disability status, with a monotonic increase of nursing home use rates by disability status up to ADL 5-6. We might expect persons with the greatest ADL dependency in 1982 , to have the highest rates of nursing home use; the slightly lower rate was due to the high mortality risks of this subgroup (Manton, 1987). The mortality risks of the 1982 community sample were directly related to disability status in 1982 as well as to age.

While Table 7 presented the proportion of community residents who were found in nursing homes after two years, it does not fully represent the nursing home use experience of the sample because some persons could have entered nursing homes in the interval and ntumed to the community or died. The full nursing home experience of the sample is presented in Table 8, which disaggregates the sample into persons who, in 1982, were Medicaid eligible and those who were not. The column headed "Any Use" gives the percentage of persons who reported spending any time in nursing homes between 1982 and 1984, while the "Nursing Homes in 1984" (i.e., current residents) refers to those persons found in an institution at the time of the 1984 survey, the equivalent rate to that in Table 7. Table 8 shows that a much higher proportion of the 1982 community residents spent some time in a nursing home, about 12 percent, than was recorded in the cross-sectional results in Table 7.

Table 8 also presents the use of nursing homes for subgroups of the disabled population by demographic and functional status characteristics. The risk of nursing home use, regardless of reasons for nursing home use, tended to be associated with those characteristics in expected directions.

Of the 12 percent of respondents who spent any time in nursing homes in the two-year interval, 24 percent died by 1984, 15 percent returned to the community with 60 percent still in nursing homes in 1984. Hence, 40 percent of nursing home admissions were for relatively short periods of stay. Among the persons who entered nursing homes but returned to the community by 1984, approximately half were in nursing homes for less than 30 days and 80 percent' had lengths of stay of less than 90 days. Those residents used nursing homes for convalescent or rehabilitative care and were distinct

Table 7
Transitions between 1982 community status and 1984 status

	Community	Nursing Home	Deceased
All cases (N = 5795)	72.2%	7.1%	20.7%
Age			
65-74	80.8	4.1	15.1
75-84	69.5	8.1	22.4
85+	59.2	11.7	29.1
Sex			
Male	68.3	5.2	26.6
Female	74.3	8.2	17.4
Race			
White	71.9	7.7	20.4
Nonwhite	73.9	3.4	22.5
Limitations			
Nondisabled	88.0	1.2	10.2
IADL only	79.7	5.6	14.7
ADL 1-2	72.4	7.5	20.0
ADL 3-4	66.7	10.0	23.3
ADL 5-6	54.1	9.8	36.1

Source: 1982 and 1984 NLTCS

Table 8
Changes in nursing home use between 1982 and 1984

	Medicaid-&l982 N = 5)		Non Medicaid in 1982 (N = 4281)	
	Any use	Nursing Homes in 1984	Any use	Nursing Homes in 1984
All Cases	11.7%	7.3%	11.8%	7.0%
Age				
65-74	7.1	4.6	5.8	3.9
75-84	12.8	7.8	14.6	8.2
85+	18.3	11.6	19.3	11.4
Sex				
Male	10.0	5.2	9.2	5.1
Female	12.4	8.1	13.5	8.1
Race				
White	14.0	9.0	12.3	7.3
Nonwhite	5.9	2.8	5.8	3.8
Limitations				
Nondisabled	4.7	2.4	2.5	1.0
IADL	8.0	5.8	8.4	5.4
I-2ADL	11.9	6.9	12.9	7.7
34ADL	18.7	11.9	16.4	8.9
5-6 ADL	13.2	7.9	17.7	10.4

Source: 1982 and 1984 NLTCS

from others who were institutionalized for very long stays. Further analyses indicated no notable difference in length of stay for those who were Medicaid eligible and not Medicaid eligible in 1982.

After examining the risk of nursing -home use, we investigated the amount of time it took for individuals with specific characteristics to enter nursing homes since the 1982 survey. While the mean time before admission was about 470 days, approximately 15 percent entered a nursing home after less than six months in the community. Similarity in duration prior to admission between Medicaid and non-Medicaid eligible persons suggests that there is little apparent difference in access for Medicaid and non-Medicaid persons. We also found no notable differences in duration prior to nursing home admissions between subsets of the Medicaid and non-Medicaid samples in terms of their demographic and functional characteristics.

These results suggest that, nationally, there was little difference in access to nursing homes for Medicaid and non-Medicaid eligible persons. However, differences in the accessibility to nursing home care by Medicaid status, or more broadly by income status, may exist in areas with excess demand for nursing home care. Moreover, some of the income related accessibility of nursing home care may be masked by the broad definition of non-Medicaid status employed. Other results, not presented, indicated that both the lowest (i.e., less than $7,000) and highest (i.e., greater than $20,000) income groups used nursing homes at higher rates than intermediate income categories. This finding suggests that persons with incomes between $7,000 and $20,000 may have had the greatest incentive to avoid nursing homes use because they had the greatest incentive to avoid Medicaid spenddown. Further analyses, which would control for health and functional status and availability of informal care, could clarify the implications of this association.

An analysis of the institutionalized population was also performed using the Grade of Membership technique. In that study (Manton, Woodbury and Corder, 1988). the National Nursing Home Surveys (1977 and 1973) and the Resident Place Surveys (1969, 1964, 1963) were used to conduct a GOM analysis of the oldest-old (i.e., those aged 85 and over). Subpopulations within samples at each date were identified and change over time and prevalence was determined. We found that the population aged 85+ in nursing homes was extremely heterogeneous in functional and health status and is tending to grow even older. Certain medically acute subgroups found in institutionalized populations did not appear in the oldest-old group.

Table 9 shows considerable age heterogeneity (e.g., 11 percent of the respondent are observed to be above age 95). The first type represents an extreme elderly population with a significant probability (26%) of being over age 95. The second group is intermediate (40% are aged 90-95), while the third group is relatively young. Not surprisingly, the two older groups are more likely to be female and unmarried while the third group is more likely to be male and have a greater chance of being married.

<u>Table 9 About Here</u>

Table 9

The λ_{kjl} coeffxients describing three GOM groups derived from an analysis of persons aged 85+ in institutions in 1969.1973, and 1977

		Frequency	PURE TYPE 1	2	3
I.	Demographic Conditions				
1.)	Age (In Years)				
	85-89	0.59	037	0.60	1.00
	90-94	0.30	0.37	0.40	0.00
	95+	0.11	0.26	0.00	0.00
2.)	Sex				
	Male	0.23	0.00	0.00	0.99
	Female	0.77	1.00	1.00	0.01
3.)	Marital Status at Admission				
	Married	0.07	0.00	0.00	0.33
	Not Married	0.93	1.00	1.00	0.67
II.	Health Status Primary Diagnosis (18)				
	Senility	0.16	0.44	0.00	0.00
	Heart Attack	0.07	0.00	0.23	0.00
	Stroke	0.06	0.17	0.00	0.00
	Hardening of Arteries	0.26	0.26	0.00	0.52
	Circulatory Disease	0.11	0.10	0.22.	0.00
	Accident	0.05	0.00	0.17	0.00
	Mental Disorder	0.02	0.00	0.00	0.07
	Muscular Disease	0.07	0.00	0.21	0.00
	Endocrine Disorder	0.04	0.00	0.00	0.13
	Respiratory Illness	0.02	0.02	0.03	0.00
	Neoplastic Disease	0.03	0.00	0.08	0.00
	Nervous Disorders	0.02	0.00	0.00	0.07
	Digestive Disease	0.02	0.00	0.04	0.01
	Infectious Disease	0.00	0.00	0.00	0.00
	Genitourinary D i i	0.01	0.00	0.00	0.04
	Skin D i i	0.00	0.00	0.01	0.01
	Blood Disease	0.01	0.01	0.01	0.00
	Other	0.05	0.00	0.00	0.15
III.	Chronic Conditions and Impairments				
5.)	Senility	0.57	1.00	0.49	0.00
6.)	Mental Disorder	0.19	0.27	0.00	0.41

Table 9 (cont'd)

7.)	Speech Defect or Paralysis (Palsy) or Other Ill Effects Due to Stroke	0.09	0.18	0.05	0.00
8.)	Heart Trouble	0.43	0.35	0.44	0.53
9.)	Paralysis or Palsy Not Due to Stroke	0.05	0.05	0.06	0.00
10.)	Arthritis or Rheumatism	0.37	0.43	0.52	0.00
11.)	Diabetes	0.11	0.00	0.00	0.47
12.)	Chronic Back or Spine Trouble	0.10	0.15	0.12	0.00
13.)	How Well Can Person Hear?				
	Can hear telephone conversation without an amplifier	0.40	0.00	0.99	0.00
	Can hear most words person says	0.44	0.55	0.00	1.00
	Can hear loud noises	0.14	0.41	0.00	0.00
	Cannot hear anything	0.02	0.04	0.01	0.00
14.)	How Well Can Person See?				
	Can read newsprint with or without glasses	0.35	0.00	1.00	0.00
	Can see television 8'-12' away	0.36	0.31	0.00	1.00
	Can recognize people without 2'-3'	0.23	0.53	0.00	0.00
	Blind	0.07	0.16	0.00	0.00
15.)	Bowel and Bladder Control--Does Person Normally:				
	Control bladder and bowels	0.54	0.00	1.00	0.65
	Use catheter	0.04	0.07	0.00	0.05
	Control bladder but not bowels	0.02	0.00	0.00	0.12
	Control bowels but not bladder	0.09	0.15	0.00	0.18
	Control neither	0.31	0.78	0.00	0.00
Personal Care Recei\During Last Seven Days					
16.)	Help with dressing, shaving, hair care	0.76	1.00	0.39	1.00
17.)	Help with bathing	0.84	1.00	0.60	1.00
18.)	Help with eating	0.36	1.00	0.00	1.00

Source: 1969.1973 and 1977 NNHS.

The groups are not only strongly ordered by age, but are also clearly distinguished by their health status. For example the oldest groups most important primary diagnoses are senility (44%), hardening of the arteries (26%), and stroke (17%). The second oldest group is affected by more acute conditions (i.e., heart attack, circulatory disease, muscular disease, cancer, accidents) and by a wider range of conditions. The third, predominantly male group seems to be most affected by hardening of the arteries and diabetes.

In examining the functional status of the three groups, very interesting patterns emerge. First, the oldest group has the greatest limitations in terms of sensory impairments as well as problems in eating. The second oldest group has few sensory problems, and the least likelihood of problems with toileting, dressing, and bathing. since both of these groups are heavily female this suggests that they represent two poles on a continuum of health and functional impairment for extreme elderly female nursing home residents. The first and oldest group is the most impaired and the second younger female group least impaired

The third group seemed to have impairments in the ability to dress, use the toilet and some incontinence. This group appeared to be more impaired than the second female group even though the female group was, on average, older.

The association of these three groups with a series of facility level variables like total charges, primary payment source, size of facility and the cross-temporal change in the prevalence of each of the groups was determined by calculating the probability of these characteristics (i.e., thus λ_{kjl}) for each subgroup. These probabilities are presented in Table 10.

<u>**Table 10 About Here**</u>

Although the organization of Tables 9 and 10 is similar, the coefficients in Table 10 were estimated differently. Specifically, the groups were defined only on the basis of the 18 variables in Table 9. The variables in Table 10 were "external" to that analysis, i.e., the probability of each response for each group or type was calculated but the calculations were not permitted to affect the definitions of the pure types. Thus, the information in Table 10 did not affect the calculation of the coefficients in Table 9.

The first variable in the table is the total monthly charge adjusted to constant dollars. The charges are higher for groups 1 and 3. The higher charge for group 1 seems to be due to their greater prevalence of functional limitations. The younger male group seems to be the most expensive probably due to greater medical acuity. Both of the more expensive groups relied more heavily on Medicaid as a payment source while group two depended most heavily on its own resources or family support. The primary distinguishing characteristics of the facilities in which the oldest-old reside was that group 3 was more likely to be in large facilities in the northeast and northcentral regions, while group 1 was concentrated in the south and northcentral regions in smaller proprietary facilities. LOS was similar for both female groups while the younger male population

Table 10

Variables associated with the three profiles identified in the GOM analysis of persons aged 85+ in 1969, 1973, and 1977

	Frequency	PURE TYPE 1	PURE TYPE 2	PURE TYPE 3
1. Total Monthly Charge (Adjusted to Constant Dollars)				
$1 - 221	0.14	0.06	0.23	0.12
$222 - 290	0.21	0.18	0.28	0.16
$291 - 358	0.22	0.27	0.22	0.15
$359 - 450	0.22	0.26	0.15	0.26
$451 and over	0.21	0.23	0.12	0.31
2.) Primary Payment Source				
Own Income or Family Support	0.42	0.38	0.49	0.38
Medicare	0.02	0.01	0.02	0.01
Medicaid	0.38	0.45	0.23	0.50
Welfare	0.15	0.15	0.21	0.05
other	0.03	0.01	0.05	0.06
3.) Number of Beds in Facility				
Less than 99	0.54	0.54	0.62	0.39
100 and over	0.46	0.46	0.38	0.61
4.) Region				
Northeast	0.24	0.18	0.25	0.34
Northcentral	0.36	0.32	0.40	0.35
south	0.24	0.31	0.19	0.21
West	0.16	0.19	0.16	0.10
5.) Ownership of Facility				
Proprietary	0.67	0.75	0.60	0.64
Non-Profit	0.33	0.25	0.40	0.36

Source: 1969.1973 and 1977 NNHS.

had significantly more persons staying less than a year--consistent with their greater medical acuity and their greater likelihood of being married. In terms of intensity of care, both the high-cost Medicaid groups (i.e., 1 and 3) had higher intensity of care with the older female group having 79 percent intensive care.

The variable labeled "Year Which Sample Was Drawn" (1969, 1973, 1977) is of particular interest in our analysis. The changing proportions for the three groups represent the change in the prevalence of each pure type group over the period 1969 to 1977 relative to the proportion of persons sampled from each survey (i.e., 31, 32, and 37%). The second group had a much greater relative prevalence in the early samples while the older female group was relatively more prevalent in 1977. This seems consistent with a trend toward the aging of the nursing home population, increases in life expectancy, and survival at very advanced ages and possibly to increases in the intensity of care provided in institutions--a trend that should increase due to constraints on nursing home bed construction. The male group does not appear in great numbers until 1977. Again this seems consistent with recent increases in the life expectancy of males at advanced ages and the fact that the acuity of care has increased in recent years.

In Table 11 we present new λ_{kjl}'s for the same 18 variables as in Table 9 as well as for 20 variables describing the nature of services and therapies delivered to the population. The λ_{kjl} coefficients for the initial 18 variables will be altered by the introduction of these service variables in the analysis which will cause the g_{ik}'s defining the three groups to change.

Table 11 About Here

The introduction of the service variables changes the pattern of coefficients significantly. This is consistent with the findings of an analysis of all persons 65+ in institutions (Manton, Liu and Cornelius, 1985) that service use is driven by variables beyond simply age, health and functional status. In that earlier analysis differences in charges and service use were strongly associated with geographic-area (i.e., state), suggesting the impact of Medicaid reimbursement limits on the services delivered to persons of the same health and functional status.

Although the three groups are still roughly ordered by age, the pattern is far less crisp. Sex and marital status are also less strongly discriminating of the groups. Although the first group still contains the highest proportion of persons over age 95, it is not the only group to contain persons of this age. The first group continues, however, to contain the highest proportion of senile, sensory impaired and functionally limited persons. The first group also utilizes the broadest range of services, though interestingly certain services seem to be provided more often.to less disabled groups (i.e., eyeglasses, hearing aids, walkers). Presumably this is because there is a substitution of more intensive services for some of these aids (e.g., wheelchairs).

The third group in this analysis now contains a large proportion of 90- to 94-year olds (40%), and 8 percent persons aged 95+. Despite this large proportion of older

Table 11

The λ_{kjl} coeffkients describing three GOM groups derived from an analysis of persons aged 85+ in institutions in 1969, 1973, and 1977 with service variables added to the disease

	Frequency	PURE TYPE 1	2	3
I. Demographic Conditions				
1.) Age (In Years)				
85-89	0.59	0.53	0.72	0.52
90-94	0.30	0.29	0.23	0.40
95+	0.11	0.18	0.05	0.08
2.) Sex				
Male	0.23	0.19	0.30	0.22
Female	0.77	0.81	0.70	0.78
3.) Marital Status at Admission				
Married	0.07	0.09	0.03	0.11
Not Married	0.93	0.91	0.97	0.89
II. Health Status Primary Diagnosis (18)				
Senility	0.16	0.31	0.18	0.00
Heart Attack	0.07	0.03	0.08	0.11
Stroke	0.06	0.16	0.03	0.00
Hardening of Arteries	0.26	0.27	0.15	0.35
Circulatory Disease	0.11	0.04	0.00	0.27
Accident	0.05	0.06	0.06	0.03
Mental Disorder	0.02	0.03	0.04	0.00
Muscular Disease	0.07	0.00	0.21	0.00
Endocrine Disorder	0.04	0.02	0.00	0.10
Respiratory Illness	0.01	0.01	0.01	0.02
Neoplastic D i i	0.02	0.03	0.03	0.01
Nervous Disorders	0.02	0.03	0.04	0.00
Digestive Disease	0.01	0.00	0.05	0.00
Infectious Dii	0.00	0.00	0.00	0.00
Genitourinary Disease	0.01	0.00	0.04	0.00
Skin Diie	0.00	0.00	0.01	0.01
Blood Disease	0.01	0.00	0.02	0.00
Other	0.05	0.00	0.04	0.11
III. Chronic Conditions and I[redacted]				
5.) Senility	0.57	1.00	0.55	0.05
6.) Mental Disorder	0.19	0.32	0.09	0.15

Table 11 (Cont'd)

7.)	Speech Defect or Paralysis (Palsy) or Other Ill Effects Due to Stroke	0.09	0.20	0.05	0.00
8.)	Heart Trouble	0.43	0.3 1	0.15	0.83
9.)	Paralysis or Palsy Not Due to Stroke	-0.05	0.07	0.07	0.00
10.)	Arthritis or Rheumatism	0.37	0.39	0.33	0.39
11.)	Diabetes	0.11	0.08	0.00	0.26
12.)	Chronic Back or Spine Trouble	0.10	0.17	0.13	0.00
13.)	<u>How Well Can Person Hear?</u>				
	Can hear telephone conversation without an amplifter	0.40	0.21	0.98	0.00
	Can hear most words person says	0.44	0.46	0.00	0.89
	Can hear loud noises	0.14	0.30	0.00	0.11
	Cannot hear anything	0.02	0.03	0.02	0.00
14.)	<u>How Well Can Person See?</u>				
	Can read newsprint with or without glasses	0.35	0.00	1.00	0.00
	Can see television 8'-12' away	0.35	0.33	0.00	0.82
	Can recognize people without 2'-3	0.23	0.48	0.00	0.18
	Blind	0.07	0.19	0.00	0.00
15.)	<u>Bowel and Bladder Control-Does Person Normally:</u>				
	Control bladder and bowels	0.55	0.00	1.00	0.63
	Usecatheter	0.04	0.11	0.00	0.00
	Control bladder but not bowels	0.02	0.00	0.00	0.07
	Control bowels but not bladder	0.09	0.00	0.00	0.30
	Control neither	0.31	0.89	0.00	0.00
<u>Personal Care Received During Last Seven Days</u>					
16.)	Help with dressing, shaving, hair care	0.76	1.00	0.17	1.00
17.)	Help with bathing	0.84	1.00	0.50	1.00
18.)	Help with eating	0.36	1.00	0.00	0.00
IV.	<u>Services and Therapies (20)</u>				
19.)	Rub or message	0.54	1.00	0.30	0.18
20.)	Administration of medication or treatment	0.61	0.91	0.65	0.23
21.)	Special diet	0.41	0.63	0.00	0.59
22.)	Application of sterile dressing or bandages	0.10	0.22	0.00	0.04
23.)	Temperature-Pulse-Respiration	0.60	1.00	0.00	1.00
24.)	Fullbed-bath	0.36	0.93	0.00	0.00
25.)	Enema	0.16	0.46	0.00	0.00
26.)	Catheterization	0.05	0.16	0.00	0.00
27.)	Blood pressure	0.64	1.00	0.00	1.00
28.)	Irrigation	0.05	0.15	0.00	0.00
29.)	Oxygen therapy	0.01	0.01	0.00	0.02
30.)	Intravenous injection	0.01	0.00	0.01	0.00
3 1.)	No services received	0.05	0.00	0.17	0.00
<u>Equipment</u>					
32.)	Eyeglasses	0.68	0.36	0.83	0.90
33.)	Hearing aid	0.08	0.00	0.03	0.21

Table 11 (Cont'd)

34.) Walker	0.19	0.00	0.12	0.49
35.) Crutches	0.01	0.00	0.02	0.00
36.) Braces	0.01	0.00	0.00	0.02
37.) wheelchair	039	0.73	0.00	0.37
38.) Other	0.27	0.00	0.00	1.00

Sources: 1969, 1973 and 1977 NNHS.

persons, this group reports no senility as a primary diagnosis and only 5 per cent report it as a medical condition. This group is, however, affected by heart disease, circulatory problems and diabetes. Interestingly, there is little difference between the three pups in terms of arthritis, whereas in the first analysis it was strongly characteristic of the second group. The third group is impaired in dressing and bathing, but not eating. It receives an intermediate amount of services. The second group is now the youngest and has the fewest impairments and receives the smallest amount of services. It is not, however, an exclusively male group like the third group was in the prior analysis.

In order to better understand how the service variables have altered the definition of the three groups, we present the association of the new groups with the same "external" variables that were presented in Table 10. These "external" variables and their coefficients are described in Table 12.

Table 12 About Here

In Table 12 we see that the amount of services provided to the three groups is correlated with total charges with the youngest, least disabled group (group 2) receiving the fewest services, with 62 percent of cases below $290 per month. As before, this low-charge group is most dependent on its own income while the more expensive groups are highly dependent upon Medicaid. Both the young, low-service and the old high-service groups have marginally greater LOS than the third group while the level of care variable is consistent with the pattern of the delivery of services.

Table 12 also present the "Year Which Sample Was Drawn" variable, an indicator of the relative prevalence of each of the groups at each survey year. Both the high-service oldest group, and the youngest group with heart disease and diabetes are more prevalent in the earlier surveys. The third group is almost exclusively observed in 1977.

Clearly when services are added to the analysis, the basic nature of the groups changes. The third group which emerges only in 1977 is much older than the third group in the prior analysis but relatively free of disabilities though more subject to specific medical problems. The first two groups, found extensively in both earlier surveys, continue to represent a group suffering from senility and sensory problems and a group with a wide range of medical problems. The power of the demographic factors to discriminate groups is strongly moderated by the service variables.

C. Transitions between States

This section will summarize research findings previously presented in a series of papers, publications and presentations on models of transitions between states. Again the relevant paper are in Appendix A.

The Response of Health Care Systems to Increasing Need for Acute and Long Term Care

Strategies for controlling acute and long term care medical expenditures were

Table 12

Variables associated with the three profiles identified in the GOM analysis with service variables in addition to health and functional status variables for persons aged 85+

			PURE TYPE		
		Frequency	1	2	3
1.)	Total Monthly Charge (Adjusted to Constant Dollars)				
	$1 - 221	0.14	0.03	0.34	0.08
	$222 - 290	0.21	0.16	0.28	0.20
	$291 - 358	0.22	0.28	0.19	0.19
	$359 - 450	0.22	0.24	0.10	0.31
	$451 and over	0.21	0.29	0.09	0.22
2.)	Primary Payment Source				
	Own Income or Family Support	0.42	0.38	0.53	0.37
	Medicare	0.02	0.02	0.01	0.01
	Medicaid	0.38	0.41	0.13	0.59
	Welfare	0.15	0.18	0.26	0.00
	Other	0.03	0.01	0.07	0.03
3.)	Number of Beds in Facility				
	Less than 99	0.54	0.57	0.66	0.37
	100 and over	0.46	0.43	0.34	0.63
4.)	Region				
	Northeast	0.24	0.19	0.29	0.25
	Northcentral	0.36	0.25	0.40	0.43
	south	0.24	0.35	0.15	0.22
	West	0.16	0.21	0.16	0.10
5.)	Owners'-				
	Proprietary	0.67	0.77	0.55	0.66
	Non-Profit	0.33	0.23	0.45	0.34
6.)	Length of Stay (In Days)				
	Up to 29	0.04	0.04	0.02.	0.05
	30- 179	0.13	0.13	0.09	0.18
	180 - 359	0.13	0.15	0.15	0.11
	360 - 729	0.22	0.22	0.23	0.20
	730 - 1,079	0.14	0.11	0.13	0.19
	1,080 and over	0.34	0.35	0.39	0.27
7.)	Level of Care				
	Intensive	0.45	0.97	0.01	0.12
	Other intensive	0.39	0.03	0.39	0.88
	Personal	0.15	0.00	0.55	0.00
	Neither	0.01	0.00	0.05	0.00

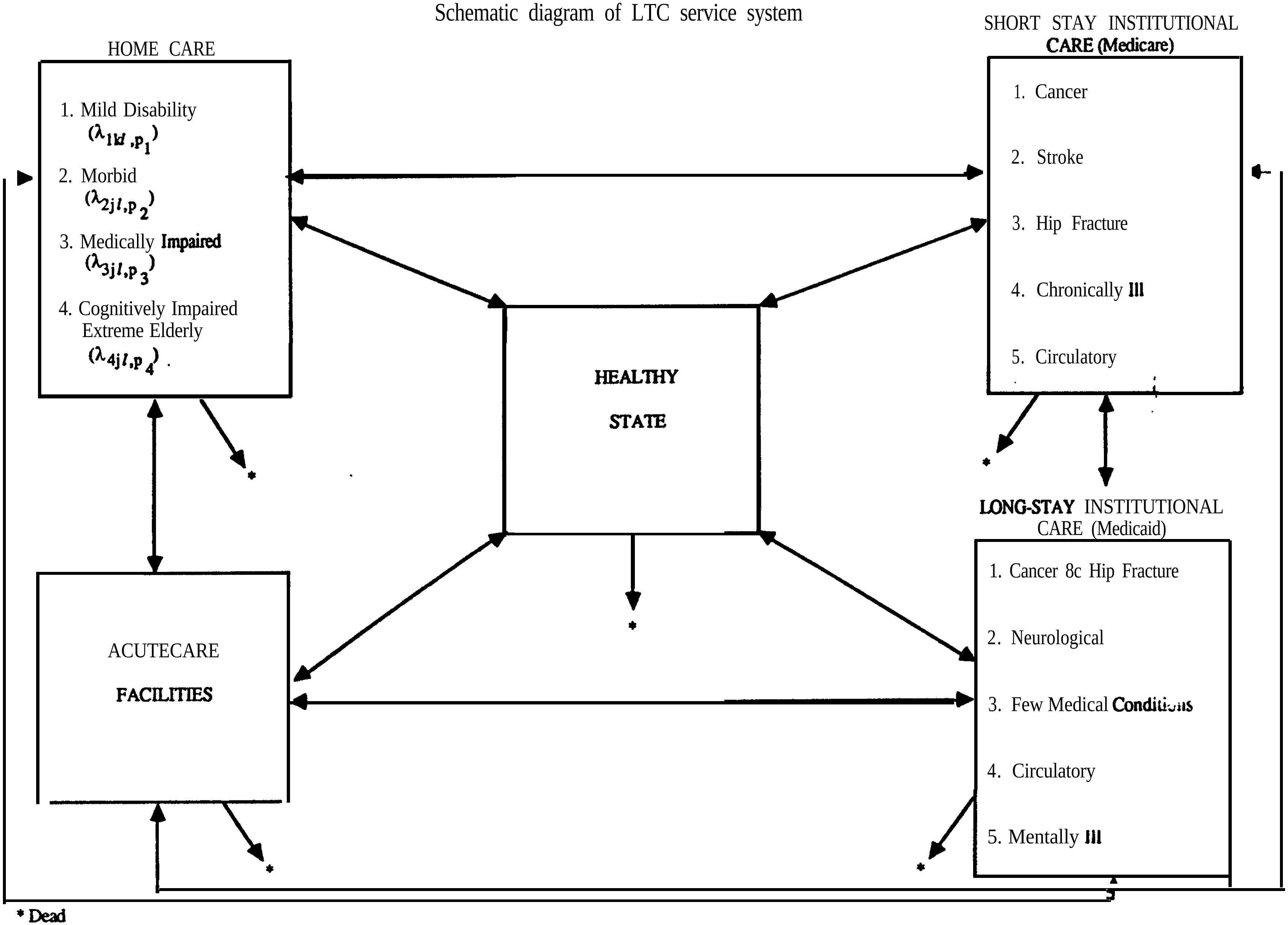
Table 12 (cont'd)

8.) Year Which Sample Was Draw				
1969	0.31	0.32	0.56	0.00
1973	0.32	0.49	0.3 3	0.00
1977	0.37	0.19	0.01	1.00

Source: 1969.1973 and 1977 NNHS.

Figure 6

Schematic diagram of LTC service system



controls on the transitions from community to institutional care, and (2) controls on the transition from acute care to institutional and home care. Clearly one cannot evaluate interventions cross-sectionally, but rather they must be implemented and assessed longitudinally. Figure 7 reflects the effect of epidemiological and demographic factors that will change the prevalence of different populations by changing their basic health characteristics and adding in a temporal component. With the logical structure specified above, the system and its control can be formally evaluated by a multistage system of equations addressing expenditures made to provide services to a particular cross-sectional configuration. Large differences were found for persons in different groups. The bed-ridden dependent patient was found to expend ***$350*** per month on formal care, while the female group with few medical problems has no **formal care** expenses. Major differences were found in terms of infomal care, however, with the highly morbid group (group 4) comsuming over 11 days of infomal care per week.

Figure 7 About Here

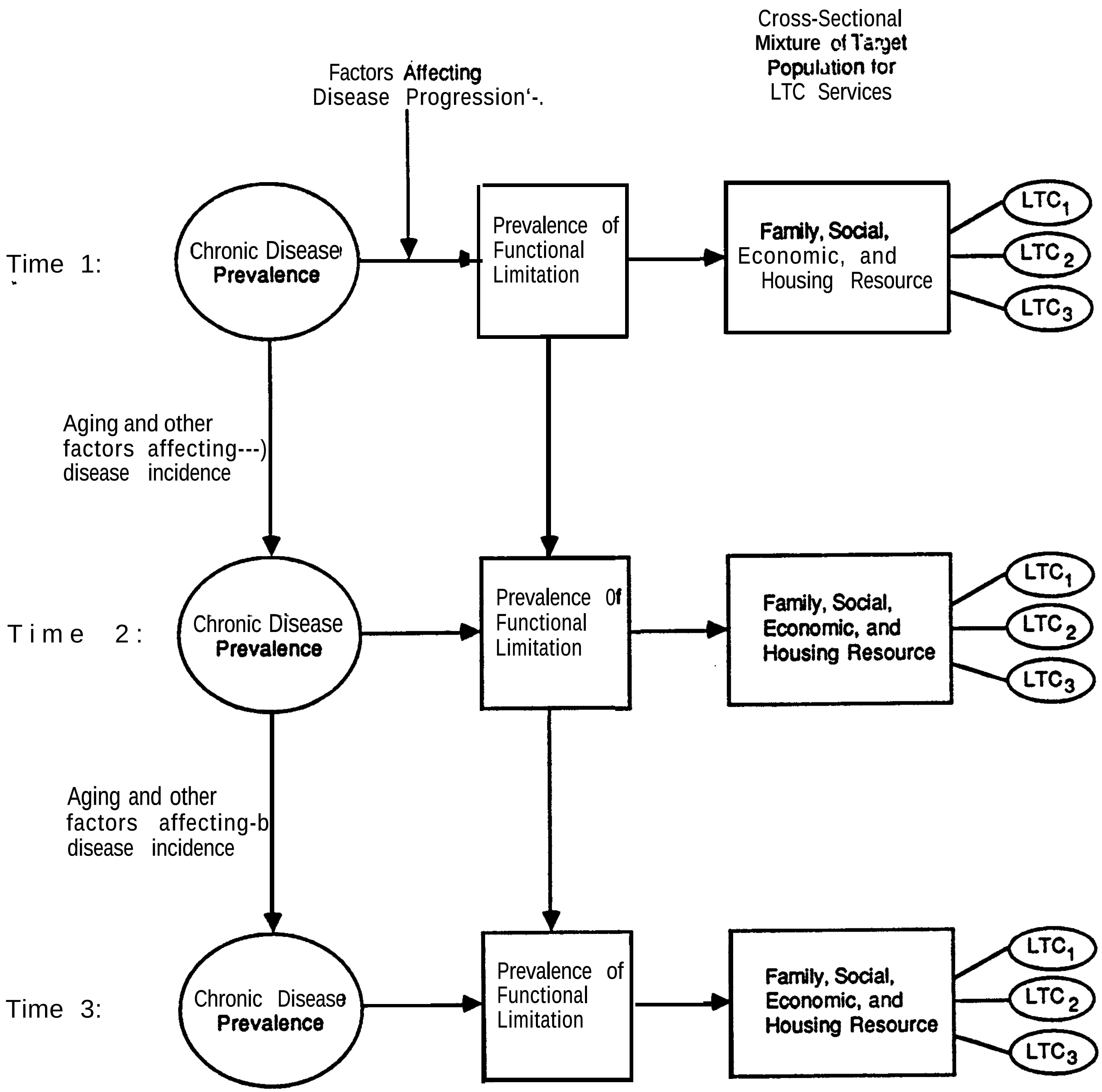
Models which can forecast how epidemiological factors might be modified by certain types of intervention were also examined by determining how health changes at advanced ages might be measured and developing a model that might be used to project those changes. These models can be used to forecast future health status and show how simulated efforts at system control affected the future trajectory of health changes.

Linkage of Chronic Morbidity, Disability and Mortality

The linkage of chronic morbidity, disability and morality was described and assessed in a recent paper by Manton (1986) appearing in the ***Journal of Gerontology*** (41(5):672-681). Methods for projecting mortality reductions at advanced ages and problems associated with those methods were discussed, and the effects of certain risk factor interventions on life expectancy and survival at later ages were illustrated using data from the Framingham Heart Study. This analysis showed that we have much to do in controlling exogenous risk factors to increase life expectancy before we can become overly concerned about biological limits to life expectancy. The potential limits to life expectancy increases by controlling the age change of measured risk factors are presented in Table 13. Three interventions (preventing the risk factor from increasing with age, eliminating individual variability on risk factors, and controlling both individual variability and age increase in risk factors) can be compared against 1982 U.S. white male age-specific life expectancy and the baseline experience of the Framingham cohort. The figures in parentheses represent the gain in life expectancy relative to the Framingham baseline. We see that control of the age increase of blood pressure is more significant at advanced ages than reducing individual variability, which has its greatest impact at younger ages. In the last two columns, the effect of imposing controls on all measured risk factors is illustrated. Age control of all risk factors greatly increases life expectancy (by 4.4 years at age 30 and 3.1 years at age 100). The last column of Table 13 shows the effect of combining age control with elimination of high risk persons. A 12.3 year increase occurs at age 30, which implies a life expectancy at age 30 of 87.3--a figure clearly beyond many'existing upper estimates of the biological limits to even female life expectancy. Clearly these life expectancy figures would be clearly difficult to

Figure 7

A model of change in LTC needs



SOURCE: Manton and Soldo, 1985, Fig. 14.

attain in a population since they require tight controls, but they suggest a much higher potential limit to life expectancy than do many recent estimates of the theoretical biological bounds.

Table.1 3 About Here

The conditional probability of being disabled with certain medical conditions was examined using data from the 1982 NLTCS. First, it was determined which medical conditions were reported as causing long-term disability for elderly persons. Table 14 shows, for selected medical conditions, the age specific frequency of cases at four disability levels reported by sample persons in the 1982 NLTCS to result from those conditions. Up to four conditions per person could be reported in the survey.

Table 14 About Here

The ten conditions reported in the table account for 86% of all disabled elderly living in the community, and 95% of persons with 5-6 ADL impairments. At all ages, diseases such as cancer and heart disease, which produce the largest number of deaths, generate only small amounts of chronic disability, even at high disability levels. Chronic degenerative conditions such as senility, arthritis, and arterosclerosis, however, are reported to cause the highest levels of disability. This implies that in order to reduce the total amount of disability in the population by controlling chronic disease risks, intervention must occur early in the degenerative process before the acute phases of the degenerative process become manifest.

A comparison of disability levels by age groups shows that at ages 85 and over, chronic degenerative conditions are even more important in causing disability. Senility, for example, is reported as a factor in 35% of disabled persons in this age group. Hip fracture declines somewhat as a disability factor with age, perhaps due to the higher risks of institutionalization at advanced ages.

The age-specific risks of disability were found to be little-altered by life expectancy increases that could result from control of risk factors for what are currently major causes of death. Reduction of disability risks instead will require a separate though coordinated effort at controlling other sets of risk factors.

The Linkage of Health Status Changes and Disability and Work Ability

A two-stage model was presented by Manton (1987) in an article published in Comprehensive *Gerontology* (1:16-24) which related the changes in risk factors to changes in disease outcomes, identified disability profiles among the chronically disabled elderly, and related those profiles to projected changes in disease outcomes for different disease groups. Calculations were presented to illustrate applications of each procedure reflecting the impact of changes in health status on functional capacity and work ability.

Life table parameters estimated from the 20-year survival and risk factor experience of 2,336 males aged 29-62 in 1950 in Framingham, Massachusetts were calculated using

Table 13

Changes in age specific life expectancy after different interventions on risk factors using the 20-year experience of Framingham males

Age	Framingham Baseline	U.S. White Males 1982	No Age Increase of Diastolic Blood Pressure or Pulse Pressure	No Variance of Diastolic Blood Pressure or Pulse Pressure	Both Controls on Diastolic Blood Pressure or Pulse Pressure	Age Controls on All Variables	Both Controls on All Variables
30	44.5	43.8	45.6 (1.1)	46.6 (2.1)	47.5 (3.0)	48.9 (4.4)	57.3 (12.3)
60	18.3	17.9	19.5 (1.2)	19.8 (1.5)	20.9 (2.6)	22.3 (4.0)	29.2 (10.9)
70	11.5	11.6	12.8 (1.3)	12.6 (1.1)	13.9 (2.8)	15.4 (3.9)	21.0 (9.5)
80	6.4	7.0	7.7 (1.3)	7.0 (0.6)	8.3 (1.9)	10.0 (3.6)	14.1 (7.7)
90	3.1		4.1 (1.0)	3.3 (0.2)	4.3 (1.2)	6.3 (3.2)	8.9 (5.8)
100	1.7		2.5 (0.8)	1.8 (0.1)	2.6 (0.9)	4.8 (3.1)	6.7 (5.0)

Source: Framingham Heat Study

Table 14

Number and percent of persons who report having a specific medical condition by disability level and age group

Condition	IADL	1-2 ADL	34 ADL	5-6 ADL	Total
Age 65-74					
Number of Persons with Condition					
Cancer	39,288	36,349	16,099	33,793	125,529
	(5.61)	(5.65)	(5.77)	(10.40)	(6.44)
Diabetes	50,026	70,200	29,235	49353	198,834
	(7.15)	(10.92)	(10.48)	(15.19)	(10.21)
Senility	30,485	20,202	3,651	9,610	63,948
	(4.36)	(3.14)	(1.31)	(2.96)	(3.28)
Emphysema & Bronchitis	65,549	44,768	22939	36,766	170,022
	(9.36)	(6.96)	(8.22)	(1131)	(8.73)
Ischemic Heart Disease	50.124	33,039	10,919	23,020	117,102
	(7.16)	(5.14)	(3.9 1)	(7.08)	(6.01)
Hypenension	99,859	87,214	46,324	36,830	270,227
	(14.27)	(13.56)	(16.60)	(11.33)	(13.87)
Arteriosclerosis	207,551	179.151	105398	166915	659,015
	(29.65)	(27.86)	(37.78)	(51.36)	(33.83)
Arthritis	213,611	292,215	121,967	90565	718358
	(30.52)	(45.45)	(43.72)	(27.87)	(36.88)
Cerebrovascular Disease	183,494	170,032	94,669	150303	598,498
	(26.21)	(26.44)	(33.93)	(46.25)	(30.72)
Hip & Other Fracture	168,636	215,994	90,084	98,232	572,946
	(24.09)	(33.59)	(3229)	(3023)	(29.41)
Total Number of Persons	700,000	643,000	279,000	325,000	1948,000
AGE 75-84					
Number of Persons with Condition					
Cancer	25,528	24,883	6,503	23826	80,740
	(4.42)	(3.80)	(2.46)	(7.31)	(4.43)
Diabetes	36,987	45.350	17.874	36.63 1	136,842
	(6.4 1)	(6.93)	(6.77)	(11.24)	(7.51)
Senility	81,588	89,603	21,832	53,464	246,487
	(14.41)	(13.70)	(8.27)	(16.40)	(13.54)
Emphysema & Bronchitis	25,065	31,276	9,845	17,946	84,129
	(4.34)	(4.78)	(3.73)	(5.50)	(4.62)

Table 14 (cont'd)

Ischemic Heart Disease	27,3 17	26,796	13.941	21,973	90,027
	(4.73)	(4.10)	(5.28)	(6.74)	(4.94)
Hypertension	'67,258	57,374	22,090	23,665	175.387
	(11.66) --	(8.77)	(8.37)	(3.79)	(9.63)
Arteriosclerosis	173.000	205,980	106,042	202,242	687,264
	(29.98)	(31.50)	(40.17)	(62.04)	(37.74)
Arthritis	187,094	272,663	125,988	106,530	692,275
	(32.43)	(41.69)	(47.72)	(32.68)	(38.02)
Cerebrovascular Disease	152,883	174,547	91,043	151,801	570374
	(26.50)	(26.69)	(34.49)	(46.56)	(31.32)
Hip & Other Fractures	95356	163321	81,700	58,504	398.88 1
	(1653)	(24.97)	(30.95)	(17.95)	(21.90)
Total Number of Persons	577,000	654,000	264,000	326,000	1,821,000

AGE 85+

Number of Persons with Condition					
Cancer	1,511	7,800	1,638	6,011	16,960
	(0.77)	(2.34)	(1.08)	(3.01)	(1.93)
Diabetes	4,036	10,381	4,970	9,583	28,970
	(2.07)	(3.11)	(3.29)	(4.79)	(3.29)
senility	78,781	98,455	44553	82,659	304,448
	(40.40)	(29.48)	(2951)	(41.33)	(34.60)
Emphysema & Bronchitis	3,696	4859	4,100	1,646	14301
	(1.90)	(1.45)	(272)	(0.82)	(1.63)
Ischemic Heart Disease	6,403	10382	2,990	8,984	28,759
	(3.28)	(3.11)	(1.98)	(4.49)	(3.27)
Hypertension	17,052	29,439	11338	17,267	75,096
	(8.74)	(8.81)	(7.51)	(8.63)	(8.53)
Arteriosclerosis	47354	96,528	49,186	103,133	296,401
	(24.39)	(28.90)	(32.57)	(51.57)	(33.68)
Arthritis	45,103	133.148	63577	65,122	306,950
	(23.13)	(39.86)	(42.10)	(32.56)	(34.88)
Cerebrovascular Disease	36,607	79,164	37,437	84,209	237,417
	(18.77)	(23.70)	(24.79)	(42.10)	(26.98)
Hip & Other Fractures	23,571	67,085	37,647	32,464	160,767
	(12.09)	(20.09)	(24.93)	(1633)	(18.27)
Total Number of Persons	195,000	334,000	151,000	200,000	880,000

Age 65+

Number of Persons with Condition					
Cancer	66,327	69,032	24,240	63,630	223,229
	(4.51)	(4.23)	(3.49)	(7.48)	(4.80)
Diabetes	91,049	126.23 1	52,079	95,567	364,646
	(3.40)	(7.74)	(7.50)	(11.23)	(7.84)

Table 14 (cont'd)

Senility	190,854	208,260	70,036	145,733	614,883
	(12.97)	(12.77)	(10.09)	(17.12)	(13.23)
Emphysema & Bronchitis	94,310	80,903	36,884	56,358	268,452
	(6.41)	(4.96)	(5.31)	(6.62)	(5.77)
Ischemic Heart Disease	83,844	70317	27,850	53977	235,888
	(5.70)	(4.31)	(4.01)	(6.34)	(5.07)
Hypertension	184.169	74,027	79,752	82,762	520,710
	(12.51)	(10.67)	(11.49)	(9.73)	(11.20)
Arteriosclerosis	428.105	481,659	260,626	472,290	1,642,680
	(29.08)	(29.53)	(37.55)	(55.50)	(35.33)
Arthritis	445,808	698,026	311,532	262,217	1.720583
	(30.29)	(42.80)	(44.89)	(30.8 1)	(37.01)
Cerebrovascular Disease	372,984	423,743	223,149	386,313	1,406,189
	(25.34)	(25.98)	(32.15)	(45.40)	(30.25)
Hip & Other Fracture	287,563	446,400	209,431	189200	1,132,594
	(19.54)	(27.37)	(30.18)	(22.23)	(24.36)
Total Number of Persons	1,472,000	1,631,000	694,000	851,000	4,649,000

Figures in parentheses are percent of disabled persons who report medical conditions. Totals may reflect rounding.

Source: Tabulations of the 1982 National Long Ten Care Survey.

a quadratic form of the hazard function. These are presented in Table 15 with the projected means and variances of the eight major risk factors included in the analysis. We can recalculate this life table to represent different scenarios about intervening in the change of the eight risk factors with age, and these results are presented in Table 16 We see that regression control of systolicand diastolic blood pressure produced bigger life expectancy increases above age 60, consistent with the fact that elevated blood pressure is a risk factor for causes of death such as stroke and heart disease most prevalent at advanced ages. The second intervention is where change with age in the mean of the risk factor is allowed, but the variance of the risk factor is reduced, implying that the mean of the blood pressure distribution is unchanged but persons with extreme risk factors have those factors brought under control. This produces a biggereffect of blood pressure on life expectancy at early ages than regression control (2.08 years vs. 1.09 years at age 30), but the variance decreases with age. The third intervention, simultaneous control of regression and variance, produces nearly additive effects. Cholesterol and blood sugar were found to have relatively small effects on life expectancy; smoking control has most of its effect before age 70, and vital capacity has a similar effect across all ages. Simultaneous control of all variables produced a large effect, and overall, variance control has a greater effect than controlling the age increase in risk factor values at early ages (regression is more important at later ages).

<u>Table 15 & 16 About Here</u>

To this point, the effects of disease and disability have been averaged over all disease types. Since diseases are differently affected by intervention strategies and specific diseases will have different implications for functional capacity and work ability of survivors, we must disaggregate these risk factor interventions by major disease groups. This is done by estimating a separate hazard function for each separate disease class which allows us to model the effects of separate disease groups in terms of their specific dependency on the risk factor distribution. Values for eliminating cancer, circulatory disease, or residual disease operating independently and dependently are found in Table 17, along with the effect of reducing a risk factor on the impact of a disease on survival.

<u>Table 17 About Here</u>

The healthy-disability relation is complicated by the high risk of multiple conditions reported to have caused disability and the difficulty of measuring multiple dimensions of disability. To describe disability patterns, we analyzed data from the 1982 NLTCS using the Grade of Membership technique (see II. Methodology, Section B for description) including 9 ADL, 10 IADL and 8 IADL2 measures of limitation. These results are found in Table 18.

<u>Table 18 About Here</u>

Five types or profiles were identified in this analysis:

1. Healthy persons with few limitations with significant ability do heavy work;

Table 15

Life table with risk factors for Framingham males*

Age	l_x	e_x	Indirect cost ($)	Direct cost ($)	Pulse Pressure[2]	Diastolic Blood Pressure2	Quetelet Index[3]	Cholesterol[4]	Blood Sugar[5]	Hemoglobin[6]	Vital Capacity[7]	Cigarettes[8]
30	100,000	44.52	10,800	1,050	45.83 (13.70)	79.57 (12.53)	261.88 (34.44)	215.22 (41.41)	79.35 (29.63)	142.11 (10.25)	139.39 (31.11)	13.24 (11.53)
40	98,366	35.17	12,809	1,696	41.22 (13.70)	83.18 (12.53)	273.30 (34.40)	241.46 (41.39)	78.48 (29.62)	147.73 (10.24)	138.61 (31.11)	14.46 (I 1.52)
50	94,588	26.35	11,670	2,636	47.78 (13.69)	83.42 (12.52)	277.01 (34.32)	241.08 (41.37)	83.92 (29.62)	149.60 (10.24)	129.95 (31.10)	12.64 (11.52)
60	86,306	18.34	6,856	3,918	55.30 (13.68)	83.37 (12.50)	274.25 (34.14)	233.10 (41.33)	91.04 (29.60)	150.43 (10.24)	116.30 (31.09)	9.16 (11.50)
70	69.071	11.53	3,315	5,490	62.80 (13.65)	82.9 1 (12.46)	266.97 (33.73)	223.21 (41.21)	98.37 (29.56)	150.76 (10.22)	99.54 (31.05)	4.72 (11.47)
80	38,708	6.39	1,554	7,103	69.92 (13.59)	82.01 (12.38)	258.00 (32.85)	213.52 (40.97)	105.47 (29.48)	150.88 (10.19)	81.30 (30.97)	0.00 (0.00)
90	8.061	3.13	841	8,414	76.37 (13.46)	80.55 (12.19)	250.80 (31.21)	205.65 (40.47)	111.63 (29.27)	151.64 (10.05)	62.66 (30.73)	0.00 (0.00)
100	121	1.70	906	9,056	81.36 (13.21)	78.78 (11.85)	250.02 (28.81)	199.78 (39.57)	116.92 (28.9 1)	152.84 (9.93)	45.96 (30.42)	0.00 (0.00)

[1]Figure in parentheses are standard deviations
[2]mmhg
[3]hg/m^2
[4]mg/dl
[5]mg/dl
[6]dg/dl
[7]cl/m^2
[8]Number of cigarettes smoked/day
Source: Framingham Heart Study

Table 16
Change in life expectancy under different interventions, Framingham males

Intervention	AGE 30	40	50	60	70	80
Baseline value of life expectancy	44.52	35.17	26.35	18.34	11.53	6.39
Regression control of pulse & diastolic blood pressures	1.09	1.08	1.11	1.22	1.33	1.30
Variance control of pulse & diastolic blood pressures	2.08	1.98	1.80	1.50	1.07	0.58
Regression & variance control of pulse & diastolic blood pressures	3.00	2.90	2.78	2.63	2.37	1.90
Regression control of cholesterol	0.12	0.12	0.11	0.10	0.12	0.14
Variance control of cholesterol	0.64	0.61	0.55	0.46	0.33	0.20
Regression & variance control on cigarette smoking	1.48	1.33	1.10	0.75	0.36	0.06
Regression control of vital capacity	1.14	1.16	1.19	1.22	1.19	1.03
Regression control of blood sugar	0.43	0.43	0.45	0.46	0.44	0.36
Regression control of all variables	4.36	4.25	4.09	3.95	3.85	3.59

Source: Framingham Heart Study

Table 17
Change in indirect and direct costs under different interventions, Framingham males

Intervention	AGE 30	40	50	60	70	80
			Indirect Costs ($)			
Regression control on pulse & diastolic blood pressures	198	164	171	332	333	194
Variance control on pulse & diastolic blood pressures	2,025	2,440	2,204	1,180	427	116
Regression & variance control on pulse & diastolic blood pressures	1,968	2,440	2,016	1303	684	292
Regression control on cholesterol	54	128	92	18	25	23
Variance control on cholesterol	657	777	698	371	135	39
Regression & variance control on smoking	2,274	2,553	2,051	868	196	12
Regression control on vital capacity	183	342	537	526	343	164
Regression control on blood sugar	60	124	211	214	142	63
Regression control on all variables	2,445	2,812	2,465	1,514	848	413
Baseline value of indirect cost	10,800	12,809	11,670	6,856	3,315	1554
			Direct Costs ($)			
Regression control on pulse & diastolic blood pressures	31	52	92	180	318	437
Variance control on pulse & diastolic blood pressures	118	179	249	305	303	213
Regression & variance control on pulse & diastolic blood pressures	135	208	308	447	592	645
Regression control on cholesterol	4	9	11	13	27	47
Variance control on cholesterol	37	56	77	95	95	70
Regression & variance control on smoking	107	150	182	178	115	20
Regression control on vital capacity	36	67	119	202	298	353
Regression control on blood sugar	13	26	46	79	116	126
Regression control on all variables	174	271	402	591	847	1,096
Baseline value of indirect cost	1,050	1,696	2,636	3,918	5,490	7,103

Source: Framingham Heart Study

Table 18
Profiles of disability attributes defined with 27 functional states measures using the GoM pattern recognition model

Variable	Frequency	TYPE 1	2	3	4	5
I. ADL						
Needs help with eating	6.31	0.00	0.00	0.00	0.00	40.72
Needs help getting in/out of bed	25.85	0.00	38.22	0.00	0.00	100.00
Needs help getting around inside	40.01	0.00	100.00	0.00	0.00	100.00
Needs help dressing	21.02	0.00	0.00	0.00	0.00	100.00
Needs help bathing	42.54	0.00	62.44	32.34	27.39	100.00
Needs help using toilet	19.71	0.00	0.00	0.00	0.00	100.00
Bedfast	0.82	0.00	0.00	0.00	0.00	4.92
No inside activity	1.45	0.00	0.00	0.00	0.00	8.88
wheelchair fast	3.32	0.00	0.00	0.00	0.00	20.10
II. IADL						
Needs help with heavy work	76.15	17.87	100.00	100.00	100.00	100.00
Needs help with light work	24.93	0.00	0.00	0.00	100.00	100.00
Needs help with laundry	46.42	0.00	38.07	52.54	100.00	100.00
Needs help with cooking	33.77	0.00	0.00	0.00	100.00	100.00
Needs help with grocery shopping	63.24	0.00	100.00	100.00	100.00	100.00
Needs help getting about outside	62.48	0.00	100.00	69.73	62.03	100.00
Needs help uaveling	60.74	0.00	100.00	100.00	100.00	100.00
Needs help managing money	28.75	0.00	0.00	0.00	100.00	85.27
Needs help taking medicine	25.16	0.00	0.00	0.00	100.00	100.00
Needs help making telephone calls	19.05	0.00	0.00	0.00	100.00	67.40
III. ARK						
How Much Difficulty Do You Have:						
Climbing						
None	16.65	50.90	0.00	0.00	17.24	0.00
Some	27.25	49.10	16.69	11.18	76.57	0.00
very difficult	34.52	0.00	59.68	76.84	6.19	15.57
cannot at all	21.58	0.00	23.63	11.98	0.00	84.43
Bending Over to do Such Things as Putting on Socks						
None	10.86	86.39	52.03	0.00	59.76	0.00
Some	28.59	13.61	47.97	44.22	40.24	0.00
very difficult	20.18	0.00	0.00	55.78	0.00	33.71
Cannot at all	10.37	0.00	0.00	0.00	0.00	66.29
Holding a 10 lb. Package						
None	26.63	75.65	0.00	0.00	31.98	0.00
Some	17.77	24.35	26.96	11.17	36.02	0.00
Very difficult	17.56	0.00	23.81	47.39	32.00	0.00
Cannot at all	38.04	0.00	49.23	41.44	0.00	100.00
Reaching overhead						
None.	52.30	100.00	100.00	0.00	100.00	0.00
Some	22.66	0.00	0.00	58.41	0.00	19.37
Very difficult	15.08	0.00	0.00	32.48	0.00	29.41
Cannot at all	9.96	0.00	0.00	9.11	0.00	51.23
Combing l-lair						
None	68.86	100.00	100.00	0.00	100.00	0.00
Some	17.63	0.00	0.00	79.67	0.00	26.14
very difficult	7.74	0.00	0.00	20.33	0.00	30.87

Table 18 (Cont'd)

Cannot at all	5.77	0.00	0.00	0.00	0.00	42.99
washing Hair						
None	52.84	100.00	100.00	0.00	99.09	0.00
Some	16.53	0.00	0.00	66.85	0.00	0.00
Very difficult	9.64	0.00	0.00	33.15	0.91	6.23
Cannot at all	20.99	0.00	0.00	0.00	0.00	93.77
Grasp an Object						
None	65.38	100.00	100.00	0.00	100.00	29.51
Some	20.09	0.00	0.00	70.02	0.00	20.78
Very difficult	10.77	0.00	0.00	29.98	0.00	23.83
Cannot at all	3.75	0.00	0.00	0.00	0.00	25.87
Can See Well Enough to Read Newsprint	73.49	100.00	100.00	100.00	0.00	57.29

Source: 1982 National Long Term Care Survey

2. Persons with mobility difficulties (especially outdoors;) due to physical problems, but with no cognitive impairment, with the highest probability of hip fracture;

3. Persons with chronic respiratory and cardiovascular disease who are limited in their ability to physically manipulate objects, but with few self-care and mobility limitations and no cognitive impairment;

4. Persons with little ADL or IADL2 impairment, but with cognitive impairment, and

5. Severely impaired medically acute persons with a broad range of physical and cognitive limitations and presumably high institutionalization risks.

Type 1 would appear highly functional and work able, and Types 2 and 3 could perform some limited economic activities. Types 4 (with cognitive impairment) and Type 5 ((highly morbid and impaired), however, exhibit little capacity for work.

To relate the distribution of disability in the population to the occurrence of explicit medical problems that might be avoided by primary prevention, we have regressed the distribution of the five groups on the interaction of age and dummy variables reflecting the presence or absence of disease. Twelve conditions were selected with from the 29 medical conditions asked about in the NLTCS and are found in Table 19. We have multiplied the regression coefficient by 67 since this is the proposed new entitlement age for social security. We can now see how much disability would be projected to be changed by disease prevention at that age. The values at the top of the table in parenthesis represent the crude prevalence of that type in the chronically disabled elderly population. The intercept, at the bottom of the table, is in effect the proportion of the population that would be of that type if no one had any of the 12 diseases listed. The crude prevalence and the intercept sum to 100% since the intercept represents the prevalence adjusted for the presence of conditions.

<u>Table 19 About Here</u>

All Type l's conditions have negative coefficients so that reducing the prevalence of any condition would tend to increase the prevalence of the first type. By eliminating all diseases, Type 1 increases from 31.3% of the disabled elderly population to 47.6 % (from 1.6 to.2.4 million persons). In general, Types 1 and 2 with potential for work, increase in prevalence when the 12 diseases are eliminated. To determine the effect of controlling a given condition, examine a given row of the matrix. For example, summing across the row for dementia yields a zero value (within rounding) which means that changing the prevalence of the condition for one type has exactly compensating changes in the prevalence of the other four types. Reducing health attacks increases the prevalence of Type 1 7.37% but reduces the other types 7.38%. Thus, the effect of controlling disease prevalence has a consistent impact over all disability types.

From the size of the coefficients for Type 1, hip fracture, stroke and dementia have

Table 19
Regression coefficient multiplied by age 67, crude prevalence by type (in parentheses), and intercept

		REGRESSION COEFFICIENTS				
Disease	**Proportion in Total Sample** With Trait	**Type 1** "Healthy" (31.4%)	**Type2** **Mobility Limited** (20.7%)	**Type3** **Circulatory and Respiratory Impaired** (19.3%)	**Type 4** **Cognitive Impaired** (11.4%)	**Type 5** **Acute Medical Problems** **(17.2%)**
Rheumatism	73.2	-8.04	**1.97**	6.69	-2.61	**2.01**
Diabetes	16.6	-7.01	**-1.47**	1.88	0.61	**6.03**
Cancer	6.4	-3.62	**-0.21**	-1.74	-0.61	**6.23**
Arteriosclerosis	31.4	-6.63	**-2.41**	1.21	2.68	**5.16**
Senility	9.2	-15.41	**• 10.72**	-7.84	**10.18**	**‘23.85**
Heart **Attack**	6.2	-7.37	**0.72**	4.29	**0.29**	**2.08**
Hypertension	47.1	-1.34	**0.64**	3.35	**-1.41**	**-1.22**
Stroke	6.6	-10.39	**-0.87**	-2.55	**-0.35**	**14.07**
Bronchitis	12.9	-5.23	**-3.28**	7.34	**-1.34**	**2.35**
Emphysema	9.9	-1.81	**-1.76**	1.27	**0.01**	**2.28**
Hip Fracture	2.3	-13.67	**14.74**	-5.16	**-4.76**	**8.84**
Other Fractures	5.5	-6.50	**0.88**	3.75	**-2.88**	**4.71**
Intercept **(%)**		**47.6**	**21.2**	**10.7**	**12.6**	7.8

Source: 1982 National Long Term Care Survey the largest impact on disability. Of these three conditions, hip fracture and stroke have identified risk factors amenable to intervention. Other factors, such as rheumatism/arthritis, generalized arteriosclerosis and hypertension have smaller individual impacts but higher population prevalence so that control of those diseases would have a large population effect--.

Increasing Life Expectancy at Older Ages and Demand for Health Services

The likely changes in future demands for acute and long term care services in the U.S., Canada, and other developed countries was discussed in an invited presentation to the Colloquium on Aging with Limited Health Resources, sponsored by the Economic Council of Canada in Winnipeg, Manitoba, May 5 and 6, 1986 and subsequently published in the meeting's ***Proceedings*** **(Manton,** 1986). Demographic factors (i.e., the larger size of more recent elderly cohorts and **increasing** life expectancy at advanced ages) were likely to require increased resources for health services--especially long term care services directed to the extreme elderly--regardless of what combination of responses are implemented to regulate service use. The future age specific numbers of persons with disabilities at different levels and the number of informal caregiver hours needed to provide services to these people at current levels of care (totally and per capita) were projected for the years 2000 and 2040 using disability rates from the 1982 NLTCS and the 1977 **National** Nursing Home Survey. These are found in Table 20.

<u>Table 20 About **Here**</u>

The growth of the disabled elderly population living both in the community and in nursing homes **will** be 39% from 1982 to 2000 (6.4 to 8.9 **million).** From 2000 to 2040, growth is 100% (from 8.9 to 17.8 million), greatly concentrated in the high service use aged **85+** group (141%). The amount of informal care services required per week per disabled person is derived by multiplying these numbers by age and disability specific average hours of excess care provided to these persons. The total amount of long term care service provided by **informal** caregivers is enormous and even a **small** percentage shift **from** informal to **formal** care would be quite expensive.

If, however, prevention efforts are introduced that decrease the amount of time a person spends in a disabled state and if these efforts at prevention are as successful as those targeted to reducing mortality, potential reductions in the demand for long term care services will be great. This can be seen in Table 21 which contains recalculations of Table 20 values to reflect disability prevention activities. The number of dependent elderly is reduced 21% in 2000 and 32% in 2340. Since the extreme elderly have higher service use, the reduction in informal **care** service hours is slightly less--19% in 2000 and 30% in 2040. Nonetheless, projected service use reduction is very large (1.7 billion person-hours in 2000 and 5.4 billion in **2040),** though still far less than the increases due to purely demographic factors.

<u>**Table 21 About Here**</u>

Life expectancy was found not to be currently near its maximum value, and medical

Table 20
Projections of number of persons age 65+ with disability and living in the community or in nursing homes and number of informal helper hours for 2000 and 2040, by age

	In Community[1] Disability Level				In Nursing Home[2]	
	IADL	1-2 ADL	3-4 ADL	5-6 ADL		Total
			Number of Persons (1,000's)			
			Year 2000			
65-74	787	726			263	2,464
75-84	878	980	405 317	371 504	762	3,529
85+	382	666	300	401	1,130	2,879
65+	2,047	2,372	1,023	1,276	2,155	8,872
			Year 2040			
65-74	1,253	1,162	512	592	436	3,955
75-84	1,710	1,899	784	989	1,484	6,866
85+	929	4,613	735	969	2,685	6,930
65+	3,893	4,674	2.03 1	2,549	4,605	17,751
			Total Informal Helper Hours Per Week (1,000's)			
			Year 2000			
65-74	14,701	15,860	9,107	14,643		54,312
75-84	16,466	21,209	12,064	19,454		69,193
85+	8,188	15,944	9,734	16,147		50,013
65+	39,356	53,014	30,904	50,244		173,518
			Year 2040			
65-74	23,489	25,436	14,755	23,244		86,924
75-84	32,137	41,416	23571	38,165		135,289
85+	20,139	38,981	24,076	39,103		122,299
65+	75,765	105.833	62,402	100513		344512

[1]Source: Tabulations of the 1982 NLTCS
[2]Source: Tabulations of the 1977 NNHS

Totals may reflect rounding

Table 21
Projections of number of persons age 65+ with disability and living in the community or in nursing homes and number of informal helper hours for 2000 ana 2040, by age, adjusted to reflect reduction in disability

AGE	In Community[1] Disability Level: IADL	1-2 ADL	3-4 ADL	5-6 ADL	In Nursing Home[2]	Percent Decline from Baseline (see Table 20)
Number of Persons (1,000's)						
Year 2000						
65-74	660	608	266	311	220	2.065 (-16%)
75-84	704	781	321	405	5%	2,807 (-20%)
85+	300	522	236	313	789	2,160 (-25%)
65+	1,663	1,912	823	1,029	1,605	7,032 (-21%)
Year 2040						
65-74	914	846	373	431	317	2,882 (-27%)
75-84	1,192	1,317	539	692	1,003	4,743 (-31%)
85+	631	1,094	498	651	1,562	4,436 (-36%)
65+	2,737	3357	1.410	1,775	2,881	12,061 (-32%)
Total Informal Helper Hours Per Week (1,000's)						
Year 2000						
65-74	12,334	13,285	7,633	12,277		45,528 (-16%)
75-84	13,234	16,999	9595	15,620		55,448 (-20%)
85+	6,442	12,529	7,644	12,568		39,183 (-22%)
65+	32,011	42,813	24,872	40,465		140,159 (-19%)
Year 2040						
65-74	17.164	18,525	10,760	16,960		63,415 (-27%)
75-84	22,472	28,877	16,252	26,659		94,260 (-30%)
85+	13,708	26,481	16,328	26213		82,730 (-32%)
65+	53,344	73,883	43341	69,832		240,405 (-30%)

*Source: Tabulations of the 1982 NLTCS
[2]Source: Tabulations of the 1977 NNHS

expenditures in the final year of life were not greatly increased by rising life expectancy. Long term care costs, however, may be thus affected, but growth in the demand for resources could be controlled through three strategies:

1. Control costs by developing interventions to prevent the emergence of chronic disease and and subsequent disability at advanced ages--much ill health and functional disability at advanced ages are due to diseases such as arthritis, senility, atherosclerosis, and fractures. These conditions can be targeted for intervention.

2. Develop cost control through prospective reimbursement systems for specific service episodes.

3. Develop capitation models where reimbursement is for a fixed service interval.

Control strategies must tolerate heterogeneity in treatment response because of future medical differences between populations and the need to have facility specialization in large scale health service delivery systems. Reimbursement on appropriately devised actuarial measures with case-mix adjustments may be an effective strategy for tolerating heterogeneity of response in a complex service delivery system, while allowing for adequate levels of individual responsibility (fiscal risk in a privately fun&d system) and decision making.

Expenses for Home Based Care for the Disabled Elderly

The dearth of information on the private costs-of long term care for the disabled elderly residing in the community has limited public policy deliberations on home-based care as potentially cost-effective compared to institutionalization. Utilizing data from the 1982 National Long Term Care Survey, Liu, Manton and Liu (1985) analyzed the expenses incurred by the disabled community elderly for home-based care, and the relationship between patient characteristics and out-of-pocket expenses in a paper published in the ***Health Care Financing*** Review (7:5 l-58)

The study found the noninstitutionalized disabled elderly population heterogeneous in level of need. Nineteen percent (850,000 persons) had 5-6 ADL limitations, while 31% (1.4 million persons) had only IADL impairment. Table 22 shows the percent of persons with limitations in activity by source of assistance and limitation level and suggests that payment for home-based cam has a diversity of roles. The relatively high percentage of persons with 5-6 ADL limitations with both paid and unpaid helpers (32.9%) may indicate that paid help is a necessary complement for unpaid help for persons with severe disability. Two-thirds of private expenditures for home-based care went for nonmedical assistance, and therefore would not conventionally be covered by public or private third party insurers. Table 23 presents the source of payment for the 1 .1 million persons who received paid care. Almost 41% indicated themselves as payment source for formal nursing care. Since 26% of respondents could not specify payment sources, we computed a distribution of payment sources for only those cases with complete information available (labelled "Adjusted" in table). The proportion of persons indicating Medicare, Medicaid or private insurance as payment source was found to rise with disability. In Table 24, we see that although 6.2 % of the IADL limitation only group indicated Medicare as a source of payment, almost 29% of the 5-6 ADL limitation group did. Self-pay is more prevalent at lower levels of disability.

<u>Tables 22, 23 & 24 About Here</u>

The estimated 1.1 million disabled community elderly receiving paid care spent an average of $164/month out-of-pocket, which implied approximately $1 billion in out-of-pocket expenditures by the disabled elderly on an annualized basis. Tables 25 and 26 present summary statistics for the estimated 608,000 persons who paid for some part of their home-based care. For the total population, the highly skewed distribution of payment amounts is indicated by the fact that one-half made payments of $40/month or less and 10% paid more than $400/month. Payments for nursing services (Table 26) is similarly skewed, but the level of payment is considerably higher. Table 27 shows that percentages of the self-payer population by ADL and payment amount are related to the proportion of the total expenses incurred in a month. Persons with 5-6 ADL limitations and paid over $135 composed only 5.3% of the self-payer population, but accounted for almost 44% of total out-of-pocket payments. Persons with only IADL limitations comprised almost 25% of the self-payer population regardless of amount paid, but accounted for only 13% of total out-of-pocket expenditures.

<u>Tables 25.36 & 27 About Here</u>

The personal characteristics and long term care service use of those who pay out-of-pocket differ from those who do not pay out of pocket, and private payers' characteristics differ by amount expended in a month. Table 28 presents a profile of the total and private payer disabled elderly. Clear differences emerge:

<u>Table 28 About Here</u>

*Median age: A two-year difference between private payers (78) and total disabled elderly (76) ;

•Smaller percentages of private payors are male or married;

*Private payors receive fewer unpaid helper days per week,

*Private payers have twice the rate of nursing home use and are twice as likely to have made payments for nursing assistance;

•Private payers have fewer days of informal help.

The most distinctive subgroup is those who reported paying more than $135/month. This group is twice as likely to be senile and is older than the total disabled population, needs assistance with meals and taking medicine, and has had a prior nursing home stay. Such factors are good predictors of nursing home admission, so private

Table 22

Percent of persons with limitations in activity, by source of assistance and limitation level: United States, 1982

Limitation level	Number of persons in thousands	Source of assistance: Paid helpers	Nonpaid helpers	Both paid and nonpaid helpers
		Percent		
Total	4,405	5.5	73.9	20.6
IADL only	1,368	6.8	81.1	12.1
ADL 1-2	1,506	6.6	74.9	18.5
ADL 3-4	683	4.0	68.6	27.4
ADL 5-6	849	2.5	64.7	32.9

NOTE: Total does not equal 4.6 million total disabled elderly because of unknowns. IADL is for instrumental activities of daily living. ADL is for activities of daily living.

Source: 1982 NLTCS

Table 23

Percent of disabled persons with all paid helpers and nursing helpers, unadjusted and adjusted for unknown payment source, by payment source: United States, 1982

Payment source	Persons with nursing helpers: Unadjusted	Persons with nursing helpers: Adjusted	Persons with paid helpers: Unadjusted	Persons with paid helpers: Adjusted
	Percent			
Sample person only	40.7	55.0	12.8	16.1
Medicare only	6.4	11.4	30.5	36.6
Medicaid only	6.0	8.1	11.7	14.0
Other organization only	4.0	6.6	5.6	7.3
Sample person and Medicare	2.7	3.6		[1]3.9
Other private persons	2.1	2.8	[1]3([2])	([2])
Medicare and private insurance	2.0	2.7	6.6	7.1
Sample person and other private persons	1.9	2.6	([2])	([2])
Sample person and other organization	1.2	1.6	([2])	([2])
Medicare and Medicaid	[1]1.0	[1]1.4	[1]1.6	[1]2.3
Insurance only	([2])	([2])	[1]2.4	3.0
All other patterns	3.2	4.3	5.4	6.8
Unknown	26.0	0	20.7	0

[1] Relative standard error greater than 30 percent.
[2] Less than 1 percent.

NOTE: The total number of persons with paid helpers was 1,151,752. The total number of persons with nursing helpers was 290,181.

Source: 1982 NLTCS

Table 24

Percent of individuals with paid care,' by payment **source** and limitation level: United States, 1982

Limitation level	Payment source[2]				
	Self	Medicare	Medicaid	Insurance	Helping oroaniration
			Percent of persons		
All levels	47.8	15.4	8.5	3.4	6.7
IADL only	54.4	6.2	7.1	1.3	7.3
AOL. 1-2	66.0	9.0	6.4	4.2	6.4
ADL. 3-4	42.0	19.2	0.6	7.0	10.1
ADL. 5-6	35.7	29.7	12.3		4.0

[1] The distribution of payment sources are baaed only an those cases in which a clear pattern for a person's payment sources can be determined (i.e., the "unknowns" in Table 2 are not included). Hence. the frequencies of tne specific payment sources could be higher than those presented. For example, an estimated 608.000 were self-paying, yet only 550.000 had complete payment source patterns.

[2] These are not mutually exclusive categories, because an individual may have more than one source of payment.

NOTE: IADL is for instrumental activities of daily living. ADL is fcr activities of daily living.

Source: 1982 NLTCS

Table 25

Summary statistics on reported out-of-pocket. payments for a month for any home care, by limitation level: United States, 1982

Item	All persons	Limitation level: IADL only	ADL 1-2	ADL 3-4	ADL 5-6
	Number in thousands				
Penons paying out of pocktr	608	150	229	105	124
	Amount				
Average monthly payment	$164	$88	$85	$117	$439
Payment at selected percentiles 10thayers:					
25th	156	6	6	6	15
		12	12	20	40
50th	40	30	30	50	140
75th	135	70	60	160	450
90th	400	226	209	312	1.260

NOTE. IADL is for instrumental activities of daily living. ADL is for activities of daily living.

Source: 1982 NLTCS

Table 26

Summary statistics on reported out-of-pocket payments for a month for home nursing care, by limitation level: United States, 1982

Item	Limitation level: All persons	IADL only and ADL 1 4	AOL. 5-6
	Number		
Persons paying out of pocket	66,000	30.700	27,394
	Amount		
Avtnge monthly payment	$424	$156	$724
Payment al selected percentiles of ptytm			
10th	9	6	24
25th	20	13	40
50th	90	74	100
75th	400	229	607
90th	680	400	1,922

NOTE IADL is for instrumental activities of daily living. ADL is for activities of daily living.

Source: 1982 NLTCS

Table 27

Comparison of percent of subgroups of out-of-pocket payers with percent of total out-of-pocket payments in a month, by payment and limitation level: United States, 1982

Payment and limitation level	Percent of all payers[1]	Percent of all payments[2]
Persons paying less than $15:		
IADL only	5.5	0.2
ADL. 1-2	6.2	0.3
ADL 3-4	4.2	0.2
ADL 5-6	4.2	0.4
Persons paying $15-135:		
IADL only	12.6	2.5
ADL 1-2	19.2	3.6
ADL 3-4	6.7	3.1
ADL 5-6	11.0	11.6
Persons paying more than $135:		
IADL only	6.5	10.6
ADL 1-2	10.4	16.1
ADL 3-4	4.3	9.3
ADL 5-6	5.3	43.9

[1] All payers totaled 608,000 persons.
[2] All payments totaled $99,524,000.

NOTE: IADL is for instrumental activities of daily living. ADL is for activities of daily living.

Source: 1982 NLTCS

Table 28

Profile of disabled. elderly, by the amount Of out-of-pocket payments incurred: United States, 1982

Characteristics	Au disabled elderly	Private payers				
		Total	Less than $15	$15-39	$40-135	$136 or more
Number in thousands	4,400	608	136	148	174	163
Median age	76.0	78.0	77.0	78.0	78.0	61 .0
Percent male	34.9	26.1	20.7	28.2	25.4	25.9
Percent married	41.9	31.6	31.0	31.0	38.9	27.5
Median family income	$8,500	18,500	5,500	7,500	9,500	13.000
Percent on Medicaid	14.9	11.5	15.9	[2]11.5	'10.4	'8.8
Median ADL[1] score	20	2.0	2.0	2.0	2.0	3.0
Percent senile	10.0	9.4	[2]3.5	[2]3.6	6.7	23.3
Percent incontinent	24.5	27.8	21.1	26.5	29.1	33.4
Percent needing help with meals	6.8	7.6	[2]6.6	[2]4.9	[2]4.7	14.6
Percent needing help with medicine	27.1	272	16.3	15.5	21.7	54.7
Percent ever in nursing home	7.6	15.6	13.4	132	13.8	21.6
Percent in hospital in past 12 months	37.6	42.5	40.7	38.0	43.2	47.5
Percent use of adult day care	5.2	5.8	3.3	7.7	'3.9	[2]4.9
Percent use of outside sources of meals	4.0	7.3	11.8	[2]5.6	[2]3.9	8.6
Percent with payments for home nursing care	62	13.9	11.6	8.4	13.3	21.6
Median number of paid helpers per week	0	1	1	1	1	1
Median number of paid helper days per week	0	2	1	1	2	7
Median number of unpaid helpers per week	1	1	1	1	1	1
Median number of unpaid helper days per week	7	2	2	2	3	2

[1]Activities of daily living.
[2]Relative standard error greater than 30 percent.

Source: 1982 NLTCS

expenditures incurred by this group may be purchasing marginal resources to keen them in the community. Prolonged high expenditures, however, may result in severe economic burden--another risk factor for institutionalization.

These analyses were extended by using logistic regression procedure to assess the risk of out-of-pocket payments as a function of multiple factors and a standard regression to assess the affect of factors on the amount of payment. These analyses are being extended to the 1984 NLTCS.

Functional Level, Medicare Utilization, Institutionalization, and Mortality

A paper presented at the Population Association of America Meetings in Chicago April 30-May 3, 1988 (Corder and Manton, 1988) presented disaggregated information on the institutionalization and mortality risks associated with various health states, examined changes in patterns of medical care use according to relatively homogeneous case mix categories, and generated life table survivorship curves for medical services for the disabled elderly living in the community in 1982-1984. The data source utilized was the 1982 and 1984 National Long Term Care Surveys.

The transitional probability of improving or losing functional capacity over the two year study period was assessed and the change of status of the 27 million persons in the 1982 U.S. elderly population is presented in Table 29. Disability was quantified at five levels: (1) the nondisabled--those elderly persons reporting no long term (90 days duration), (2) those who report IADL limitations only, (3) those reporting 1-2 ADL limitations, (4) those reporting 3-4 ADL limitations, and (5) those reporting 5-6 ADL limitations. Transitional probabilities are presented in Table 29.

Table 29 About Here

In this table, we have proportionally allocated the 2.66% of persons followed to 1984 whose status was undetermined in 1984 to each of the known 1984 statuses. We have retained transitions to the death state for 1984. Down the left hand column of the table, the status of the persons in 1982 is given, and across the top, the status of persons two years later in 1984. For example, of the roughly 20 million persons nondisabled in 1982, 81.6% remained nondisabled in 1984, while 1.5% were institutionalized and 8.1% died. Although mortality rapidly increases with disability, a high rate of improvement in disability is evidenced over the interval (e.g., for persons with 1-2 ADL limitations in 1982, 18.2% improve their functional status by 1984). Considerable improvement occurs even at advanced disability levels. Nearly 24% of persons with 3-4 ADL limitations and 22.2% with 5-6 ADL limitations improve. Even if we normalize for death (i.e., divided the 22.2% of persons with 5-6 ADL limitations by .6278) to yield the rate of disability improvement among survivors to 1984, a 35.3% rate of improvement is noted among survivors. Neither does the risk of institutionalization increase from 3-4 to 5-6 ADL limitations, although the risk of mortality is over 50% higher. The only strongly absorbing state is institutionalization where 54.2% of persons remained and only 6.2% were released.

TABLE 29

1982 Versus 1984 Disability Status Weighted Counts

1982 STATUS	1984 STATUS: Not Disabled	IADL	1-2 ADL's	3-4 ADL's	5-6 ADL's	Institutional	Deceased	% Distribution in 1982
Not Disabled*	81.59	4.02	2.96	0.99	0.86	1.48	8.09	78.06
IADL Only	9.31	40.78	19.89	4.93	4.22	5.71	15.15	4.94
1-2 ADL's	3.62	14.58	34.36	12.61	6.46	7.68	20.69	5.60
3-4 ADL's	1.85	4.09	17.65	22.78	19.69	9.96	23.99	2.42
5-6 ADL's	0.75	4.81	7.74	8.89	30.88	9.71	37.22	2.71
Instutionalized	0.96	1.07	0.97	1.14	1.09	54.18	40.58	5.42
'82 Detail Noncompleters	5.04	7.47	8.86	6.61	7.59	16.51	47.89	0.85
% Distribution in 1984	64.6	6.3	5.95	2.62	2.66	5.49	12.4	100.00

*Includes those not disabled on screener or detailed interview

Source: 1982 and 1984 NLTCS

Table 29 also shows the transition probabilities a.) for persons who were institutionalized in 1982 (and hence did not receive the detailed instrument) and b.) for persons who, though identified as chronically disabled at the time of the screen, did not receive the detailed household interview. All of these groups have extremely high mortality rates with the non-responders having the highest mortality rates (47.9 percent) of any group. Among those not institutionalized in 1982, the non-responder group had the highest risk of becoming institutionalized (i.e.. 16.5 percent vs. 10.0 percent for those with 3 to 4 impairments). The high mortality and institutionalization risk of the nonresponder group probably reflect the fact that extremely poor health was a major reason for nonresponse. In addition we see differences between the group institutionalized on April 1, 1982 (a group which represents an institutional current resident sample) and the group which became institutionalized between April 1, 1982 and the date of the screen or the date of the attempted household interview (which represents a set of newly admitted institutional residents). The newly admitted cases are apparently more medically acute with a higher mortality rate than the current institutionally resident group but also with a significantly greater chance of returning to the community (14.65 percent vs. 3.65 percent).

Because of the very different numbers of persons in each state in 1982 it is useful to translate these transition probabilities into the estimated frequencies of persons who make each transition. The magnitude of these groups are dependent upon Census Bureau estimates of the population in each sample component in 1982 and they are dependent upon assumptions made to produce those estimates. Nonetheless the general magnitude of the number are of interest. These estimates are presented in Table 30.

<u>Table 30 About Here</u>

We see that there were 17.4 million non-disabled and non-institutionalized elderly in 1984 of the total of 26.9 million persons who started alive in 1982. Over 3.3 million persons died over the two-year interval with 1.7 million of the deaths occurring among those who were not disabled in 1982, 502,000 deaths occurring in the cross-sectional sample of institutionalized persons, 90,000 deaths occurring in those institutionalized after April 1, 1982 and 272,000 deaths occurring for people with 5 to 6 ADL impairments.

There were about 730,000 persons with 5 to 6 ADL impairments resident in the community in 1982 and about 720,000 in the survivors to 1984. The disability level which manifested the largest increase is the population component with only IADL impairments. The group- that contributed the largest number of new nursing home residents was the non-disabled group.

By adding up the appropriate entries in Table 30 we see that by 1984, about 872,000 of the persons disabled in 1982 improved their functional status. Because of the large size of the non-disabled group in 1982 many more people lost functional status or became institutionalized (-2.17 million). If one examines only those persons with disability in 1982 the number who lost functional status or became institutionalized is

Table 30

Number of persons (in thousands) by transitional status, 1982 versus 1984 disability status weighted counts

1982 STATUS	1984 STATUS							
	Not Disabled	IADL	1-2 ADL's	3-4 ADL's	5-6 ADL's	Institutional	Deceased	Population Distribution in 1982
Not Disabled[a]	17,139	845	623	209	180	311	1,701	21,008
IADL Only	124	543	265	66	56	76	202	1,330
1-2 ADL's	55	220	518	190	97	116	312	1,506
3-4 ADL's	12	27	115	148	128	65	156	650
5-6 ADL's	5	35	57	65	225	71	272	730
Institutional as of 4-I-82	7	9	7	12	11	701	502	1,249
'82 Detail Noncompleters	12	17	20	15	17	38	109	228
Institutional (after 4-1-82)	7	6	7	5	5	89	90	210
Total Population in 1984	17,361	1,702	1,606	710	719	1,467	3,344	26.9 11

[a]Includes those not disabled on screener or detailed interview.

Source: 1982 and 1984 NLTCS.

about 1.1 million versus the 872,000 who improve their status.

The transitional probabilities in Table 29 were also computed by sex (Table 31) and age (Table 32). The probability of death at all levels of disability is higher for males than females, though the probability of remaining disabled over the two-year period is not differentiated by sex. Functional status of females is more likely to deteriorate, while males are likely to remain with only IADL limitations or regain functional status. At higher disability levels, however, females are more likely to maintain functional level or improve than males. At the 5-6 ADL limitation level there is little difference by sex in transition probabilities. Female institutionalization rates are higher, reflecting the lesser likelihood of a surviving spouse. Only a small proportion of either males or females leave institutions at a level of improvement, and females tend to remain in institutions primarily due to lower mortality rates.

<u>Tables 31 & 32 About</u>

The age stratification by three categories in Table 32 shows mortality increases with age in all disability levels. A large drop in the proportion not disabled over the interval is also evidenced: from 87.5% at age 65-74 to 47.3% at age 85+. The likelihood of regaining function also decreases with age for both IADL and ADL limitations. Age differences decline, however, as ADL limitation level increases. Institutionalization increases less rapidly with age at 5-6 ADL limitations, and mortality for the institutionalized is very close to that for persons with 5-6 ADL limitations.

Transition probabilities were also computed by marital status in Table 33 which shows that at each ADL limitation level, the non married experience much higher levels of institutionalization. Transitional probabilities by education level were computed but showed no clear patterns.

<u>Table 33 About Here</u>

Medical utilization by the nondisabled elderly population was also analyzed for Medicare hospital episodes, Medicare SNF episodes and Medicare HHA episodes. These results are presented in Table 34. Medicare hospital episodes showed overall decline in length of stay (LOS) and death rates. Discharge to Medicare SNF was stable, while discharge to HI-IA increased, and to community unchanged. LOS in Medicare SNF declined slightly, and hospital readmission declined from 14.4 in 1982 to 8.5 in 1984. Discharge from HI-IA increased dramatically from 8.6 in 1982 to 24.0 in 1984. An increase in discharge to community was observed as was an overall decline in SNF deaths. Medicare HI-IA episodes showed an overall increase in LOS, hospital readmission declined and discharge to SNF was insignificant. A great increase in LOS was observed along with probable increase in the death rate among the very ill receiving care.

<u>Table 34 About Here</u>

Table 3 1: Weighted Percentage Distribution of Case Status in 1984 by Case Status in 1982 According to Sex

1982 Status	1984 STATUS Non Disabled	IADL Only	1 or 2 ADLs	3 or 4 ADLs	5 or 6 ADLs	Institutional	Deceased
Non-Disabled							
Males	81.05	3.25	2.28	0.82	0.84	1.04	10.72
Females	81.97	4.58	3.46	1.12	0.87	1.80	6.20
IADL only							
Males	11.69	42.32	13.37	3.73	5.63	4.16	19.10
Females	7.87	39.86	23.84	5.66	3.36	6.65	12.76
1 or 2 ADLs							
Males	2.50	12.56	28.70	12.31	8.72	6.19	29.02
Females	4.16	15.54	37.06	12.75	5.37	8.40	16.72
3 or 4 ADLs							
Males	3.17	3.92	13.22	18.90	18.08	7.17	35.54
Females	1.16	4.17	19.96	24.79	20.53	11.41	17.98
5 or 6 ADLs							
Males	1.12	4.73	7.16	9.10	29.03	6.75	42.10
Females	0.52	4.86	8.10	8.75	32.03	11.54	34.19
Institutional							
Males	1.04	0.96	1.36	1.35	0.95	46.25	48.11
Females	0.92	1.11	0.83	1.07	1.13	57.14	37.70

Source: 1982 and 1984 NLTCS.

Table 32

1982 Versus 1984 Disability Status Weighted **Counts by Age Groups**

19112 STATUS				**1984 STATUS**			
	Not Disabled	IADL	**1-2** ADL's	3-4 ADL's	**5-6** ADL's	**Institutional**	**Deceased**
Not Disabled*							
65-74	87.53	3.07	**1.81**	0.76	0.55	0.55	5.73
75-84	73.40	5.75	**4.48**	1.29	1.21	2.51	11.36
85+	47.28	7.04	**10.18**	2.64	3.03	8.14	21.68
IADL Only							
65-74	13.72	46.82	**17.19**	3.75	3.67	3.21	11.63
75-84	7.08	37.26	**21.62**	6.03	4.39	7.36	16.27
85+	0.87	30.52	**23.99**	5.71	5.58	9.37	23.94
1-2 **ADL's**							
65-74	6.25	18.17	**36.68**	12.78	5.65	4.61	15.55
75-84	2.65	14.02	**34.80**	11.46	5.39	7.85	23.83
85+	0.48	8.15	**28.99**	14.56	10.11	13.30	24.40
3-4 **ADL's**							
65-74	3.58	5.79	**24.42**	25.74	17.07	4.75	18.65
75-84	1.16	3.51	**16.87**	2224	19.84	11.76	24.61
85+	0.00	2.10	**7.08**	18.48	24.08	15.99	**32.28**
5-6 **ADL's**							
65-74	1.16	7.49	**9.61**	10.14	32.29	6.74	**32.57**
75-84	0.80	4.54	**7.07**	8.81	31.64	10.97	**36.17**
85+	0.00	0.85	**5.81**	6.94	27.30	1251	**46.60**
Instutionalized							
65-74	2.77	1.48	**1.91**	2.29	1.39	60.20	**29.96**
75-84	0.91	1.60	**1.40**	1.02	1.31	55.69	38.06
85+	1.00	0.35	**0.12**	0.71	0.70	49.72	48.28
'82 Detail Noncompleters							
65-74	6.45	11.46	**11.35**	10.35	6.36	6.29	47.74
75-84	6.63	6.76	**9.11**	4.98	9.12	17.48	45.94
85+	0.00	3.19	**4.67**	4.42	5.89	27.03	47.94
% Distribution **in** 1984							
65-74	77.13	5.41	**4.17**	1.92	1.69	2.09	7.58
75-84	53.38	7.98	**8.09**	3.26	3.42	7.75	16.12
85+	19.94	6.48	**10.45**	5.08	6.43	20.10	31.51

*Includes those not disabled on screener or detailed interview
Source: 1982 & 1984 NLTCS

Table 33: Weighted Percentage Distribution of Case Status in 1984 by Case Status in 1982 According to Marital Status

1982 Status	1984 STATUS Non Disabled	IADL Only	1 or 2 ADLs	3 or 4 ADLs	5 or 6 ADLs	Institutional	Deceased
IADL Only							
Married	12.69	43.39	15.52	5.38	5.03	3.43	14.56
Not Married	6.69	39.12	23.30	4.52	3.63	1.40	15.32
J or 2 ADLs							
Married	5.31	14.38	33.20	J 1.55	7.99	4.73	22.83
Not Married	2.61	14.72	35.08	13.03	5.48	9.55	19.54
3 or 4 ADLs							
Married	3.68	5.85	17.31	19.02	22.20	5.78	26.16
Not Married	0.42	2.72	18.00	25.81	17.80	13.28	21.97
5 or 6 ADLs							
Married	1.09	5.76	7.53	8.20	33.68	7.24	36.49
Not Married	0.44	3.97	8.07	9.68	28.26	12.02	37.57

Source: 1982 and 1984 NLTCS.

Table 34

Medical utilization 1982-1984

	Medicare Hospital Episode 1	Medicare SNF Episode 2	Medicare HHA Episode 3
	Total	Total	Total
1982 Rate	100.0	100.0	100.0
LOS	8.4	25.1	37.9
1984 Rate	100.0	100.0	100.0
LOS	7.9	23.9	42.4
	Discharge to SNF	Discharge to Hospital	Discharge to Hospital
1982 Rate	2.9	14.4	10.0
LOS	13.9	13.7	30.5
1984 Rate	2.9	8.5	8.0
LOS	12.8	14.5	23.7
	Discharge to HHA	Discharge to HHA	Discharge to SNF
1982 Rate	10.9	8.6	0.5
LOS	11.0	19.4	71.5
1984 Rate	12.9	24.0	0.7
LOS	9.3	31.3	51.0
	Discharge to Community	Discharge to Community	Discharge to Community
1982 Rate	74.5	46.9	72.8
LOS	7.78	26.4	29.4
1984 Rate	74.2	52.4	81.6
LOS	7.5	23.8	39.4
	Discharge to Death	Discharge to Death	Discharge to Death
1982 Rate	9.4	19.1	5.5
LOS	7.9	13.3	46.3
1984 Rate	8.3	11.0	4.2
LOS	5.4	7.9	89.5

SOURCE: National Long Term Care Survey.

Transitional Probabilities of Disability, Institutionalization, and Mortality for the U.S. Elderly

Papers in ***The Journal of Gerontology*** (Manton, 1988) and in the ***Annual Review of Gerontology*** present the results ofalongitudinal analysis of transitonal probabilities of mortality, institutionalization, and functional status as estimated from the 1982 and 1984 National Long Term Care Survey. These results update the transitions presented in order by minor adjustments in episode definitions and sample weights. This analysis showed interesting aspects of sex differentials in risk of functional impairments emerging at advanced ages. Female incidence of impairment, for example, was lower than male up to age 85 over the two year period. Higher impairment prevalence for females is the consequence of lower female mortality than males at each age and disability level, which implies longer life expectancy and duration of time spent by females in impaired states.

Such differences in disability incidence and duration will have tremendous consequences for level and type of **LTC services** required by the elderly. Males would seem to require more medically acute types of care but for more limited time periods. Females would possibly require less medically intensive care, but for more extended periods of time. Due to social factors, more males would tend to be cared for at home than females.

The figures in Table 29 give a sense of the transition risks for individuals while those in Table 30 provide a sense of the volume of the population flows. The transition risks are the most important statistics for assessing the likelihood of improvement in the functional status of an individual. The flow volume tells us how much community and institutional LTC services are required under current conditions. In assessing the volume of services required it is important to know not only the total amount of services required at a given point in time but also the volume of flow into and out of certain service need states since those flows determine the duration over which services are required and consequently, the need for relatively permanent institutional and maintenance care versus the need for transient cam -- possibly with much higher medical acuity and greater rates of both improvement and mortality. Thus, in both cases the rate and volume of long-term functional status improvement are significant.

What the figures do not tell us are the risks of making certain transitions for persons who survive to 1984 or for persons who survive and remain in the community. Each of these specially defined populations has specific implications for service needs. These figures are provided in Table 35 and demonstrate that the risks appear to be very different for these subgroups.

Table 35 About Here

In Table 35 we provide three types of transition probabilities for each transition type. The first is the unadjusted transition probability from Table 29. The second is the set of transition probabilities adjusted for mortality (i.e., they have been divided by the probability of survival for that group so that the probabilities sum to 100 percent among the survivors). The third is the set of transition probabilities adjusted both for

Table 35

Transitional probabilities (%) of 1982 versus 1984 disability status, unadjusted, adjusted for mortality and adjusted for mortality and institutionalization

1982 STATUS	1984 STATUS							
	Not Disabled	IADL	1-2 ADL's	3-4 ADL's	5-6 ADL's	Institutional	Deceased	% Distribution in 1982
Not Disabled*								
Unadjusted	81.59	4.02	2.96	0.99	0.86	1.48	8.09	
Adjusted for mortality	88.77	4.37	3.22	1.08	0.94	1.61		
Adjusted for mortality & Institutionalization	9022	4.45	3.27	1.09	0.95			78.06
IADL Only								
Unadjusted	9.31	40.78	19.89	4.93	4.22	5.71	15.15	
Adjusted for mortality	10.97	48.06	23.44	5.81	4.97	6.73		
Adjusted for mortality & Institutionalization	11.76	51.53	25.13	6.23	5.33			4.94
1-2 ADL's								
Unadjusted	3.62	14.58	34.36	12.61	6.46	7.68	20.69	
Adjusted for mortality	4.56	18.38	43.32	1550	8.15	9.68		
Adjusted for mortality & Institutionalization	5.05	20.35	47.97	17.60	9.02			5.60
34 ADL's								
Unadjusted	1.85	4.09	17.65	22.78	19.69	9.96	23.99	
Adjusted for mortality	2.43	5.38	23.22	29.97	25.90	13.10		
Adjusted for mortality & Institutionalization	2.80	6.19	26.72	34.49	29.81			2.42
5-6 ADL's								
Unadjusted	0.75	4.81	7.74	8.89	30.88	9.71	37x2	
Adjusted for mortality	1.19	7.66	1233	14.16	49.19	13.47		
Adjusted for mortality & Institutionalization	1.41	9.06	1458	16.75	58.19			2.71
Institutional as of 4-l-82								
Unadjusted	054	0.75	0.55	0.94	0.87	56.14	40.20	
Adjusted for mortality	0.90	1.25	0.92	157	1.45	93.88		
Adjusted for mortality & Institutionalization	14.75	20.49	15.03	25.68	23.77			4.64
'82 Detail Noncompleters								
Unadjusted	5.04	7.47	8.86	6.61	7.59	16.51	47.89	
Adjusted for mortality	9.67	14.34	17.00	12.68	14.57	31.68		
Adjusted for mortality & Institutionalization	14.16	20.98	24.89	18.57	21.32			0.85
Institutional (after 4-l-82)								
Unadjusted	3.44	2.97	3.51	2.36	2.37	42.50	42.85	
Adjusted for mortality	6.02	5.20	6.14	4.13	4.15	74.37		
Adjusted for mortality & Institutionalization	23.48	20.27	23.96	16.11	16.18			0.78
TOTAL								
Unadjusted	64.60	6.30	5.95	2.62	2.66	5.49	12.40	
Adjusted for mortality	73.74	7.19	6.79	2.99	3.04	6.27		
Adjusted for mortality & Institutionalization	78.67	7.67	7.25	3.19	3.24			100.00

*Includes those not disabled on screener or detailed interview.
Source: 1982 & 1984 NLTCS

institutionalization and mortality. These adjustments represent a type of "competing risk" adjustment for the forces of decrement of mortality and institutionalization. Note, however, that since the adjustments are made within institutional and functions1 disability levels they are "dependent competing" risk adjustments, i.e., the mortality and institutional status adjustments are allowed to interact with functional and institutional status.

We see that these adjustments provide very different impressions of individual changes in functional status -- especially for persons at the higher levels of impairment. For example, after adjusting for mortality 49.2 percent remain at the 5 to 6 ADL impairment level while resident in the community with only 15.5 percent going into institutions. Among the two-year survivors with 5 to 6 ADL impairments in 1982 we find that 35 percent improve their functional status. Among survivors with 3 to 4 ADL impairments the improvement rate is about 31 percent with an institutionalization rate of about 13 percent. Interestingly those with 3 to 4 ADL impairments still appear to be in the most unstable state with only 30 percent remaining at that level of impairment two years later. Of this group of survivors nearly 26 percent progress to having 5 to 6 ADL's two years later. Among the detail non-completers in 1982 we see that about 32 percent are institutionalized two years later while 24 percent have no impairment or only an IADL impairment. Because of the low mortality rate the non-disabled persons have the smallest adjustment. Nearly 89 percent of the survivors of this group remain non-disabled with only 1.6 percent going into institutions. Overall, we see that the total population is only marginally more disabled in 1984 (after adjustment for mortality) consistent with two years of aging changes.

The second level of adjustment shows the effects of removing the risk of institutionalization for each disability status group. After this adjustment we see that 42 percent of these surviving persons who had 5 to 6 ADL's in 1982 and remained in the community had functional improvements. The community resident surviving group with 3 to 4 ADL impairments again shows a high rate of progression to the 5 to 6 ADL impairment state. After adjustment we see that persons who were institutionalized on April 1, 1982 (i.e., those persons in the "cross-sectional" or current resident sample who are likely to be disproportionately long-term nursing home residents) and who return to the community have an over 85 percent chance of manifesting some disability, i.e., these persons seldom return fully rehabilitated to the community. In contrast the group who was newly institutionalized (i.e., those entering after April 1, 1982) has a higher proportion of persons returning unimpaired (23.5 percent) and at the lower levels of impairment.

The results in Table 36 show the differential effects of selection of both mortality and institutionalization. One of these forces of decrement, the force of institutionalization, is directly controllable by policy decisions. For example, recent constraints on the growth of the nursing home bed supply, and, more recently, changes in the medical acuity of nursing home patients due to changes in the admission patterns and duration of acute hospitals stays, could change the probability that community resident elderly improve their functional status because the rate of transition to nursing homes may be altered for different subgroups thereby changing the composition of the community population (Liu and Manton, 1988). The force of mortality selection, on the other hand, is probably less easily changed requiring control of the mortality risks of the wide range of medical conditions which cause disability.

Overall the numbers above show the extreme heterogeneity of the functional change of disabled persons and the important effects of selection due both to mortality and institutionalization. Specifically, it suggests that both functional improvement and mortality are more powerful forces of decrement to the disabled elderly community resident population than is institutionalization.

So far we have not decomposed the functional transitions by either age or sex. This is done in Table 36 for three age groups (65-74; 75-84; and 85+).

Table 36 About Here

The table shows some rather striking features of the sex differences in the risk of functional change and institutionalization.

First, we see that females have a lower probability of becoming (incident cases) functionally impaired than males for the largest two age groups (i.e., those 65 to 74 and those 75 to 84). This can be contrasted with the lower probability of females being (prevalent cases) non-disabled (i.e., at ages 65 to 74, 87.6 versus 86.4 percent; at ages 75 to 84, 75.7 versus 69.0 percent; at ages 85 and over, 50.4 versus 39.7 percent). The fact that females have a modestly lower probability of not remaining disabled at ages 85 and above (i.e., 46.5 percent versus 48.8 percent) is probably due to the higher rate of systematic selection of seriously ill males at earlier ages, i.e., since males tend to have disability caused more by lethal conditions many males likely to become disabled have died at younger ages where those lethal conditions have high relative mortality risks.

Second, we see that, at comparable functional status and age levels, females have much better survival than males. For example, non-disabled females at ages 65 to 74 -have a 3.8 percent two-year risk of death versus 8.2 percent for males. Taking the inverse of these quantities give a crude approximation of life expectancy for these groups. At ages 85 and over, non-disabled females have an 19.3 percent two-year mortality risk (i.e., 10.4 years of life expectancy) compared to 26.3 percent for males (about 8 years of life expectancy). Even at high levels of functional disability this mortality differential holds. For example, for females aged 65 to 74 with 5 to 6 ADL impairments, the two-year mortality is 30.4 percent (about 6.6 years life expectancy) and, for those aged 85+, 44.5 percent (4.5 years life expectancy). Male mortality at this same level of disability, and for corresponding ages is much higher (35.1 percent and 53.6 percent). In contrast to mortality, institutional risks are generally elevated for females, e.g., for males aged 85+ with 5 to 6 ADL impairments the risk of institutionalization is 6.4 percent compared to 14.3 percent for females. Thus, the higher prevalence of functional disability among females is a result of their greater longevity at each functional status level (and the longer time that they can expect to remain in that impaired state) and not due to a greater individual risk of incurring functional disability.

Table 36
Transition Probabilities **(%)** of 1982 Versus 1984 Disability Status **for Males and Females by Three Age Groups**

	1984 STATUS															
	Not Disabled		IADL Only		1-2 ADLs		3-4 ADLs		5-6 ADLs		institutional		Deceased		TOTAL	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Not Disabled'																
65-74	as.99	88.73	2.48	3.54	1.39	2.13	0.72	0.77	0.55	0.55	0.62	0.50	8.24	**3.79**	87.56	86.37
75-84	72.87	73.74	4.77	6.39	3.66	5.01	0.71	1.66	1.42	1.06	1.63	3.08	14.93	9.06	75.74	68.95
85+	48.77	46.49	6.69	7.24	11.76	10.92	3.14	2.38	2.05	3.56	4.32	10.16	26.27	19.25	50.41	39.65
1982 STATUS																
IADL only																
65-74	14.62	13.09	48.62	45.56	12.49	20.48	0.95	5.71	4.87	2.84	1.90	4.13	16.54	8.19	3.63	4.02
75-84	II.00	4.90	36.64	37.60	13.93	25.81	6.54	5.74	7.15	2.87	6.69	7.72	18.05	15.29	6.17	6.61
85+	1.42	0.60	33.41	29.12	15.40	**28,21**	6.65	5.25	4.04	6.34	5.68	**11.18**	33.4 I	19.31	**7.81**	6.75
1-2 ADLs																
65-74	3.43	7.88	15.96	19.92	31.24	39.82	16.24	10.79	7.15	4.79	5.32	4.22	20.67	12.61	3.04	4.10
75-84	2.62	2.66	11.47	15.09	29.59	37.00	8.26	**12.81**	8.08	4.26	2.49	**10.11**	37.49	18.08	5.82	a.33
85+	0.00	0.61	6.58	**8.81**	20.86	32.39	10.97	16.07	13.79	8.57	15.68	12.32	32.13	21.18	12.57	12.15
3-4 **ADLs**																
65-74	4.63	2.85	5.44	6.03	**19.89**	27.61	22.**15**	28.28	17.19	16.98	2.43	6.38	28.29	**11.88**	1.51	1.62
75-84	3.09	0.41	3.09	3.68	8.55	20.14	18.54	23.70	18.17	20.50	10.46	12.26	38.10	19.32	2.34	3.53
85+	0.00	0.00	**1.82**	2.24	**5.45**	7.85	12.14	**21.52**	19.98	26.04	12.72	17.55	47.90	24.18	6.10	5.43
5-6 ADLs																
65-74	1.26	1.08	6.18	8.64	9.81	9.39	10.13	10.16	31.90	32.68	5.69	7.65	35.12	30.40	1.87	1.64
75-84	1.35	0.45	4.72	4.42	5.02	8.38	8.11	9.26	26.40	35.04	8.12	12.82	46.27	29.64	3.61	3.29
85+	0.00	0.00	0.00	1.10	4.28	6.27	8.56	6.45	27.14	27.36	6.42	14.34	53.60	44.49	**5.18**	7.30
Institutional as of 4-i-82																
65-74	1.68	2.14	0.84	0.61	2.53	1.07	0.84	2.29	1.68	1.24	57.34	68.95	35.08	23.71	1.45	**1.54**
75-84	0.54	0.38	1.64	0.97	0.54	0.60	1.63	0.60	0.56	1.09	49.83	61.78	45.25	34.58	4.14	6.90
85+	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.83	0.00	0.66	37.54	53.05	62.46	44.91	13.54	**23.91**
'82 Detail Noncompleters																
65-74	4.63	a.74	6.69	17.48	4.63	19.82	9.41	11.51	4.46	8.74	9.08	2.77	61.10	30.91	**0.62**	il.39
75-84	6.72	6.57	9.33	5.28	6.72	10.49	2.24	6.55	8.96	9.21	4.49	25.00	61.52	36.89	1.24	1.22
85+	0.00	0.00	5.55	2.33	5.55	4.67	0.00	7.01	0.00	9.34	16.67	34.65	72.22	42.02	2.00	1.86

Table 36 **(cont'd.)**

Institutional (after 4-1-82)																
65-74	7.77	**5.80**	3.88	6.18	0.00	5.42	7.77	3.09	2.89	0.00	38.84	43.54	38.85	35.95	0.31	0.32
75-84	0.00	5.16	0.00	**5.95**	5.12	**6.06**	**0.00**	2.69	2.59	3.60	35.84	41.11	56.45	35.44	0.93	1.17
as+	0.00	1.34	0.00	0.00	4.00	0.00	4.00	0.00	5.74	2.69	32.00	52.13	60.00	**43.85**	2.39	2.95
TOTAL																
65-74	76.27	77.80	4.67	5.98	3.15	4.95	1.76	2.03	1.77	1.64	1.92	2.22	10.46	5.38	loo.00	loo.00
75-84	56.25	51.70	6.95	a.58	5.89	9.38	2.25	**3.85**	3.52	3.36	4.83	9.47	20.30	13.67	loo.00	loo.00
85+	24.24	18.16	7.05	6.24	a.92	11.09	4.76	6.71	5.74	6.71	12.06	23.45	37.25	29.12	**100.00**	loo.00

[a] **Includes (hose not disabled oo screener or detailed** interview.

SOURCE: 1982 **and 1984 National Long Term Care Survey**

To investigate these changes further we calculated the mortality adjusted risk of institutionalization and functional changes for males and females over age. To conserve space we present the values only for the two extreme age groups, i.e., those 65 to 74 and those 85+. These are presented in Table 37 which presents sex specific functional disablement rates net of mortality.

Table 37 About Here

In this table we see the effects of eliminating mortality on the transition probabilities. What we see is, despite an adjustment for very different mortality levels, that the sex differentials in the transition rates for nondisabled persons (i.e., with females having lower transition rates to functional impairments) remain at ages 65 to 74. At ages 85 and above the transition rate to disability is clearly higher for females. For persons with very serious impairments (i.e., with 5 to 6 ADL impairments) we find strong differentials with females having higher risks of institutionalization.

D. Demographic Projections, 1980-2040

As discussed in Section II.F, projections of the size of the long term care community and institutionalized population were produced specific to age, sex, marital status and disability level. In order to understand the role age plays in influencing health status, consider Figure 1 (originally presented in Section II., Methodology, p. 43) which is constructed from a series of life table survival curves that describe the change in the proportion of a cohort that can expect to survive to a given age without either morbidity, disability, or mortality occurring (Manton and Soldo, 1986).

The horizontal axis of the figure represents age; the vertical the probability (expressed as a percent) of surviving to a given age without suffering one of the three health events. The areas of the figure are defined by a product of age (time) and the average probability (for an individual) of being in a given health state. The areas, therefore, represent the number of person-years spent by the cohort or life table population in specific health states. The area marked A, for instance, is the number of person-years spent free of disease; B, with chronic disease but unimpaired, and C, disabled. Areas A and B together represent the potentially productive or "active" life expectancy.

Using Figure 1 as a conceptual framework, we have constructed Figures 2a and 2b (in Section II, Methodology, p. 44-45) to understand what the rate estimates imply for the distribution over age of disability within a cohort. We see that disability risks increase for both males and females up to age 85 and that females have a much greater prevalence of disability (or institution&ion) at all ages.

Projections were then conducted to estimate the size of the long term care community-

Table 37

Transitional probabilities (%) of 1982 versus 1984 disability status, adjusted for mortality, for males and females by two age groups

1982 STATUS	1984 STATUS Not Disabled Males	Not Disabled Females	IADL Males	IADL Females	1-2 ADL's Males	1-2 ADL's Females	3-4 ADL's Males	3-4 ADL's Females	5-6 ADL's Males	5-6 ADL's Females	Institutional Males	Institutional Females	% Distribution in 1982 Males	% Distribution in 1982 Females
Not Disabled*														
65-74	91.82	92.23	2.70	3.68	1.51	2.21	0.78	0.80	0.60	0.57	0.68	0.52	87.56	86.37
85+	66.15	57.57	9.07	8.97	11.88	13.52	4.26	2.95	2.78	4.41	5.86	12.58	50.41	39.65
IADL only														
65-74	17.52	14.21	58.26	49.44	14.97	22.22	1.14	6.20	5.84	3.08	2.28	4.48	3.63	4.02
85+	2.13	0.74	50.17	36.09	23.13	34.96	9.99	6.51	6.07	7.86	8.53	13.85	7.81	6.75
1-2 ADL's														
65-74	4.32	9.02	20.12	22.79	39.38	45.56	20.41	12.35	9.01	5.48	6.71	4.83	3.04	4.10
85+	0.00	0.85	9.70	11.18	30.74	41.09	16.16	20.39	20.32	10.87	23.10	15.63	12.57	12.15
34 ADL's														
65-74	6.46	3.23	7.59	6.84	27.74	31.33	30.89	32.09	23.97	19.27	3.39	7.24	1.51	1.62
85+	0.00	0.00	3.49	2.98	10.46	10.44	23.30	28.61	38.35	34.62	24.41	23.33	6.10	5.43
5-6 ADL's														
65-74	1.94	1.55	9.53	12.41	15.21	13.49	15.61	14.60	49.17	46.95	a.77	10.99	1.87	1.64
85+	0.00	0.00	0.00	1.98	9.22	11.29	18.45	11.62	58.49	49.28	13.84	25.83	5.18	7.30
Institutional as of 4-l-82														
65-74	2.59	2.81	1.29	0.80	3.90	1.40	1.29	3.00	2.59	1.63	88.32	90.38	1.45	1.54
85+	0.00	0.00	0.00	0.91	0.00	0.00	0.00	1.51	0.00	1.20	100.00	96.40	13.54	23.91
'82 Detail **Noncompleters**														
65-74	11.90	12.65	17.20	25.30	11.90	28.69	24.19	16.61	11.47	12.65	23.34	4.01	0.62	0.39
85+	0.00	0.00	19.98	4.02	19.98	7.36	0.00	12.09	0.00	16.11	60.01	59.76	2.00	1.86
Institutional (after 4-1-82)														
65-74	12.71	9.06	6.35	9.65	0.00	8.46	12.71	4.82	4.73	0.00	63.52	67.98	0.31	0.32
as+	0.00	2.39	0.00	0.00	10.00	0.00	10.00	0.00	0.00	4.79	80.00	92.84	2.39	2.95
TOTAL														
65-74	85.18	82.22	5.22	6.32	3.52	5.23	1.97	2.15	1.98	1.73	2.14.	2.35	100.00	100.00
85+	38.63	25.62	11.24	8.80	14.22	15.65	7.59	7.36	9.08	9.47	19.22	33.09	100.00	100.00

***Includes those not disabled oo screener or detailed interview**

Source: 1982 and 1984 NLTCS

n

based and institutionalized populations. These projections produced age, sex, marital status, and disability level estimates for 1980, 1990, 2000, and 2040 which are presented in Table 38. One can see the considerable growth of the noninstitutionalized long-term care population based on the current rate structure, and its concentration among unmarried, elderly females aged 75 and over.

Table 38 About Here

The projected growth of the nursing home population is presented in Table 39. It is expected to increase to over 2.2 million persons by 2000 and over 4.6 million persons by **2040.** As with the long term care community population, growth of the institutionalized group is also concentrated in the unmarried female group aged 75 and over (e.g., in 2040, about 66 percent of the total).

Table 39 About Here

The above projections assume that the current rate structure is stable through time. We computed another set of projections assuming that disability rates are reduced proportionally as fast as mortality declines. These results for the long term care community population are presented in Table 40. By 1990, the disabled elderly population would be 13.4% lower under the assumption of heath status improvements. By 2040, the reduction would be 25.9%. Nursing home population projections also decrease assuming improvement in health. Table 41 shows that under such a scenario, the nursing home population would be reduced 25.5% by 2000, and 37.4% by 2040. Under these assumptions, the nursing home bed pool would only have to increase at the rates of 1.4% annually.

Tables 40 & 41 About Here

E. Cross-National Comparisons

In addition to assessing the size, characteristics and service use/need patterns of the U.S. elderly disabled population residing in the community, we also conducted comparative analyses of select international data bases. These analyses yielded insights on a.) the manner in which the needs of the long-term care population are met in societies at different levels of development with different health and social service delivery systems; b.) the effects of different societal factors on the WHO conceptual model of impairments, disabilities and handicaps (WHO, 1980), and c.) different strategies for meeting long-term care needs.

Indonesia

The World Health Organization, in collaboration with the Indonesian Institute of Health Research and Development, conducted a survey of disability in 14 of 24 Indonesian provinces designed to assess the validity of the disablement process as described in WHO's (1980) classification of impairments, disabilities, and handicaps. We analyzed these data with the Grade of Membership to simultaneously identify subgroups in the surveyed population and the typical attributes of those subgroups

Table 38

Projections of the noninstitutionalized long-term cm population by age, sex, marital status and disability level, 1980-2040 (number in thousands)

YEAR	IADL	1-2 ADL	34 ADL	5-6 ADL	Total+	IADL	l-2 ADL	3-4 ADL	5-6 ADL	Total*
					DISABILITY LEVEL					
	Married Males					Married Females				
Age 65-74										
1980	217	167	79	136	600	143	170	76	85	472
1990	255	197	93	160	706	175	208	93	104	580
2000	256	197	94	161	708	175	207	93	104	579
2040	399	308	146	250	1,103	288	343	153	171	955
Age 75-84										
1980	133	114	49	89	385	76	73	47	52	281
1990	185	160	68	125	538	116	112	72	79	379
2000	230	198	84	154	666	150	145	94	102	491
2040	452	389	165	303	1,309	310	299	193	211	1,013
Age 85+										
1980	19	46	28	25	118	11	14	9	12	46
1990	26	61	38	33	159	12	14	9	12	47
2000	42	98	60	53	253	20	24	16	21	82
2040	112	263	162	143	681	57	68	46	59	230
	Unmarried Males					Unmarried Females				
Age 65-74										
1980	59	56	30	20	165	260	233	86	75	653
1990	71	67	35	24	197	282	251	94	81	708
2000	79	74	39	27	219	277	247	92	80	6%
2040	153	144	76	52	425	413	368	137	119	104
Age 75-84										
1980	53	65	16	30	164	283	365	138	137	922
1990	67	82	20	38	208	361	465	176	174	1,176
2000	82	101	25	47	254	416	536	202	201	1355
2040	194	239	59	111	602	755	972	367	364	2,458
Age 85+										
1980	39	47	18	19	124	111	204	'85	130	530
1990	47	57	22	23	150	166	305	127	194	791
2000	67	80	31	33	211	253	463	193	294	1,203
2040	176	212	82	87	557	585	1.069	445	680	2,779

*Totals may reflect rounding errors.

Source: 1982 NLTCS.

Table 39

Nursing home population by age, sex, and marital status, 1980 to 2040

YEAR	MARRIED MALES	MARRIED FEMALES	UNMARRIED MALES	UNMARRIED FEMALES
		Age 65-74		
1980	21,556	20,348	64,897	118,292
1990	25,345	25,012	77,624	128,335
2000	25,429	24,932	86,186	126,220
2040	39,608	41,132	167,412	187,877
		Age 75-84		
1980	38,639	29,358	90,095	338,627
1990	53,914	44,801	114.238	431,609
2000	66.834	58,143	139,362	497,557
2040	131,314	119,867	330,740	902,507
		Age 85+		
1980	23,646	13,755	77,406	406,708
1990	31,886	14,029	93,376	607,308
2000	50,709	24,276	131,516	923,549
2040	136,518	68,279	347,202	2.132920

Source: 1977 NNHS.

Table 40

Projections of the noninstitutionalized long-term care population assuming improved health status by age, sex, marital status and disability level, 1980-2040 (number in thousands)

YEAR	IADL	1-2 ADL	3-4 ADL	5-6 ADL	Total*	IADL	1-2 ADL	3-4 ADL	5-6 ADL	Total*
	DISABILITY LEVEL									
	Married Males					Married Females				
Age 65-74										
1980	217	167	79	136	600	143	170	76	85	472
1990	226	171	83	142	625	153	181	81	90	505
2000	216	167	79	136	598	145	173	77	86	481
2040	296	228	108	185	817	206	245	109	122	683
Age 75-84										
1980	133	114	49	89	385	76	73	47	52	281
1990	167	144	61	112	485	96	93	60	66	315
2000	1%	169	72	132	569	114	110	71	78	374
2040	340	293	125	228	986	201	194	125	137	656
Age 85+										
1980	19	46	28	25	118	11	14	9	12	46
1990	23	54	33	29	140	9	11	7	9	37
2000	34	80	49	44	208	14	17	11	14	56
2040	80	188	115	102	485	32	39	26	34	132
	Unmarried Males					Unmarried Females				
Age 65-74										
1980	59	56	30	20	165	260	231	86	75	653
1990	63	59	31	21	175	246	219	82	71	618
2000	67	63	33	23	186	231	206	77	66	580
2040	115	108	57	39	318	297	265	99	85	746
Age 75-84										
1980	53	65	16	30	164	283	365	138	137	922
1990	61	75	18	35	189	305	392	148	147	991
2000	71	87	21	40	219	323	415	157	155	1,050
2040	149	184	45	85	463	503	647	244	242	1.636
Age 85+										
1980	39	47	18	19	124	111	204	85	130	530
1990	42	51	20	21	135	141	258	107	164	670
2000	56	68	26	28	179	195	357	149	227	927
2040	132	160	62	65	419	387	708	295	450	1,839

*Totals may reflect rounding errors.

Source: 1982 NLTCS.

Table 41

Nursing home population, assuming improved health status, by age, sex, and marital status, 1980 to 2040

YEAR	MARRIED MALES	MARRIED FEMALES	UNMARRIED MALES	UNMARRIED FEMALES
		Age 65-74		
1980	21556	20,348	64,897	118,292
1990	22,454	21,753	68,770	111,611
2000	21,457	20.69 1	72,724	104,748
2040	29310	29,388	123.889	134335
		Age 75-84		
1980	38,639	29,358	90,095	338,627
1990	48,574	37,128	102,922	357,691
2000	56,871	43,953	118,586	376,122
2040	98,354	76,962	247,724	579,462
		Age 85+		
1980	23,646	13,755	77,406	406,708
1990	27,720	10,835	81,178	469,045
2000	40,993	16,447	106,317	625,703
2040	95,015	38,013	241,649	1,187,442

Source: 1977 NNHS

(Manton, Dowd & Woodbury, 1986). The purpose of the analysis was to (a) determine the association of basic patterns of physical and psychological impairments with disabilities (limitations of the ability to perform certain functions) and handicaps (limitations in the ability to fulfill social roles); (b) assess how those disabilities and handicaps were expressed in urban and rural contexts in a developing country; and (c) determine how the relation of impairments with disabilities and handicaps varied with age.

Two analyses of these data were done. The first is of the 2,180 respondents of all ages who reported significant impairment, disability or handicap. These 2,180 respondents represent roughly 10.4% (somewhat over 10 million persons) of the total population. In addition, a subsample of the 876 persons aged 45 and over who reported significant impairment, disability, or handicaps was analyzed. These 876 persons represent roughly 25.5% of the population 45 or over in the 14 provinces. The analysis of the 2,180 persons will show us how disability profiles changed across the full age range, while that of persons over age 45 will yield a more detailed view of impairments and disability among older persons.

An analysis of disability at all ages

In this section we discuss the individual weights (g_{ik}) and probability profiles (λ_{kjl}) obtained from an analysis of the 2,180 respondents of all ages who report significant impairments. In Tables 42 and 43 the five probability profiles for the 46 variables used to define subgroups are presented. These variables included 12 sociodemographic variables and 34 physical or mental chronic impairments. The 12 sociodemographic variables (Table 42) were used to define the groups because such factors interact with physical and psychological impairments in determining which disabilities and handicaps are expressed. The probabilities for the 12 so&demographic variables (i.e., (λ_{k1l} to λ_{k12l}) are presented in Table 42 and should be read one column at a time.

Tables 42 & 43 About Here

In the first column both variable labels (e.g., 'Economic Classification of Household') and response labels (e.g., 'Poor') are presented. The second column contains the observed distribution of the study population over the response levels of the *j*th variable. To the right of that are five columns containing the profile probabilities ((λ_{kjl}) produced in our analysis. The solution with five profiles were found to be statistically better than four based upon the likelihood ratio test, while the sixth profile did not significantly improve the ability of the model to reproduce the data.

The five impairment profiles are determined by the analysis to be strongly associated with different age categories. For example, the first type is identified as children up to age 9. This is consistent with their relation to head of household (child) and education. The economic class of the households of these persons is lower on

Table 42

Sociodemographic response profiles for disability at all ages

Variable	Sample Proportion	Profile 1 "Young Children"	2 "School Age Adolescents"	3 "Middle Age Females"	4 "Middle Age Males"	5 'Elderly Females"
1. Economic Classification of Household						
Poor	29.0	43.2	0.0	34.2	23.4	39.4
Just below average	36.2	35.9	26.5	38.6	48.3	29.2
Average	29.4	21.0	40.6	27.2	28.4	31.4
Rich	5.6	0.0	32.9	0.0	0.0	0.0
2. Sources of Social Welfare						
Relative	79.0	32.7	99.9	75.7	79.3	82.4
Neighbors	3.9	16.2	0.0	8.7	0.0	0.0
Village Chief	0.5	0.0	0.1	... 2.0	0.1	0.1
Lurah	...		0.0	13.7 0.0	11.4	0.0
Other	4.4 7.3	23.0 23.4	0.0		9.2	0.0
Combination of any above	4.9	4.7	0.0	0.0	0.0	17.6
3. AjUrbanInvestigation						
Rural	78.5 21.5	100.0 0.0	100.0	0.0	0.0	0.0
			0.0	100.0	100.0	100.0
4. Respondent's Relationship to Head of Household						
Husband	29.2	0.0	0.0	0.0	100.0	0.0
Wife	24.2	0.0	0.0	98.5	0.0	0.0
Child	29.7	90.6	79.3	0.0	0.0	0.0
Parent or parent-in-law of head	8.4	0.0	0.0	0.0	0.0	71.9
Other relative	7.9	9.4	19.8	0.0	0.0	28.1
Non-relative	0.5	0.0	0.9	1.5	0.0	0.0
5. Sex						
Male	50.0	51.7	60.3	0.0	100.0	0.0
Female	50.0	48.3	39.7	1cMI.o	0.0	100.0
6. Education						
Under school age (≤ 7 yrs.)	13.7	75.7	0.0	0.0	0.0	0.0
No schooling at ail	33.9	0.0	0.0	0.0	0.0	100.0
Attended < 3 years primary school	16.0	24.3	0.0	38.8	37.5	0.0
Completed 3 years school		0.0	35.4	30.2	34.5	0.0
Finished 6 years school	16.0	0.0	28.4	22.4	18.2	0.0
Completed high school or higher education	6.4		36.2		0.0	0.0
Other	2.8	0.0 0.0	0.0	0.0	9.9	0.0

Table 42 (cont'd)

7. Type of Work						
Industrial and clerical workers	4.2	37.9	7.4	0.0	0.0	0.0
Service workers	13.7	62.0	44.5	9.2	0.0	0.0
Construction workers	4.5	0.1		3.2	8.8	0.0
Professionals	4.3	0.0	3:::	0.0	0.0	0.0
Combined or other	8.0	0.0	5.2	6.9	17.6	0.0
Agricultural	65.2	0.0	0.0	80.7	73.7	100.0
8. Advice for Chronically Impaired Person Sought From:						
Traditional healer	14.4	9.8	0.0	11.7	23.0	27.9
Community leader	2.6	0.0	1.2		0.0	10.4
Local health staff	30.9	38.4	0.0	2 %	66.8	28.3
Hospital or physician	22.6	3.5	98.9	0.0	10.2	5.2
No help sought	29.6	48.2	0.0	60.6	0.0	28.2
9. Use of Aids by Chronically Impaired (e.g., Crutches)	5.6	0.0	0.0	0.0	0.0	27.6
10. Physical Barries in House for Chronically Impaired (e.g., Stairs)	9.6	0.0	0.0	0.0	0.0	46.4
11. Attitude Toward Chronically Impaired Person						
Rejected	2.0	0.0	13.3	0.0	0.0	0.0
Not rejected	98.0	100.0	86.7	100.0	100.0	100.0
12. Age (In Years)						
0 - 9	17.4	100.0	0.0	0.0	0.0	0.0
10 - 24	16.0	0.0	100.0	0.0	0.0	0.0
25-44	26.5	0.0	0.0	100.0	0.0	0.0
45 - 64	27.3	0.0	0.0	0.0	100.0	47.7
65+	12.9	0.0	0.0	0.0	0.0	52.3

Source: 1977 Indonesian Institute of Health Research and Development Survey

Table 43

Response profile on subjective health impairments of persons of all ages

Variable	Sample Proportion	Profile 1 "Young Children"	2 "School Age Adolescents"	3 "Middle Age Females"	4 "Middle Age Males"	5 "Elderly Females"
Physical Impairments						
Coughing	16.1	0.0	0.0	0.0	100.0	0.0
Chest Pain	7.7	0.0	0.0	0.0	42.8	0.0
Breathlessness	13.9	0.0	0.0	0.0	75.9	0.0
Headache	10.4	0.0	0.0	38.7	0.0	0.0
Backache	6.5	0.0	0.0	0.0	11.8	19.5
Pain in arms or hands, swelling in arm	3.9	0.0	0.0	0.0	0.0	19.0
Pam in legs or feef swelling in legs	6.5	0.0	0.0	0.0	0.0	31.1
Abdominal pain	5.6	6.5	16.8	7.2	0.0	0.0
D i i	2.8	15.8	0.0	0.0	0.0	0.0
Eye complaints	8.5	0.0	0.0	0.0	0.0	39.8
Ear complaints	4.1	22.4	0.0	0.0	0.0	0.0
Skin infection, loss of sensation	6.3	33.3	0.0	0.0	0.0	0.0
Chronic teeth trouble	18.4	0.0	0.0	66.7	0.0	0.0
Recurring fever with chills	2.6	6.4	9.1		0.0	0.0
Missing limbs	0.5	0.0	3.2	8.3	0.0	0.0
Fracture or dislocation	0.8	0.0	2.9	0.0	0.0	1.6
Lame, weak or spastic muscles	3.5	0.0	8.0	0.0	0.0	11.5
Urinary tract problems	1.4	0.0	8.7	0.0	0.0	0.0
Gynecological problems	1.6	0.0	9.9	0.0	0.0	0.0
Malnutrition	3.3	19.0	0.0	0.0	0.0	0.0
Accidents	1.1	0.0	6.7	0.0	0.0	0.0
Other	2.4	0.0	14.9	0.0	0.0	0.0
Mental Health Impairments						
Withdrawal, isolation. avoidance of social contact	1.3	0.0	8.5	0.0	0.0	0.0
Disturbance of emotions	0.9	0.0	5.6	0.0		0.0
Disturbance of thought	0.7	0.0	4.4	0.0	8.3	0.0
Anxiety and phobias	0.9	0.0	2.2	2:o	0.0	0.0
Excessive sadness with or without suicidal thoughts	0.3	0.0	1.2	0.5	0.0	0.0
Fersistent difficulty in relating to others	0.4	0.0	2.3	0.0	0.0	0.0
Learning difficulties	1.3	0.0	8.5	0.0	0.0	0.0
Seizures, convulsions, epilepsy	0.8	1.7	3.4		0.0	0.0
Forgetfulness	0.6	0.0	1.1	x.3	0.0	2.3
Trance states of possession	0.1	0.0	0.3	0.1	0.2	0.0
Possible sexual deviation	0.1	0.0	0.3	0.0	0.0	0.0

Table 43 (cont'd)

Other mental impairments perceived by household members	0.2	0.0	1.4	0.1	0.2	0.0

Source: 1977 Indonesian Institute of Health Research and Development Disability Survey

average than for the total set of 2,180 disabled persons. They are also primarily rural. The profile is not distinguished by sex nor characterized by the use of aids. Welfare services are provided to children through all sources except the village chief, though less than might be expected from relatives and more from community sources. Medical help is not sought for 48.2% of the cases of this type. The primary source of help is the local health staff. The head of household for such persons is in industrial and service occupations.

The second type refers to persons aged 10-24 years who are primarily school-age children with at least three years' education. These children typically come from families with a higher than average economic class. Welfare services are provided primarily through the family. This group is typically urban and more likely to be male. Aids are not utilized by this group. There is some chance of rejection by household -- perhaps a rejection of older children whom parents feel can fend for themselves. The medical services received by this group are likely to be from doctors and hospitals. The heads of the household are primarily involved in shopkeeping and professional occupations.

The third group is aged 25 to 44, typically female and most likely wives. This group is a little less than 'average' on economic status with some limited education. Welfare services are channeled through the family and no aids are used. A large proportion of the heads of household is involved in agriculture. Most medical services are provided by traditional helper or local health staff. A large proportion (60.6%) of persons do not seek help.

The fourth group is aged 45 to 64, typically male, and likely to be heads of household (husband). Welfare services are channeled through relatives, and the community council (Lurah). This group is predominantly rural, agricultural, and has limited education. Medical services are provided by traditional healer and local health staff.

The fifth group is older, primarily female, rural, and with a head of household in an agricultural occupation. Medical services are usually provided by traditional healer and local health staff. This group is the only one with a high probability of using aids to cope with functional limitations. Significant number employ both personal aids (e.g., glasses) and aids to facilitate activities around the house. Consistent with its advanced age and rural character, the group has little education and generally low economic status. Persons in this group are often grandparents in the household Welfare services are channeled through the household or a combination of agencies.

The second class of variables used to define the five profiles are physical and psychological limitations. Their probabilities are provided in Table 43. The second column in Table 43 shows that the most frequent physical and mental impairments observed in the population are chronic dental problems (18.4%), coughing (16.1%), breathlessness (13.9%), headache (10.4%), eye problems (8.5%). and chest pain (7.7%). Mental impairments are rare.

The primary problems in the first analytically generated group (Profile 1: young, dependent children) are diarrhea1 disease, hearing problems, skin conditions, fever, abdominal pain, malnutrition and seizures. The second group (older school age children and young adults) have abdominal pain, fever, missing limbs, fracture, muscle problems, urinary tract problems, gynecological problems, and accidents. This group also has mental impairments such as learning problems, isolation, disturbances of emotion, and thought. The third group (wives aged 25 to 44) has problems with headache, abdominal pain, and chronic dental problems. The fourth group (males aged 45 to 64) has high probabilities of coughing, chest pain, and shortness of breath. The oldest (primarily female) group manifests joint and mobility problems (i.e., backache, arm and leg pain), visual problems, fractures and muscular problems. Thus, the five impairment profiles reported in Table 43 are consistent with the five sets of demographic characteristics recorded in Table 42.

The WHO classification suggests that an individual's set of impairments determines which disabilities and handicaps are expressed. Therefore, we examined the probability of having specific disabilities and handicaps for each of the five demographic and impairment profiles. Note that the association of each of the impairment 'profiles' with specific disabilities and handicaps is examined and not their association with individual impairments. This is important because different physical or psychological problems may produce the same handicaps or disabilities. For example, persons with different medical conditions (e.g., cancer or heat disease) may be bed-ridden and unable to perform specific important self-care functions (e.g., bathing or dressing). The profiles collect all medical conditions strongly associated with one another in a single pattern to determine if a coherent set of medical conditions is associated with particular disabilities or handicaps.

The probability of each of the disabilities and handicaps being manifest by a person described by the *K*th profile of impairments (because of the g_{ik}'s a person need not have all of the medical conditions or demographic attributes to be associated with a given profile) is presented in Table 44.

<u>Table 44 About Here</u>

The first set of variables in Table 44 describes disabilities. The pattern of disabilities reported for young children (group I) seems consistent with its pattern of impairments where there were significant complaints about physical problems involving the ear (leading to problems in hearing and communication), malnutrition and diarrheal diseases (2.8% being bedfast, 2.7% have difficulty walking long distances). The few disabilities reported for school age children and females aged 25-44 (groups 2 and 3) are consistent with the associated profile of impairments. The primary disability for middle-aged men (10.7% have difficulty walking long distances) is consistent with the report of chest pain and breathlessness. The disabilities for the elderly female group seem to be related to impairments involving the muscles and joints of the extremities and physical problems with the eyes.

The second set of variablis in the table describes four types of handicaps: self-care, household, work, and social. Only the school age group (Profile 1) has difficulty with

Table 44

Subjective disabilities and handicaps for all persons

Variable	Sample Proportion	Profile 1 "Young Children"	Profile 2 "School Age Adolescents"	Profile 3 "Middle Age Females"	Profile 4 "Middle Age Males"	Profile 5 "Elderly Females"
Disabilities						
Bedfast	1.5	2.8	1.8	0.0	0.0	3.7
Unable to stand or walk normally	1.4	0.1	0.9	0.3	0.2	5.7
No use of arms or hands	0.5	0.0	2.2	0.0	0.0	0.6
Difficulty speaking	1.4	2.9	3.6	0.1	0.0	0.2
Difficulty hearing	2.9	7.4	0.7	0.7	1.3	5.3
Difficulty seeing	5.3	2.3	1.1	0.6	1.9	20.0
Difficulty walking long distances	5.6	2.1	2.0	2.8	10.7	9.3
Difficulty bending	1.5	0.0	0.0	1.0	1.7	4.6
Other limitations	0.8	0.4	1.9	0.0	1.2	0.8
Handicaps Affecting:						
1.) Self-Care Activities						
Difficulty feeding self	2.4	0.0	1.2	7.5	1.3	0.0
Difficulty dressing self	0.2	0.0	1.2	0.0	0.0	0.0
Difficulty bathing self	0.2	0.0	1.4	0.0	0.0	0.0
Difficulty using lavatory	1.0	2:o	0.0	0.0	0.6	2.4
2.) Household Activity						
Difficulty fetching water	1.1	0.0	0.0	1.0	0.4	3.7
Difficulty tending children	0.4	0.6	1.4	0.2	0.2	0.0
Difficulty shopping	1.0	0.0	1.2	1.2	0.9	1.3
Difficulty cooking	0.5	0.0	0.0	0.9	0.2	0.9
Difficulty washing clothes	1.2	0.0	1.2	2.3	0.0	1.9
Difficulty repairing house	2.0	0.0	0.0	0.0	8.3	1.7
3.) Work Activities						
Partly or totally unable to support family	3.0	0.0	0.0	1.9	6.3	6.2
Unable to take part in communal work	6.0	0.0	3.1	0.0	13.4	14.4
4.) Social Activities						
Unable to go to school	1.4	0.9	5.8	0.0	0.0	1.2
Unable to join in family activities	1.8	1.0	7.6	0.0	0.6	1.7
Difficulty parenting	6.8	0.0	0.0	8.1	15.9	7.3
Unable to join in meetings	10.6	0.8	11.7	0.0	6.9	37.9
Unable to vote	3.7	0.0	4.3	3.7	1.4	8.6

Table 44 (cont'd)

Unable to joint in religious ceremonies	10.4	1.1	10.9	0.0	8.8	34.9
Unable to join in ritual meals	10.2	0.8	12.0	0.0	8.9	33.1
Unable to join in special meals	2.3	0.0	5.8	0.0	0.9	6.1
Other disturbances in social ability	0.5	0.0	0.3	0.0	0.8	1.5

Source: 1977 Indonesian Indonesian Institute of Health Research and Development Disability Survey the self-care activities of dressing and bathing. The middle-aged female group has problems with eating and the elderly females with using the lavatory.

Some of the activities involving household functions are most relevant for developing countries (e.g., hauling water)., Fetching water is a significant handicap only for the oldest group. Difficulties in going to market and doing laundry are significant problems for all but the youngest group and adult males. Clearly in rural Indonesian villages these functions imply considerably greater physical capacity than in developed countries. Difficulties in conducting home repairs is a problem for adult males.

Handicaps affecting work activities are relevant for the three adult groups (groups 3 to 5). Both of the oldest group (groups 4 and 5) have significant handicaps in terms of either household or community support. This is less of a problem for middle age females.

The fourth area of handicap involves expectations about how individual fulfill specific social roles. The first such role has to do with whether they stopped going or had not gone to school because of physical or mental impairment, This was a significant problem for adolescents (group 2). The second handicap -- inability to participate in normal family activities -- also affects adolescents and suggests a high prevalence of mental impairments. Problems in parenting are a common handicap affecting all of the adult groups. The adolescent and oldest groups are the least likely to attend community meetings, although due to different impairments. Failure to vote is a problem for the four oldest groups. Attendance at funerals and ritual meals and other organized activities seems to be most problematic for adolescents and elderly females. The fact that adolescents and older females show several of the same social handicaps suggests the effect of a relative social disadvantage interacting with their impairments.

The final element in the analysis is an assessment of whether the observed impairments of an individual are best described by one or multiple impairment profiles. This is done by examining the distribution of individual weights (g_{ik}) which describes how the K impairment profiles must be combined to best predict a person's observed impairments (i.e., his x_{ijl}). About 10.6% (232 of 2,180) of respondents were well described (i.e., a $g_{ik} > 0.975$) by one of the five impairment profiles. The rest were best described by a weighted mixture of the profiles though most (1,639 or 75.2%) are strongly related ($g_{ik} > 0.5$) to one of the groups. The g_{ik}'s can also be used to determine the prevalence of the five profiles. The prevalence of the five groups are 1.8%. 1.6%, 2.6%, 2.0% and 2.0%, respectively. Thus, middle aged females are most prevalent and have the greatest amount of self-care handicaps. The adult males with symptoms suggesting major pulmonary or cardiac problems probably represent the most serious impairments. Both adult males and elderly females, however, have the greatest probability of both disabilities and handicaps. Adult males have serious mobility disabilities (in Indonesia in rural areas this involves the ability to walk long distances; in developed countries this might involve the ability to use various modes of transportation). Elderly females have significant problems in functions involving hearing and seeing, the greatest probability of being bedfast. as well as mobility disabilities.

Both adult males and elderly females have the most handicaps involving household and work activities while elderly females are severely handicapped in social activities (e.g., participating in ritual meals, religious ceremonies, special meals and meetings). This presumably results from the high prevalence of disabilities in communication resulting from visual and hearing impairments. It may also reflect interactions with social factors such as widowhood and consequent changes in social role. It **is** interesting that, while the village community is significantly involved in providing welfare services to children under age 9 (e.g., 23.0% receive aid from the village council **(Lurah)** and 23.4% from other sources), 79.3% of adult males and 82.4% of elderly females. receive aid only from relatives. This suggests that the management of impairments of young children is viewed as a community responsibility while the dependent elderly (and other age groups) are viewed as a responsibility of the family.

Analysis of disability in middle and old age

Given the concentrations of disability and handicaps in groups 4 and 5 we conducted a more focused analysis of 876 persons aged **45+.** Four groups were found to be adequate to describe the variation of impairments in the age-defined population. We use the same set of 46 demographic and impairment variables as in the **first** analysis. The profiles (λ_{kjl}) for the 12 so&demographic variables are presented in Table 45.

Table **45 About Here**

The sample proportions in column 2 in Table 45 show clear differences from the characteristics of the total population. For example, the population in Table 45 gets more help from relatives, is more rural, has more husbands and grandparents, is **more male,** has less education, is more agricultural, uses more aids and obviously is older. Some interesting similarities do **occur,** e.g., the economic level of households and sources of medical advice.

An examination of the probabilities for age and sex shows two male and two female groups with one female group (group 4) being age **65+.** In examining the economic classification of the household, the **first,** third and fourth groups tend to have lower status than the second group. Sources of social welfare are similar for three groups with over 88% coming from relatives. The **first** group receives most welfare from nonrelatives. Of the four groups only the second is likely to be urban. Males are likely to be heads of household whereas the two female groups are grandparents and wives. Males are better educated than females and the second (urban) group has the highest level of education. Groups 1 and 3 are likely to be engaged in agricultural occupations whereas the second group is likely to have a head of household who is a shopkeeper, service worker, professional or other occupation (consistent with their being in urban areas). Older females are in households with a broad range of occupations. Females are less **likely** to seek medical advice. Persons in rural areas are more likely to seek traditional healer and males in rural areas are **more likely to go to local health clinics, while urban males are more** likely to go to hospitals and private doctors. **Older** females are the only group likely to use aids.

Table 45

Sociodemographic response profiles for persons age **45+**

		Profile			
		1	2	3	4
Variable	Sample Proportion	**"Rural** Males"	**"Urban** Males"	"Middle Age Females"	**"Elderly** Females"
Economic Classification of Household					
Poor	28.6	27.8	10.8	37.0	36.7
Just below average	36.2	47.5	31.9	40.6	20.8
Average	29.4	24.7	31.0	22.4	42.5
Rich	5.8	0.0	26.3	0.0	0.0
Source of **Social Welfare**					
Relative	84.1	38.4	100.0	89.3	88.3
Neighbors	2.7	9.2	**0.0**	**3.8**	**0.0**
Lurah	3.5	23.0	**0.0**	**0.0**	**0.0**
Other sources	4.4	14.2	**0.0**	**6.9**	**0.0**
Combination of any above	5.3	15.2	0.0	0.0	11.8
Area of Investigation					
Urban	20.0	0.0	89.0	0.0	0.0
Rural	80.0	100.0	11.0	100.0	100.0
Respondent's Relationship to Head of Household					
Husband	46.7	100.0	94.3	**0.0**	**0.0**
Wife	25.3	0.0	0.0	**97.8**	**0.0**
Child	0.7		**5.7**	**0.0**	**0.0**
Parent or parent-in-Jaw of head	20.2	8.8	**0.0**	**0.0**	75.6
Other relative	**6.5**	**0.0**	**0.0**	**0.0**	24.4
Non-relative	**0.6**	0.0	0.0	**2.2**	0.0
Sex					
Male	**55.0**	100.0	**100.0**	0.0	0.0
Female	45.0	0.0	0.0	loo.0	100.0
Education					
No schooling at all	56.8	37.1	0.0	100.0	100.0
Attended c 3 years primary school	13.9	56.3	**0.0**	0.0	**0.0**
Completed 3 years school	15.1	**0.0**	**54.4**	**0.0**	**0.0**
Finished 6 years school	7.8	**0.0**	**28.1**	**0.0**	**0.0**
Completed high school or higher **Education**	**2.1**	**0.0**	**7.7**	**0.0**	**0.0**
Other	**4.3**	**6.6**	**9.9**	**0.0**	**0.0**
Type of Work					
Industrial **&** clerical workers	3.6	0.0	**4.0**	0.0	21.4
service workers	12.0	0.0	**44.1**	10.9	13.2
Construction workers	4.4	**3.1**	**0.0**	0.0	22.7
Professionals	2.8	**0.0**	18.6	**0.0**	**0.0**
Combined or other	a.4	4.2	33.2	**5.5**	**0.0**

Table 45 (cont'd)

Agricultural	68.9	92.8	0.0	83.5	42.8
Advice for Chronically Impaired Person Sought From:					
Traditional healer	18.1	29.0	0.0	10.3	30.2
Community leader	3.0	1.0	4.3	5.3	1.2
Local health staff	31.9	64.0	0.0	21.3	32.9
Hospital or physician	21.0	6:0	95.7	4.9	2.5
No help sought	26.1	0.0	0.0	58.4	33.2
Use of Aids by Chronically Impaired (e.g., Crutches)	10.4	0.0	0.0	0.0	43.8
Physical Barrier in House for Chronically Impaired (e.g., Stairs)	15.1	0.0	0.0	0.0	58.7
Attitude Toward Chronically Impaired Person					
Rejected	1.3	0.0	6.5	0.0	0.0
Not rejected	98.7	100.0	93.5	100.0	100.0
Age (In Years)					
45-64	67.9	100.0	100.0	100.0	0.0
65+	32.1	0.0	0.0	0.0	100.0

Source: 1977 Indonesian Institute of Health Research and Development Disability Survey

In Table 46 we present the impairment profiles. The sample proportions in this table show that a higher proportion of persons aged **45+** report impairments. The **first** group (rural males) are distinguished by the symptoms of cough, chest pain and breathlessness. Backache,. pain in legs and feet, or swelling and abdominal pain is characteristic of the urban (second) group, as is a range of other joint and limb problems. Headache, skin infections and chronic dental problems are characteristic of middle aged females (group 3). A series of problems with eyes and ears as well as muscular weakness are reported by the older female group as well as the highest proportion of mental impairments.

Table 46 & 47 About Here

In Table 47 the probabilities of disabilities and handicaps are presented for the four impairment profiles. The frequency of reported disability is only a little higher (79.1%) than in Table 44 (75.2%). The most frequent male disability is difficulty in walking while females have greater difficulty in abilities involving seeing or hearing. The elderly female group also has problems standing with a higher likelihood of being bedfast.

The prevalence of limitations of daily activities and household activities is only a little higher than in Table 44. **Difficulty** in repairing the house is typically a male handicap whereas difficulty in fetching water is a female handicap.

Limitations of work activities are higher (85.5% vs. 91.0%) in the **45+** age group with higher proportions both unable to take part in communal work and unable to support their households. A large proportion of persons are unable to take part in social activities. For example, large portions of males have problems in parenting. The second and fourth groups have significant problems in joining meetings, religious ceremonies, or ritual or special meals.

An example of the distribution of the g_{ik}'s indicates that about 10% of persons are uniquely described ($g_{ik} <$ 0.975) by one profile while 78.5% are described predominantly (i.e., $g_{ik} >$ 0.5) by a single **profile.** The prevalence of these four groups in the population aged **45+** is much higher than the prevalence of the five impairment groups in the total population. The most prevalent group (7.4%) has few impairments. The rural male group with the most serious impairments has a prevalence of 7.2%. The elderly female group, which has the most serious self-care limitations (though not the most reported impairments), has a prevalence of nearly 6%.

In summary, we **identified** five groups at all ages strongly associated with age, sex and household position in the first analysis. The pattern of physical impairments reported was consistent with the age and sex identity of the groups and with the disabilities and handicaps associated with each group, suggesting the disability process model using **self-**reports of impairments described our study population reasonably well.

A second analysis of 876 persons aged **45+** was conducted to determine how impairment patterns, and the association of these patterns with disability and handicaps, differed for the elderly. Older persons had a higher reported prevalence of functional

Table 46

Response profile on subjective health impairments of persons age 45+

Variables	Sample Proportion	Profile 1 "Rural Males"	2 "Urban Males"	3 "Middle Age Females"	4 "Elderly Females"
Physical Impairments					
Coughing	22.3	100.0	0.0	0.0	0.0
Chest Pain	11.5	46.5	0.0	0.0	0.0
Breathlessness	20.9	80.8	0.0	0.0	0.0
Headache	10.3	0.0	0.0	33.3	0.0
Backache	9.7	0.0	45.4	0.0	0.0
Pain in arms or hands, swelling in arm	6.1	0.0	29.7	0.0	0.0
Pain in legs or feet, swelling in legs	10.1	0.0	45.3	0.0	0.0
Abdominal pain	2.9	0.0	14.4	0.0	0.0
Diarrhea	0.7	0.0	3.5	0.0	0.0
Eye complaints	12.2	0.0	0.0	0.0	46.7
Ear complaints	1.9	0.0	0.0	0.0	8.3
Skin infection, loss of sensation	2.3	0.0	0.0	7.7	0.0
Chronic teeth trouble	18.2	0.0	0.0	57.8	0.0
Recurring fever with chills	1.1	2.3	0.0	1.7	0.0
Missing limbs	0.3	0.0	1.8	0.0	0.0
Fracture or dislocation	0.6	0.0	1.7	0.0	1.0
Lame, weak or spastic muscles	3.4	0.0	7.6	0.0	8.7
Urinary tract problems	1.3	0.0	6.4	0.0	0.0
Gynecological problems	0.3	0.0	0.0	1.2	0.0
Malnutrition	0.6	0.6	0.0	0.4	1.2
Accidents	0.8	0.0	4.2	0.0	0.0
Other	0.9	0.0	3.8	0.6	0.0
Mental Health Impairments					
Withdrawal, isolation, avoidance of social contact	0.5	0.0	0.0	1.6	0.0
Disturbance of emotions	0.3	0.0	0.9	0.6	0.0
Disturbance of thought	0.2	0.0	0.0	0.0	0.8
Anxiety and phobias	0.5	0.0	2.3	0.0	0.0
Excessive sadness with or without suicidal thoughts	0.3	0.0	0.0	0.7	0.6
Persistent difficulty in relating to others	0.1	0.0	0.0	0.0	0.5
Forgetfulness	1.3	0.0	1.9	0.0	3.9
Trance states of possession	0.1	0.0	0.0	0.4	0.0
Other mental impairments perceived by household members	0.1	0.0	0.0	0.0	0.5

Source: 1977 Indonesian Institute of Health Research and Development Disability Survey

Table 47

Subjective disabilities and handicaps for persons age 45+

Variables	Sample Proportion	Profile 1 "Rural Males"	2 "Urban Males"	3 "Middle Age Females"	4 "Elderly Females"
DISABILITIES					
Bedfast	1.4	0.0	1.3	0.4	4.3
Unable to stand or walk normally	1.6	0.0	0.0	1.6	4.8
No use of arms or hands	0.3	0.0	1.7	0.1	0.0
Difficulty speaking	0.3	0.0	0.9	0.6	0.0
Difficulty hearing	3.7	0.0	3.2	6.1	5.4
Difficulty seeing	6.9	1.2	1.3	3.3	21.9
Difficulty walking long distances	7.0	7.7	12.9	4.2	4.4
Difficulty bending	2.7	0.8	6.7	3.3	1.1
Other limitations	0.9	1.7	0.0	0.0	1.9
HANDICAPS AFFECTING:					
1.) Self-Care Activity					
Difficulty feeding self	3.3	1.0	2.1	9.2	0.0
Difficulty using lavatory	0.8	1.0	0.0	0.0	2.3
2.) Household Activity					
Difficulty fetching water	1.4	0.2	0.0	2.3	2.8
Difficulty tending children	0.1	0.4	0.0	0.0	0.0
Difficulty shopping	1.1	1.6	0.0	1.0	1.7
Difficulty cooking	0.9	0.4	0.0	1.9	1.1
Difficulty washing clothes	1.0	0.0	2.3	1.0	1.3
Difficulty repairing house	3.9	4.8	10.8	0.0	2.1
3.) Work Activities					
Partly or totally unable to support family	4.3	8.0	0.0	2.8	5.4
Unable to take part in communal work	10.2	15.6	6.2	0.0	20.1
4.) Social ctivities					
Unable to join in family activities	0.6	0.0	0.0	0.0	2.4
Difficulty parenting	10.4	15.8	17.6	6.9	2.1
Unable to join in meetings	18.0	6.2	10.2	2.6	60:o
Unable to vote	4.3	3.5	1.8	1.4	11.1
Unable to join in religious ceremonies	17.0	10.2	8.0	1.4	52.9
Unable to join in ritual meals	16.3	8.4	9.7	0.8	52.5
Unable to join in special meals	3.2	1.5	1.5	0.0	10.7
Other disturbances in social ability	0.9	1.4	0.9	1.2	0.0

Source: 1977 Indonesian Institute of Health Research and Development Disability Survey

impairments but a diffuse relation of specific impairments to self-care limitations. This is similar to what is generally observed in elderly populations, i.e., the relation of specific medial problems to specific functional restrictions becomes less clear with age (Minaker and Rowe 1985). This association became more diffuse with age and was more diffuse for females. For example, for males, many disabilities and handicaps were associated with specific cardiac and pulmonary problems. For females, many handicaps were produced by increasing disability in communication skills (due to physical sensory impairments).

In general, the model was successful in identifying profiles of impairments which were associated with specific disabilities and handicaps. It is also clear that the relation of impairments to handicaps is probabilistic, i.e., many different types of impairments may produce a specific type of self-care problem. Handicaps as envisioned in the WHO disablement process reflect societal responses to specific medical problems and functional restrictions. Though social in nature, analysis of the handicaps is important in determining the impact of specific medical problems and functional limitations on the quality of an individual's life.

The Republic of Korea, Philippines, Malaysia, and Fiji

The association of chronic morbidity and disability has been well studied in developed countries. However, there is relatively little evidence on those associations in developing countries. We conducted analyses on data from the WHO regional office of the Western Pacific-sponsored surveys conducted in four countries (the Republic of Korea, the Philippines, Malaysia and Fiji) which provide detailed information on that association. These data are analyzed using a multivariate analytic procedure (GOM) that can identify both distinctive morbidity/disability patterns and the subgroups which manifest these patterns (Manton, Myers and Andrews, 1987). In addition, we examine the implications of those relations for elderly persons' ability to remain socially and economically integrated. The results are presented in Table 48.

Table 48 About Here

Grade of Membership analysis identified five distinct subgroups, namely,

Group 1: Persons of this type ate not functionally impaired (except for vision) and are generally healthy.

Group 2: Persons who are also generally healthy except for a low prevalence of a few select acute medical problems (e.g., hip fracture, pacemaker, catheter) and uses of tobacco and alcohol.

Group 3; Persons with a number of specific medical problems (e.g., hypertension, rheumatism), but few ADL and IADL limitations. People report more sick days than those in either type 1 or 2 and have a significant (2918%) probability of being hospitalized in the last month.

Table 48

λ_{kjl} for five pure type solution, GOM analysis of Malaysia, The Republic of Korea, Philippines and Fiji

Variable	Percentage	Pure Type 1	2	3	4	5
Medical Conditions						
Infections/parasitic disease	3.9	0.0	0.0	51.2	0.0	0.0
Cancer	0.3	0.0	0.0	4.0	0.0	0.0
Diabetes	3.7	0.0	0.0	49.0	0.0	0.0
Disease of blood and blood forming organs	0.5	0.0	0.0	6.8	0.0	0.0
Disease of eye	3.2	0.0	0.0	42.8	0.0	0.0
Hypertension	12.0	0.0	0.0	100.0	0.0	0.0
Cerebrovascular disease	0.9	0.0	0.0	0.0	0.0	12.6
Arteriosclerosis	0.5	0.0	0.0	6.4	0.0	0.0
Pneumonia/influenza	1.1	0.0	0.0	14.9	0.0	0.0
Bronchitis	4.0	0.0	0.0	51.6	0.0	0.0
Stomach disease	3.3	0.0	0.0	44.0	0.0	0.0
Rheumatism	15.5	0.0	0.0	100.0	0.0	0.0
Hip fracture	0.4	0.0	0.7	0.0	1.4	0.0
Other	27.7	0.0	0.0	loo.0	0.0	0.0
Does Patient Use:						
Cane	7.5	0.0	0.0	0.0	30.7	28.2
Walker	3.4	0.0	0.0	0.0	0.0	41.6
Wheelchair	0.3	0.0	0.0	0.0	0.0	4.1
Leg brace	0.6	0.0	0.0	0.0	0.0	7.9
Back brace	0.3	... 0.0	0.0	2.7	0.0	0.9
Pacemaker	1.3	77.8 0.0	3.4	0.0	0.0	4.9
Glasses	49.8		0.0	100.0	0.0	52.9
Artificial limb	0.5	... 0.0	0.0	0.0	0.0	6.9
Hearing aid	0.4	0.2 0.0	0.0	0.0	0.0	5.2
Colostomy bag	0.2		0.0	0.0	0.0	1.0
Catheter	1.7	0.0	4.3	0.0	0.0	7.4
Other	5.1	8.7	0.0	0.0	9.7	0.0
Does Patient Ha e Ient Have						
IADL Limitations						
Telephoning	39.0	0.0	0.0	0.0	100.0	100.0
Traveling	33.7	0.0	0.0	0.0	100.0	100.0
Shopping	29.3	0.0	0.0	0.0	100.0	100.0
Preparing meals	17.4	0.0	0.0	0.0	100.0	100.0
Managing money	20.3	0.0	0.0	0.0	100.0	100.0
ADL Limitations						
Eating	3.1	0.0	0.0	0.0	0.0	62.3
Dressing	4.1	0.0	0.0	0.0	0.0	100.0
Grooming	4.6	0.0	0.0	0.0	0.0	100.0
walking	'IO.5	0.0	0.0	0.0	0.0	100.0
Bathing	6.8	0.0	0.0	0.0	0.0	100.0
Hearing	19.6	0.0	0.0	0.0	0.0	93.1
seeing	63.6	100.0	0.0	100.0	100.0	84.5
Walking Distance of 300 meters	23.6	0.0	0.0	0.0	100.0	100.0
Bedfast	6.0	0.0	0.0	0.0	0.0	100.0

Table 48 (Cont'd)

Number (Bowel/Bladder)/Week:						
None	92.0	100.0	100.0	100.0	100.0	23.8
1-2	5.2	0.0	0.0	0.0	0.0	48.9
2+	2.9	0.0	0.0	0.0	0.0	27.3
Does Person Use:						
Tobacco products	40.0	0.0	loo.0	0.0	0.0	16.2
Alcohol	29.4	0.0	100.0	0.0	0.0	20.0
Number of Sick Days in Last Month:						
None	86.4	100.0	92.7	0.0	100.0	34.0
1-3	3.9	0.0	7.3	30.0	0.0	4.1
4-7	3.9	0.0	0.0	70:o	0.0	0.0
8-29	3.6	0.0	0.0	0.0	0.0	38.7
29+	2.1	0.0	0.0	0.0	0.0	23.2
Number of Days Hospitalized in Last Month:						
None	95.9	100.0	100.0	70.2	100.0	70.0
1-7	2.5	0.0	0.0	29.8	0.0	10.4
7+	1.5	0.0	0.0	0.0	0.0	19.7
Person in Nursing Home Last Month:	0.9	0.0	0.0	0.0	0.0	12.1

Source: Malaysia, The Republic of Korea, Philippines and Fiji Surveys of Aging.

Group 4: Person with mobility problems and IADL limitations, but no ADL limitations or hospital or nursing home care.

Group 5: Persons with a wide range of both ADL and IADL problems, using significant amounts of equipment, with the highest health service use. No medical conditions are specifically identified for this group except cerebrovascular disease.

Similar GOM analysis of community-based elderly persons in developed countries (e.g., Manton and Soldo, 1986) also show such 'frail elderly' population groups. In those surveys the frail subgroup reported primarily neurological problems including senility. Senility was not an explicit diagnosis ma& in the survey because such a diagnosis would require a proxy respondent. Nonetheless, the IADL impairments of managing money and telephoning are indicators of cognitive impairment and were found in the developed country surveys to be strongly associated with senility. Thus, it is reasonable to presume that this group manifests significant senile dementia.

To further our understanding of the five pure types, it is useful to study their socio-demographic characteristics included in the analyses as external variables. These variables, which ate *not* used to identify the types, are presented in Table 49.

<u>Table 49 About Here</u>

We see that the first group is more likely to be female than the total sample, and is also more likely to be married, living with spouse and children, and younger. The second type, which also was reasonably healthy but with tobacco and alcohol use, is more likely male, married, living with spouse and children, but slightly older and less well educated than the first group. Both of these groups are more likely to have full or part-time employment (i.e., between 25 and 30%).

The third, acutely ill group is nearly twice as likely to be male as the total sample, much more likely to be married and living with spouse, children and relatives. It should be noted that these are not exclusive categories; therefore, the total percentage exceeds 100.0%. It is also the group with the greatest likelihood of using paid helpers. This group is also the best educated and the youngest. Thus, it is an acutely ill population that remains in the community because it has extensive family and economic resources. Interestingly similar types of groups are found in developed country surveys. These acutely ill, heavily male populations generally have short survival (e.g., Manton, Siegler and Woodbury 1986). Their early selection from the population tends to reduce the age rate of mortality increase at more advanced ages.

The fourth group, which had IADL impairments but was relatively physically healthy, is predominantly female (95.1%). not married, and living with children. It is a very old group (i.e., 53.6% are aged 75-84 and 12.1% are over age 85) and has the least education. The IADL problems in telephoning and managing money (along with their advanced ages) suggest that this group has significant cognitive impairment. Similar types of persons are found in developed countries, although in such countries they have a

Table 49

So&demographic variables, GOM analysis of Malaysia, The Republic of Korea, Philippines and Fiji

Variable	Percentage	Pure Type 1	2	3	4	5
Sex						
Male	41.8	32.3	67.4	79.3	**4.9**	51.1
Female	58.2	67.7	32.6	20.7	**95.1**	48.9
Marital Status						
Married	58.5	63.4	70.7	88.3	20.5	44.2
Not married	41.5	36.6	29.3	11.7	79.5	55.8
Living Arrangement						
Alone	4.4	**5.6**	**4.6**	0.0	5.4	**0.0**
With spouse	53.7	**58.0**	**63.8**	93.4	16.1	**39.0**
With children	82.5	**81.6**	**77.4**	90.5	86.3	**88.4**
With other relatives or friends	11.3	6.8	**8.3**	40.5	12.0	14.8
With paid helpers	1.9	1.6	**0.0**	11.8	0.6	2.9
Age						
60-64	26.6	35.4	28.9	45.7	**1.0**	6.2
65-74	46.6	49.6	55.1	52.0	**33.3**	23.7
75-84	22.8	14.3	15.1	**2.3**	**53.6**	51.4
85+	4.0	0.7	1.0	**0.0**	12.1	18.8
Years Education Completed						
None	48.4	**47.0**	46.3	**0.0**	83.6	60.0
1-3	15.0	**9.5**	16.9	**36.6**	10.1	13.4
4 6	22.6	**28.3**	24.3	25.7	6.4	20.8
7-12	12.0	**12.9**	10.5	34.2	**0.0**	4.3
12+	1.9	2.3	2.0	3.5	**0.0**	1.6
Employment Status						
Full-time worker	12.8	18.1	20.6	**2.4**	0.0	0.0
Part-time worker	**6.1**	7.9	**8.8**	**0.0**	**3.2**	0.0
Unemployed	**81.2**	74.0	**70.6**	**97.6**	**96.8**	100.0

Source: Malaysia, The Republic of Korea, Philippines and Fiji Surveys of Aging.

significantly greater chance of institutionalization. The lack of institutionalization in these countries reflects traditional cultural norms that favor family assistance (Myers and Nathanson 1982).

The last group is somewhat more likely to be male than the total population, a little less likely to be married, most likely to be living with children and are, by far, the oldest population. This is the one group with significant nursing home use. Given the lesser availability of institutional space in these countries, it is only the most frail subpopulation who apparently utilize such services. This group represents the extremely frail, very elderly population.

The so&demographic variables helped described each of the five groups defined on functional and health variables. These groups were seen to have very distinct sociodemographic profiles. In this section we will examine the nature of the social interactions in which these groups participate by examining external variables that describe different types of social interaction. The λ_{kjl} for these variables are presented in Table 50.

Table 50 About Here

This table is structured and interpreted in the same manner as the first two tables. It is probably best examined by describing differences between the two healthy (type 1 and 2) and the two frail (type 4 and 5) groups and comparing them to the one acutely ill group (type 3).

In the two relatively healthy elderly groups we find that type 1, which had a higher proportion of females, was more likely to attend religious meetings; while type 2, which was more male, was more likely to participate in non-religious organizations. Type 2 was more frequently visited by relatives (68% have more than one visit per month), but was also less satisfied with the frequency with which that contact took place. The two types confided in primarily family member, though type 1 had a higher percentage of confiding in no one. Both groups relied upon the same sources of help when they were ill. Type 1 was most prevalent in Malaysia and infrequently found in Fiji and the Republic of Korea, while type 2 was most prevalent in the Republic of Korea and Fiji. This suggests that the two groups represented primarily healthy elderly, but with strong differences in the activities of the healthy elderly in the four countries.

The acutely ill third type is most likely to participate in some limited religious meetings, but not in non-religious meetings. This type has the lowest frequency of visits by relatives, but is satisfied with the frequency of visits. It is the least likely to confide in anyone (25.5%), but persons in this group do confide in spouse and relatives. This type is unusual in not confiding in children at all. It also is most dependent on spouse or other relatives for are when ill. This type appears to be too ill to participate in any social organization except infrequently in religious meetings. The failure to rely on children as a source of care is probably a result of the relatively young age of this group and the severity of its medical problems. This type is most likely to occur in the Philippines and Fiji.

Table 50

Social interaction variables, GOM analysis of Malaysia, The Republic of Korea, Philippines and Fiji

Variable	Percentage	Pure Type 1	2	3	4	5
Number of Religious Meetings Attended in Last Month						
None	41.5	39.6	62.0	0.0	55.9	94.7
1-4	38.1	40.8	24.6	91.4	31.6	1.3
5-29	9.1	10.0	12.2	5.1	7.7	3.9
29+	5.2	9.7	1.3	3.5	4.8	0.1
Participation in Non-Religious Meetings						
Does not belong	77.0	78.7	60.0	87.2	93.4	82.1
Belongs to, but does not participate	6.2	5.1	6.9	12.9	5.5	3.5
Occasionalattendance	9.6	8.8	19.7	0.0	1.2	6.6
Frequent attendance	5.7	5.2	ll:o	0.0	0.0	7.8
Leader of group	1.5	2.2	2.4	0.0	0.0	0.0
How Often is Person Visited by Relatives						
Less than once a month	21.7	24.1	11.9	55.0	19.0	8.2
Once a month	24.7	31.1	20.1	45.0	9.3	15.5
More than once a month	53.6	44.8	68.0	0.0	71.7	76.3
Does Person See Their Family as Often as Would Like?						
Yes	63.3	83.5	54.3	98.2	37.8	4.5
No	36.8	16.5	45.7	1.8	623	95.4
Person Cares for Children	57.4	62.9	67.1	72.9	43.2	5.1
In Whom Do You Confide?						
No one	16.0	15.5	7.6	25.5	23.3	18.9
Spouse	32.5	39.1	40.3	41.9	1.3	2.2
Child	40.5	38.3	43:o	0.0	63.6	54.9
Relative	10.4	6.8	7.6	32.6	11.1	4.9
Other	0.6	0.2	1.5	0.0	0.7	0.0
Who Helps You When You Are Ill?						
No one	13.7	15.0	12.2	9.3	8.9	27.6
Spouse	24.9	28.9	26.4	52.6	3.6	12.3
Child	54.1	51.1	57.8	11.9	77.7	53.9
Relative	6.5	3.5	3.1	26.2	9.2	6.2
Other	0.8	1.4	0.6	0.0	0.6	0.0
Country of Residence						
Malaysia	28.2	54.6	3.7	0.4	61.2	6.5
Philippines	23.4	23.7	2.8	64.6	8.7	2.4
The Republic of Korea	27.7	17.7	64.7	0.0	0.9	72.4
Fiji Islands	20.7	3.8	28.8	34.9	29.3	18.7

Source: Malaysia, The Republic of Korea, Philippines and Fiji Surveys of Aging.

The two frail types have very different patterns of social interaction. The elderly female group (type 4) was a little less likely than the total sample to participate in religious meetings and unlikely to participate in non-religious organizations. The very frail fifth type seldom participated in religious meetings and only infrequently in non-religious ones. Both groups were likely to bevisited more than once a month by relatives, but were unlikely to be satisfied by the frequency of visits. Persons in both groups were likely to confide in children, but type 5 had greater dependence on spouse -- consistent with its greater likelihood of being male. Both types did not see their family as often as they would like and both were heavily dependent upon children for care during illness. Type 4 was most likely to occur in Malaysia and Fiji, while the fifth type was most likely to occur in the Republic of Korea.

The pattern of occurrence of the five types in the four countries requires further comment. First, to help interpret these patterns we present basic statistics on each of the five countries in Table 5 1.

Table 5 1 About Here

In Table 51 we present recent estimates of the percent urban, median age, percents aged **60+** and **80+,** per capita gross national product, total fertility rate, and life expectancy for the four countries. We see that the Republic of Korea and Malaysia are the most affluent of the countries, and have the greatest percent aged 60 and over. The Republic of Korea and Fiji have the highest life expectancies, although it should be note that the level of the Tagalog Region of the Philippines are probably higher than the average figure for the entire country. The Republic of Korea is by far the most urban country, but it should be noted that the Tagalog also **are** two-third urban. It is evident that a considerable range of variation in socio-economic development is represented by the four countries.

To interpret the distribution of the five pure types across the countries, we can examine within-country patterns. First, we note that the primary pattern for Malaysia involves two types (1 and 4) with high proportions of females. These two groups are also reasonably healthy, representing both a young and old group. The relative deficits of the other three groups in these community populations is similar to what was found in a 1977 survey in Indonesia, i.e., the elderly population was predominantly female with limited medical problems **(Manton,** Dowd and **Woodbury** 1986).

In the Philippines we find a different pattern with large **proportions** of either healthy older females or large proportions of younger, acutely ill persons. This pattern probably reflects (a) somewhat lower life expectancy, with few of the oldest-old (hence few in types 4 and **5),** (b) the high proportion of urban dwellers with access to modem medical facilities supporting a morbid subpopulation.

The Republic of Korea is an interesting contrast to Malaysia in that the most prevalent groups are the two male types (2 and 5). There is a modest prevalence of healthy females (Le., type 1). We may speculate that males, even when ill, are retained by the family, while elderly females without spouses may be **more** likely institutionalized.

Table 5 1

Selected sociodemographic statistics of Philippines, Malaysia, The Republic of Korea, and Fiji

	Fiji	Malaysia	Korea	Philippines
Percent of population aged 60+ in 1985	5.50	5.88	6.95.	5.92
Percent of population aged 80+ in 1985	0.44	0.40	0.44	0.30
Median age in 1985	21.4	20.7	23.7	19.4
Life expectancy (5-year average 1980-85)	69	67	68	62
Percent urban in 1985	41	38	65	40
Total fertility rate	3.5	3.9	2.6	4.4
Crude birth rate	31	31	23	33
Gross national produce (per capita) in U.S. dollars, 1983	1,790	1,860	2,010	760
Percent illiterate (15-years and over)	14.5	26.6	12.4	14.3
Gross enrollment at secondary levels	74	49	86	64

Sources: United Nations. 1985. ***World Popukuion Prospects: Estimates and Projections as Assessed in 1982.*** Medium Variant,

United Nations Fund for Population Activities, 1986.

UNESCO Statistical Digest, 1984.

Finally, the Fiji, four of the types (excluding 1) have a high prevalence. This is both a result of a relatively high life expectancy, which may explain why there is a significant proportion of very elderly (types 4 and 5), and possibly a higher retention of elderly persons in the community due to a low availability of nursing home facilities.

Next, we will describe the distribution of the g_{ik} across the five pure types. This distribution indicates the degree to which persons are members of more than a single group, and also the prevalence of these groups in the elderly population of the four countries. These statistics are presented in Table 52.

Table 52 About Here

We see that type 3, 4 and 5 are least likely to have persons-as exclusive members of a single group. This is because of the large number of attributes that are necessary to define those groups. In contrast, the two healthy populations (types 1 and 2) have a fairly high prevalence in the community population. Group 4, very elderly females without spouses, is reasonably prevalent in the population.

In summary, we found that five types identified in the Grade of Membership analysis could be defined on these variable that were strongly discriminated by sociodemographic and social interaction characteristics. These five types clustered into two healthy elderly groups and two frail very elderly groups, with each group being distinguished to a degree by sex and an acutely ill group. The five types were found to be distributed strongly across the four countries on the basis of (a) life expectancy and (b) family norms regarding the retention of frail elderly family member of different sex in the family.

The results of this analysis can be compared to similar analyses of community elderly populations in the U.S. (Manton 1988a; Liu and Manton 1987) discussed previously. In the analysis we also fmd (a) an acutely ill, relatively young group, predominantly male, with strong informal care resources, (b) healthy persons who are very old and with a high likelihood of being female, and (c) 'frail' elderly who are often male. Thus, some of the basic age, sex, morbidity and disability associations found in the four developing countries have similar counterparts in the elderly population in a more developed country like the U.S. What appears to differ most from the U.S. is the high frequency of elderly living both with children and spouse, which indicates mom extended families and greater informal are resources.

Table 52

Distribution of g_{ik}, GOM analysis of Malaysia, The Republic of Korea, Philippines and Fiji

Range	Pure Type 1	2	3	-4	5
0.0	761	1.103	1,705	1,605	2,227
0.1 ≤ 25%	463	758	1.578	902	975
25 - 50%	834	1,007	220	624	169
51 - 75%	850	482	1	319	76
76-97.5%	480	103	0	51	45
97.6%+	116	51	0	3	12

Source: Malaysia, The Republic of Korea, Philippines and Fiji Surveys of Aging.

V. DISCUSSION

In this report we discussed a.) evaluation methods for the analysis of duration based measures of Medicare service use and for defining multivariate case-mix measures based upon both functional status and health information, b.) the nature of the 1982 and 1984 NLTCS data and their linkage to Medicare Part A files, and the applications of that data to a wide range of scientific and policy questions, and c.) findings from a wide range of national and international studies of age changes in functional and health status and the relation of those changes to changes in health service delivery and reimbursement systems.

The range of substantive and policy findings was quite large and reviewed in detail above and in the papers in Appendix A. It was clear that those findings changed a number of our perceptions about functional status changes and acute and LTC service use among U.S. elderly persons. These findings stress the importance of using the appropriate types of data (i.e., the longitudinal component of the 1982-1984 NLTCS to study individual transitions gives different impressions about sex and age patterns of functional loss than cross-sectional surveys, as does the use of exact amounts and dates of service use from Medicare records rather than self-reported service use) and analytic concepts (i.e., the use of life table measures and competing risks adjustments) and methods (e.g., the GOM dynamic analyses). Without the combination of these elements studies of LTC service use may be misleading. Thus the products of this study are methodological as well as substantive and policy related

Overall the assessment of substantive issues suggest the strong sex differentials in the attainment of functional impairment at advanced ages. These sex differentials in functional impairment were related to sex differentials in the underlying morbidity processes with males more subject to highly lethal conditions and females more affected by more slowly progressing chronic degenerative conditions. The analyses of the operation of these sex specific morbidity, disability and mortality processes over age and time suggested the strong possibility that there could be effective interventions delaying the onset and rate of progression of the underlying chronic diseases and thereby controlling the rate of growth of the period spent in the typical lifespan in serious functional impairment states. Those analyses also stressed the extreme heterogeneity of those functional impairment states involving both cognitive, social and physical dimensions.

Apart from describing the basic physical processes inducing functional impairments, and thereby identifying possible intervention mechanisms, we also identified possible interventions for dealing with the needs of the functionally impaired elderly population by evaluating their personal, social and financial resources and by evaluating current service use patterns. These evaluations identified Possible areas of service substitutions -- especially in the area of home based cam.

The findings sketched out above suggest that there are innovative intervention strategies that could be employed at a number of different points to cope with the projected large growth in the need for LTC services as the population experiences aging and life expectancy increases.

Preceding page blank

VI. REFERENCES

Andrews GR, Esterman AJ, Braunack-Mayer AJ, Runge C. 1986. Aging in the Western Pacific: A four-country study. Manila: Western Pacific Region WHO.

Branch G, Jette AM. 1982. A prospective study of long term care institutionalization among the aged. ***American Journal of Public Health 72:*** 1373-1379.

Chiang CL. 1979. Survival and stages of disease. ***Mathematical Biosciences*** **43:159-171.**

Chiang CL. 1984. The *Life* ***Table and Its Application.*** **Krieger,** Malabar, Florida.

Clive J, **Woodbury** MA, Siegler IC. 1983. Fuzzy and crisp set-theoretic-based classification of health and disease. ***Journal of Medical Systems*** **7:317-332.**

Cohen JE. 1976. The distribution of the chi-squared statistic under interval sampling from contingency tables. ***Journal of the American Statistical Association*** **71:665-670.**

Corder L, **Manton** KG. 1987. Assessment of risk: Functional level, medical care utilization, institutionalization, and mortality in a longitudinal panel of aged persons: United States, 1982-1984. Presented at the Population Association of America meetings, Chicago, April **30-May** 2.

Duncan DB, Horn SD. 1972. Linear dynamic **recursive** estimation for the viewpoint of regression analysis. ***Journal of the American Statistical Association*** **67:815-821.**

Fay RE. 1982. Contingency table analyses for complex designs: **CPLX.** In ***Proceedings of the Section on Survey Research Methods, American Statistical Association,*** pp. **44-53.**

Fay RE. 1983. CPLX--Contingency table analysis for complex' sample designs, program documentation. Unpublished report. U.S. Bureau of the Census.

Fay RE. 1985. A **Jacknifed** Chi-squared test for complex samples. ***Journal of the American Statistical Association*** **80:148-157.**

Fergany N. 1971. On the human survivorship function and life table construction. ***Demography*** **8:331-334.**

Fienberg SE, Mason WM. 1979. Identification and estimation of age-period-cohort models in the analysis of discrete archival data. In ***Sociological Methodology 1979*** (Schuessler KF, Ed.). San Francisco, Jossey-Bass pp. l-65.

Heckman JJ, Singer B. 1984. A method for minimizing the impact of distributional assumptions in econometric models for duration **data.** ***Econometrica*** **52(2):271-320.**

Hoem JM. 1984. A flaw in actuarial exposed-to-risk theory. Stockholm Research **Reports** in ***Demography 15,*** University of Stockholm, Section of ***Demography,*** **Sweden.**

Hoem JM, **Fong** MS. 1976. A Markov chain model of working life tables. Working Paper 2. Copenhagen, Laboratory of Actuarial Mathematics, University of Copenhagen.

Hoem JM, Funck-Jensen UF. 1982. Multistate life table methodology: A probablist critique. Department of Statistics, University of Stockholm, Sweden.

Horvitz DG. 1966. Computer simulation of hospital discharges. Series 2, No. 13, PI-IS Pub. No. 1000, PHS, USGPO.

Jaquez JA. 1972. ***Compartmental Analysis in Biology and Medicine.*** **Elsevier, Amsterdam.**

Kalbfleish JD, Lawless **JF.** 1985. The analysis of panel data under a Markov assumption. ***Journal of the American Statistical Association*** **80:863-87 1.**

Keeler EB, Kane RL, Loloman DH. 1981. Short- and long-term residents of nursing homes. ***Medical Care*** **12:363-370.**

Kiefer J, Wolfwitz J. 1956. Consistency of the maximum likelihood estimator in the presence of infinitely many parameters. ***Annals of Mathematical Statistics*** **27:887-906.**

Kleinman JC. 1973. Proportions with extraneous variance: Single and independent samples. ***Journal of the American Statistical Association*** **68:46-54.**

Krishnamoorthy S. 1979. Classical approach to increment-decrement life tables: An

Preceding page blank

application to the study of the marital status of United States females, 1970. *Mathematical Biosciences 44:* 13% 154.
Laird N. 1978. Empirical Bayes methods for two-way contingency tables. ***Biometriku* 65:581-590.**
Lalonde M. 1975. A New Perspective in the Health of Canadians. Ottawa, Canada. Information Canada.
Leonard, T. 1975. Baysian Estimation Methods for Two-way Contingency Tables. ***Journal of the Royal Statistical Society,*** pp 23-26.
Liu K, Manton KG. 1983. The characteristics and utilization pattern of an admission cohort of nursing home patients. ***The Gerontologist* 23:92-98.**
Liu K, Manton KG. 1984. The characteristics and utilization patterns of an admission cohort of nursing home patients (II). ***Gerontologist* 24:70-76.**
Liu K, Manton KG, Liu B. 1987. Home health cart expenses for noninstitutionalized elderly with ADL and IADL limitatoins. ***Health Care Financing Review,*** forthcoming.
Liu K, Manton KG. 1988a. Effects of Medicare's hospital Prospective Payment System (PPS) on Medicare service utilization. DHHS.
Liu K, Manton KG. 1988b. Effects of PPS on hospital readmissions and mortality of disabled Medicare beneficiaries. In review at ***Inquiry.***
Manton KG. 1985.. Future patterns of chronic disease incidence, liability, and mortality amont the elderly. N.Y. ***Journal of Medicine* 85:623-633.**
Manton KG. 1987. Outcome assessment for the purpose of determining the health status of the public. Presented at the Quality of Care Symposium, HCFA, June 1 l-12.
Manton KG. 1987b. The linkage of health status changes and workability. ***Comprehensive Gerontology,*** forthcoming.
Manton KG. 1987c. Manuscript submitted to ***The Gerontologist.***
Manton KG. 1988a. Planning long term care for heterogeneous older populations. In ***Annual Review of Gerontology and Geriatrics,*** Vol. 8 (Maddox GL, Ed.), Springer, NY, forthcoming.
Manton KG. 1988b. A longitudinal study of functional change and mortality in the U.S. ***Journal of Gerontology,*** forthcoming.
Manton KG, Dowd JE, Woodbury MA: 1987. Conceptual and measurement issues in assessing disability cross-nationally: Analysis of a WHO-sponsored survey of the disablement process in Indonesia. ***Journal of Cross-Cultural Gerontology,*** forthcoming.
Manton KG, Hausner T. 1987. A multivariate grouping approach to case mix for home health services. ***Health Care Financing Review,*** forthcoming.
Manton KG, Liu K. 1987. Longitudinal sample weights and time weighted sampling issues in assessing health outcomes in the 1982 & 1984 NLTCS.
Manton KG, Liu K. 1988. Effects of PPS on service use patterns of disabled Medicare beneficiaries. In review at ***HCF Review.***
Manton KG, Liu K, Cornelius E. 1985. An analysis of the heterogeneity of U.S. nursing home patients. ***Journal of Gerontology* 40:34-46.**
Manton KG, Myers GC, Andrews G. 1987. Morbidity & disability patterns in four developing nations: Their implications for social and economic integration of the elderly. ***Journal of Cross-Cultural Gerontology,*** forthcoming.
Manton KG, Patrick CH, Johnson K. 1987. Health differentials between blacks and whites: Recent trends in mortality and morbidity. ***Milbank Memorial Fund Quarterly: Health and Society,*** forthcoming,
Manton KG, Siegler IC, Woodbury MA. 1986. Patterns of intellectual development in later life. ***Journal of Gerontology* 41:486-499.**
Manton KG, Soldo BJ. 1985. Dynamics of health changes in the oldest-old: New perspectives & evidence. ***Milbank Memorial Fund Quarterly: Health and Society* 63:206-285.**
Manton KG, Soldo BJ. 1987. Disability and mortality among the oldest-old: Implications

for current and future health and LTC service needs, In ***Forecasting the Health of the Oldest Old*** (Manton KG et al., Eds.), Oxford University Press, forthcoming.

Manton KG, Stallard E. 1981. Methods for the analysis of mortality risks across heterogeneous small populations: Examination of space-time gradients in cancer mortality in North Carolina counties **1970-75.** ***Demography*** **18(2):217-230.**

Manton KG, Stallard E. 1982. A population-based model of respiratory cancer incidence, progression, diagnosis, treatment, and mortality. ***Computers and Biomedical Research*** **15:342-360.**

Manton KG, Stallard E. 1984. ***Recent Trends in Mortality Analysis.*** Academic Press: Orlando, Fla.

Manton KG, Stallard E. 1987. ***Chronic Disease Modelling: Measurement and Evaluation of The Risks of Chronic Disease Processes.*** Charles Griffith Ltd., London, forthcoming.

Manton KG, Stallard E, Woodbury MA, Yashin AI. 1986. Applications of the Grade of Membership technique to event history analysis: Extensions to multivariate unobserved heterogeneity. ***Muthemuticul Modelling.***

Manton KG, Stallard E, Woodbury MA, Yashin AI. 1987. Grade of Membership techniques for studying complex event history processes with unobserved covariates. ***Sociological Methodology 1987*** (Clogg, C, Ed.), forthcoming.

Manton KG, Woodbury MA, Corder L. 1987. The characteristics of the oldest-old institutionalized population: **1969-** 1977. ***Jownul of Gerontology,*** in review.

Manton KG, Woodbury MA, Liu K. 1984. Life table methods for assessing the dynamics of nursing home utilization: 1976-1977. ***Journal of Gerontology*** **39:79-87.**

Manton KG, Woodbury MA, Stallard E. 1981. A variance components approach to categorical data models with heterogeneous cell population: Analysis of spatial gradients in lung cancer mortality rates in NC counties. ***Biometrics*** **37:259-269.**

Manton KG, Woodbury MA, Stallard E, Dowd JE. 1986. A composite estimation model for producing stabilized health rate estimates for small areas using sample surveys: Experience for health surveys in Ethiopia, India, and Indonesia. In Platek R and Singh MP (Eds.) ***Small Area Statistics,*** pp 182-206. Carleton University, Ottawa.

Manton KG, Yashin AI. 1987. Control issues in stochastic models of national and subnational health service delivery systems. Chapter 6 in ***Control Aspects of Biomedical Engineering*** (Nalecz M, Ed.) Pergam Press, London, pp. 207-219.

Matis JH, Wehrly TE. 1979. Stochastic models of compartmental systems. ***Biometrics*** **35:199-220.**

Matis JH, Wehrly TE. Compartmental models with multiple sources of stochastic variability: The re-compartment models with clustering. ***Bulletin of Mathematical Biology*** **43:65 *l-664.***

Minaker KL, Rowe JW. 1985. Health & disease among the oldest old: A clinical perspective. ***Milbunk Memoriul Fund Quarterly: Health and Society*** **63:324-349.**

Morris CN. 1983. Parametric empirical Bayes influence: Theory and applications. ***Journal of the American Statistical Association*** **78:47-65.**

Muthen B, Christoffersson A. 1981. Simultaneous factor analysis of dichotomous variables in several groups. ***Psychometriku*** **46:407-419.**

Nihon University. 1982. ***Population Aging in Japan: Problems and Policy Issues in the 21st*** *Century.* Intemat. Symp. on an Aging Society: Strategies for 21st Century Japan, Nov. 24-27.

Pollard JH. 1982. The expectation of life and its relationship to mortality. ***Journal of the Institute of Actuaries*** **109:225-240.**

Rao JNK, Scott AJ. 1981. The analysis of categorical data from complex sample surveys: Chi-squared tests for goodness of fit and independence in two-way tables. ***Journal of the American Statistical Assoiution*** **76:221-230.**

Rogers A. 1975. ***Introduction to Mulriregional Mathematical Demography. New*** York, Wiley.

Rogers A. 1986. Parameterized multistate population dynamics and projection. ***Journal of the American Statistical Association*** **81:48-61.**
Royal RM, Cumberland WG. 1981. An empirical study of the ratio estimation and estimations of its variance. ***Journal of the American Statistical Association*** **76:66-89.**
Schoen R, Land K. 1979. A general algorithm for estimating a Markov-generated incrementdecrement life table with applications to marital status patterns. ***Journal of the American Statistical Association*** **74:761-776.**
Smith DM. 1983. Maximum likelihood estimation of the parameters of the beta binomial distribution. ***Journal of the Royal Statistical Society*** pp 196-204.
Soldo BJ, Manton KG. 1985a. Health status and service needs of the oldest-old: Current patterns and future needs. ***Milbank Memorial Fund Quarterly: Health and Society*** **62:286-3** 19.
Soldo BJ, Manton KG. 1985b. Demographic challenges for socioeconomic planning. ***Socio-Economic Planning Sciences*** **19:227-247.**
Tolley I-ID, Manton KG, Woodbury MA. 1987a. Large sample properties of a fuzzy partition.
Tolley I-ID et al. 1987. Estimating life tables for pure types of a fuzzy partition. Chapter in ***Forecasting the Health of the Oldest Old*** (Manton KG et al., Eds.). Oxford Univ Press,
Tsutakawa RK. 1985. Estimation of cancer mortality rates: A Bayesian analysis of small frequencies. ***Biometrics*** **41:69-79.**
Tsutakawa RK, Shoop GL, Marienfeld CJ. 1985. Empirical Bayes estimation of cancer mortality rates. ***Statistics in Medicine*** **4:201-212.**
U.S. General Accounting Office. 1986. Report to the Chairman, Special Committee on Aging, U.S. Senate. Medicare: Need to Strengthen Home Health Care Payment Controls and Address Unmet Needs. **GAO/HRD-87-9,** December.
Wilkin JC. 1982. Recent trends in the mortality of the aged. ***Transactions,*** Society of Actuaries, Vol. XXXIII: 1 l-62.
Wilkins R, Adams 0. 1983. ***Healthfulness of Life. The*** Institute for Research on Public Policy. Montreal, Canada.
Willekens FJ, Shah I, Shah JM, Ramachandran P. 1982. Multi-state analysis of marital status life tables: Theory and application. ***Population Studies 36:*** 129-144.
Woodbury MA, Manton KG. 1985. A GOM analysis of complex sample design data: An approach. Presented at NCHS seminar, Washington, DC, Sept. 26.
Woodbury MA, Manton KG, Blazer D. 1987. Trends in US suicide mortality rates 1968 to 1982: Race and sex differences in age, period, and cohort components. In review at ***International Journal of Epidemiology.***
Woodbury MA, Manton KG, Yashing AI, Lowrimore GL. 1986a. Estimating hidden morbidity via its effect on mortality and disability. Presented at Methods for Longitudinal Data Analysis in Epidemiological and Clinical Studies Workshop, Risk Factors and Survival. Sponsored by NHLBI, Bethesda, MD, Sept. 25.
World Health Organization. 1980. ***International Classification of impairments, Disabilities, and Handicaps: A Manual of Classification Relating to the Consequences of Disease. WHO,*** Geneva.
World Health Organization. 1984. The Uses of Epidemiology in the Study of the Elderly. WHO Technical Report Series 706. WHO, Geneva, Switzerland.
Yashin AI, Manton KG, Vaupel JW. 1985. Mortality and aging in a heterogeneous population: A stochastic process model with observed and unobserved variables. ***Theoretical Population Biology*** **27(2):154- *175.***
Yashin AI, Manton KG, Stallard E. 1986. Dependent competing risks: A stochastic process model. ***Journal of Mathematical Biology*** **24:119-140.**