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Assistant Secretary for Planning and Evaluation
Office of Disability, Aging and Long-Term Care Policy

EPIDEMIOLOGICAL, DEMOGRAPHIC, AND SOCIAL CORRELATES OF DISABILITY AMONG THE ELDERLY

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INTRODUCTION

In analyzing "disability" or "functional impairment" among subgroups of the U.S. population, the elderly and oldest-old populations require special attention. Special attention is necessary both because, the elderly represent by far the largest numbers of disabled persons, but perhaps more critically, they are the population group for which defining disability and functional impairment is most difficult. This is because, until relatively recently, both popular concepts and the scientific literature have tended to viewed functional loss as a necessary and nearly universal correlate of the aging process.

More recent research on aging has challenged the inevitability of the linkage of severe functional loss and impairment with age. A number of new studies have shown that the age rate of decline of physiological parameters and function with age found in prior studies was, in part, a product of flaws in the design of many of those studies (e.g., Lakatta, 1985). Specifically, in many of the older studies "representative" samples of elderly were selected. Since the prevalence of chronic disease, both manifest and latent, tends to increase with age, a large part of the functional loss with age in the older studies reflected the effects of an increasing prevalence of chronic disease on function--not the "natural concomitants" of aging itself.

Many newer studies are specifically designed to unconfound the effects of chronic disease and aging by carefully screening for the presence of both latent and manifest disease (e.g., Lakatta, 1985). These studies show that many physiological functions can be preserved to greater age's than previously thought. Other studies have shown that there is great individual variation in the trajectory of functional loss with age which depends upon the type of chronic disease affecting the individual. These studies of the so-called "terminal drop" show that the rate of physical and cognitive functional decline before death at advanced is often quite rapid producing, in some groups of elderly individuals, very short periods of impairment (e.g., Manton, Siegler and Woodbury, 1986). In addition other studies have shown that many mechanisms emerge at later ages which compensate for specific types of functional loss, and that there is a much greater potential for rehabilitation and regaining function at advanced ages than previously supposed (World Health Organization, 1982). In sum, the current scientific evidence suggests that though there is certainly a strong correlation of functional loss with age, function can (by appropriate early preventive actions) be preserved to more advanced ages and at higher levels than was previously believed, that individuals show considerable variability in the rate at which functional losses occur, and that interventions can help improve functional status at later ages for many individuals.

This evidence suggests that the past acceptance as "natural" of age-related loss of function and disability among the elderly has been counterproductive--a type of self-fulfilling prophecy--and that a more active stance should be adopted to attempting to preserve function at later ages. This stance must be reflected in changes both in the

medical and institutional response to disability and chronic disease among the elderly and in the self-concepts accepted by many elderly themselves.

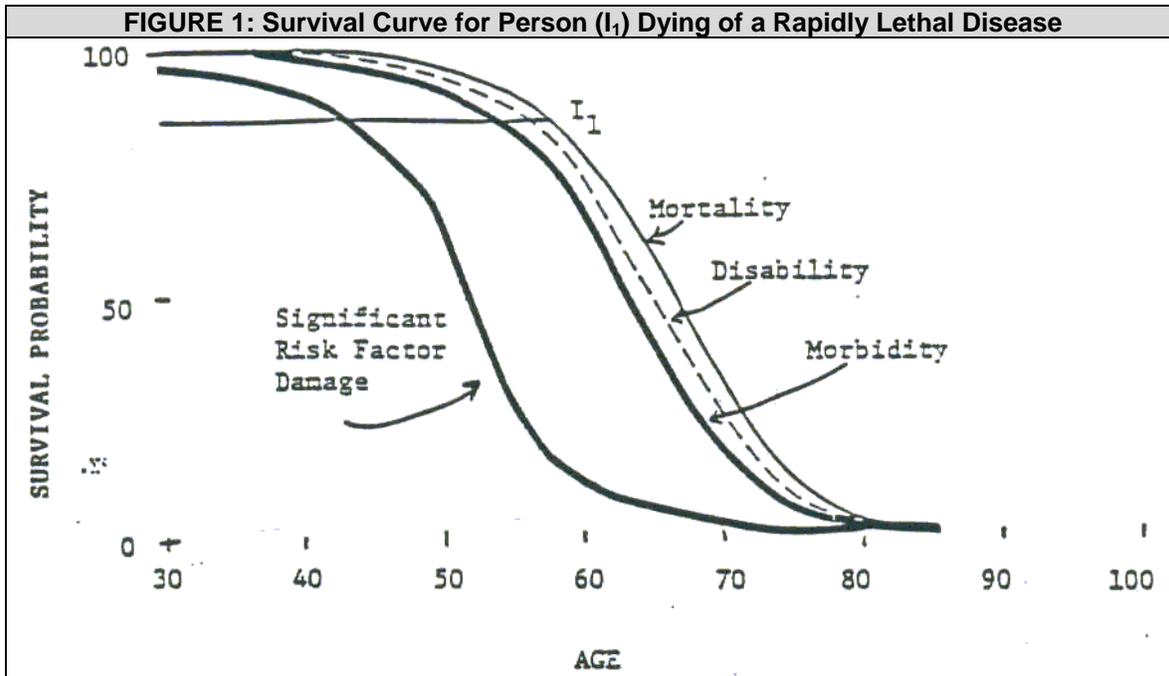
The evidence also suggests the need for more active research into the lifestyle and other risk factors of functional loss (e.g., Manton, 1989). Specifically, much of the past epidemiological investigation of chronic disease risk factors has focused upon the identification and control of risk factors for acute lethal conditions--especially those affecting middle-aged males. Because of this research emphasis medical science has been reasonably successful in identifying risk factors (e.g., blood pressure, serum cholesterol, smoking, obesity) for lethal conditions like coronary heart disease, stroke, and cancer. In addition to identifying the risk factors for these diseases, considerable progress has occurred in the development of medical and pharmacological technologies to control those factors. For example, there are now four major classes of anti-hypertensive agents (i.e., diuretics, beta blockers, ACE inhibitors, calcium channel blockers) which can be used singly, or in specific combinations, for different types of hypertension. By responding to very specific features of the disease mechanisms in different groups, these different classes of drugs have resulted in greater degrees of risk factor control with less adverse side effects.

More recently, the potential efficacy of treatment, control and prevention of these acute disease processes and their risk factors at advanced ages, has been demonstrated. For example, while early analyses of the effects of controlling the standard heart disease risk factors suggested little benefit at advanced ages (e.g., Kannel and Gordon, 1980) recent studies which controlled for the general rise of mortality with age show that many of these factors continue to be as important (or more so) at advanced ages. Studies of a large group of persons with relatively healthy lifestyles (i.e., non-smokers and light drinkers) show significantly higher life expectancy at age 65 (Lew and Garfinkel, 1984). Even after adjusting for other risk factors like smoking, parental longevity and blood pressure, the benefits of physical activity have been demonstrated in significantly enhanced life expectancy up to at least age 80 (Paffenbarger et al., 1986). These recent epidemiological findings have caused the revision of clinical principles about treating persons at more advanced ages and led to the development of randomized controlled intervention trials for such conditions as isolated systolic hypertension (i.e., the SHEPS project).

Because of their characteristic natural history acute, lethal conditions, however, do not generate the largest amount of disability in the elderly population. This can be understood by examining Figure 1, where we present a modification of a World Health Organization (1984) life table model of the impact of chronic disease on disability and mortality of the elderly.

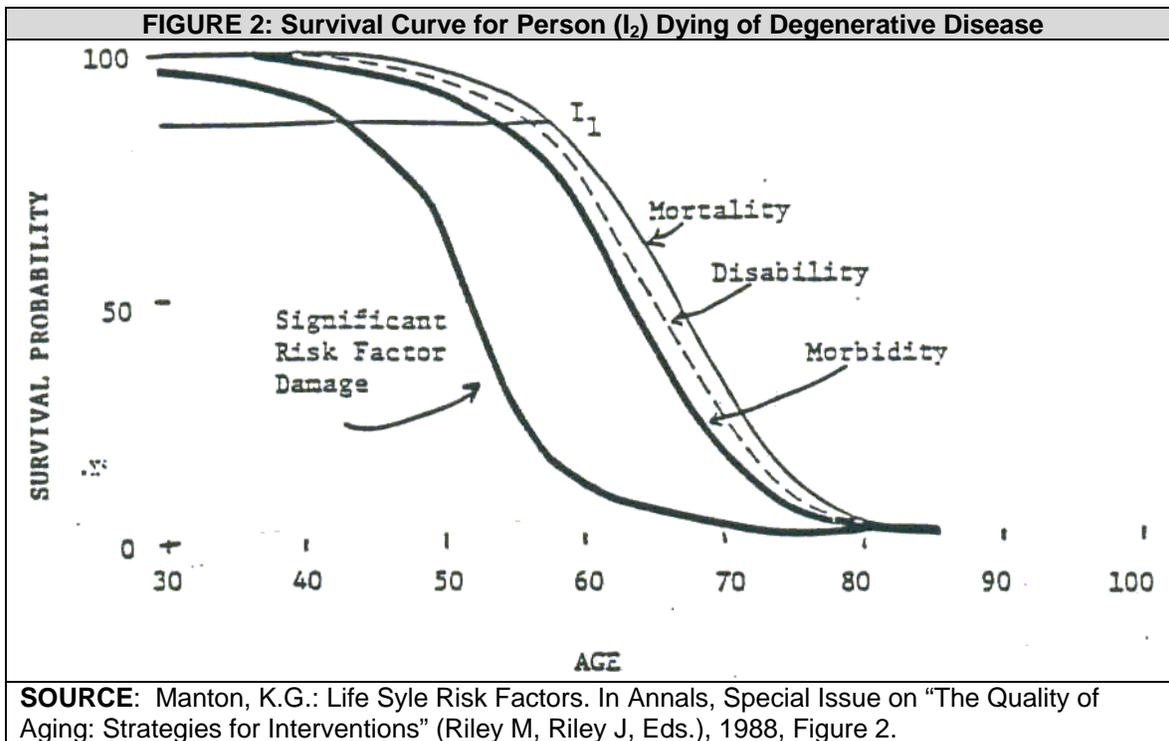
In the figure we see that four lines are presented. The outermost line labelled "Mortality" represents the decline with age of the probability of living to age x. The line labelled "Morbidity" represents the probability of surviving to age x free of a major chronic disease. The area under this line represents "healthy" life expectancy. The intermediate line labelled "Disability" represents the probability of surviving to age x free

of serious disability. The area under this curve represents what has been termed "active" life expectancy (e.g., Wilkins and Adams, 1983; Katz et al., 1983). The line labelled "significant risk factor damage" represents the age by which risk factor exposure has begun to generate latent physiological changes that will lead to the manifestation of the disease.



The figure has been modified from the model presented in the original World Health Organization (1984) report to reflect the typical impact of acute lethal diseases on healthy and active life expectancy among the elderly. Thus, the areas between the morbidity, disability and mortality curves have been compressed to represent the shorter survival time after an acute lethal condition is expressed. Furthermore, the curve is drawn to reflect the fact that such conditions (e.g., heart attack, cancer) affect mainly persons in late middle-age and in the so-called "young-old" population (Manton, Sealer and Woodbury, 1986). These changes in the WHO model are intended to represent the characteristic natural history or age "kinetics" of such acute lethal disease processes, not indicate that such diseases do not have a lengthy degenerative phase. Indeed, the curve for the age at onset of risk factor damage is intended to represent the initiation of the accumulation of such damage. Rather it is that much of the accumulated damage is "latent" in terms of the gross physical functioning of the individual. The manifest phase of the disease thus represents a rapid "catastrophic" failure of a critical organ system of the individual leading to rapid death (e.g., Manton, Siegler and Woodbury, 1986).

In contrast to Figure 1 we can present a second type of survival curve model modified to represent the morbidity, disability and mortality patterns typically associated with those chronic degenerative conditions (e.g., osteoarthritis, rheumatoid arthritis, osteoporosis, diabetes, Alzheimer's disease) which produce most of the duration-weighted impact of disability in the elderly population.



The natural history or age "kinetics" of this type of disease process is quite different in that the effects on physical functioning become manifest at much earlier ages—long before the "catastrophic" failure of the individual. Consequently, the figure shows that persons affected with such slowly developing conditions will tend to live longer and spend a greater proportion of the life span in a disabled state. It should be noted that, while such diseases become manifest much earlier in the life span, they too will eventually cause catastrophic organ system failure (i.e., death). For example, poor nutrition, high alcohol consumption and smoking may cause a woman to have very low bone density pre-menopausally. As a consequence, post-menopausally, she may rapidly manifest the initial signs of osteoporosis. Typically, the progression of osteoporosis will be lengthy until the skeleton becomes so unstable that there is high risk of serious fracture (e.g., hip fracture). Such catastrophic acute consequences of osteoporosis will often lead to extended bedrest, debilitation, heightened risk of infection and other co-morbidities all of which in the context of poor physiological homeostatic forces at advanced ages can trigger rapid physiological decline leading to death.

A prime factor differentiating the acute, lethal and chronic degenerative disease processes is the different organ systems and physiological functions they primarily impact. For example, many of the chronic conditions producing much of the disability affect the musco-skeletal, immunological and neurological systems. Many acute conditions affect the coronary or pulmonary systems or are produced by neoplastic processes. It must be stressed that the situation for any given individual may be more complex with multiple, interacting chronic diseases often present at advanced ages.

Furthermore, certain chronic degenerative diseases, like diabetes, may heighten the risk of loss of physical function and of acute lethal disease.

While we have been successful in identifying and controlling the risk factors associated with many acute, lethal conditions (Figure 1), medical science to date has been far less successful in identifying and managing the chronic degenerative conditions which most affect active life expectancy. This has been demonstrated in population studies such as in Canada (Wilkins and Adams, 1983) where, of approximately six years of life expectancy gained at age 65 between 1950 and 1978, 80 percent (about 4.7 years) was in an impaired state.

In addition to the problems in defining the biomedical dimensions of disability among the elderly there are additional problems in defining the social and behavioral consequences of disability. That is why WHO has developed a classification system based upon a multidimensional assessment of disability like that presented in Figure 3 (WHO, 1980).

FIGURE 3. A Comparison of the Logic of the Medical/Epidemiological Model of Disease and the Extension of the Model for Assessing Disease Consequences	
1.	Medical/Epidemiological Model Etiology --> Pathology --> Manifestation
2.	Extension of Medical Model for Disease Consequences Disease --> Impairment --> Disability --> Handicap where <i>Impairments</i> are "concerned with abnormalities of body structure and appearance and with organ or system function, resulting from any cause; in principle, impairments represent disturbances at the organ level." <i>Disabilities</i> are "reflecting the consequences of impairments in terms of functional performance and activity by the individual; disabilities thus represent disturbances at the level of the person." <i>Handicaps</i> are "concerned with the disadvantages experienced by the individual as a result of impairments and disabilities; handicaps thus reflect interaction with and adaptations to the individual's surroundings."
SOURCE: World Health Organization 1980, 14.	

In the figure we see that a conceptual distinction is made between impairments, disabilities, and handicaps. Impairments refer to the loss of specific physical functions. Disabilities refer to the incapacity of performing certain basic self-care functions. Handicaps refer to the restrictions that impairments and disability place on the individual's capacity to perform certain basic social roles and to successfully interact with one's environment. Services and care might be directed at any level of the impairment process, i.e., to compensate for impairments, disabilities or handicaps. It is also clear that, for the elderly, the same level of impairment might produce different levels of disability and handicap because of different social expectations about the functional capacity of the elderly (e.g., expectations about the ability of the elderly to fulfill labor force roles). In the following discussion we will not attempt to resolve these

more general issues. We will utilize the term disability to refer to loss of self-care capacity and focus our analysis on the physical dimensions of the process though these definitional problems will re-emerge in later sections where we discuss the service needs of the disabled elderly.

In the remainder of this paper we will explore the quantitative implications of these concepts for the U.S. elderly population--both now and for the future. To do this we will explore the current and future patterns of disability expected in the U.S. elderly population based upon data from several large national surveys. We will then explore how those disability patterns would be affected by altering the risks of various diseases that are reported as causing chronic disability. Finally we will examine the implication of those changes for the service requirements of the disabled elderly population by examining current patterns of "unmet" need for long-term care (LTC) services in the U.S. elderly population.

PROJECTIONS OF DISABILITY IN THE ELDERLY POPULATION

In this section we present projections of the growth of the disabled and institutionalized elderly population. These projections are based on two recent national surveys. In particular the characteristics of the community-based chronically disabled elderly population are derived from the 1984 National Long Term Care Survey (NLTCS). This survey was designed to describe the characteristics of community-dwelling, elderly (over 65) persons with "chronic" disability, i.e., persons who reported an Activity of Daily Living (ADL) or instrumental Activity of Daily Living (IADL) that had lasted or was expected to last at least 90 days. The survey population was identified by screening for chronic disability a large sample of Medicare eligible persons over age 65 drawn from Health Care Financing Administration records. The sample of disabled persons identified in 1984 was large (approximately 6,000 community-based disabled persons) and included persons who were followed from a similarly constituted survey conducted in 1982 (Manton and Soldo, 1987). An important feature of the NLTCS sample design was its age stratification with an over-sample of about 2,000 persons drawn from the Medicare eligible population over age 85. This is an age group with high prevalence and levels of disability. Thus its importance for studying disability among the elderly is far out of proportion to the numbers of persons over age 85. The NLTCS, however, is one of the few national surveys to over-sample this group to obtain precise estimates of its characteristics.

The characteristics of the institutionalized population are derived from the 1985 National Nursing Home Survey (NNHS). This survey collected detailed information on a large sample of discharges over a preceding 12-month period and a large sample of current residents. The current resident sample was used to calculate the rates employed in this study.

The rates estimated from the 1984 NLTCS and 1985 NNHS were used to project the future growth of the community-based disabled and institutionalized elderly populations using a static component model. Rates of disability, specific to sex, age, marital status and disability level are derived from the 1984 NLTCS. Institutionalization rates specific to age, sex and disability level are derived from the 1985 NNHS. These rates are applied to projections of the growth of the U.S. elderly population (specific to age, sex and marital status) produced by the Social Security Administration (SSA) actuaries for 1987 (Social Security Administration, 1987) in order to project the future growth of the disabled and institutionalized elderly populations. The SSA population projections are adjusted to reflect the U.S. resident population. These projections are updates and extensions of projections reported earlier (Manton and Liu, 1984) based on the 1982 NLTCS, the 1977 NNHS and the SSA projections of the social security entitlement population for 1982.

TABLE 1. Projections of the Community-Based Disabled, Institutionalized, and Non-Disabled Elderly Population 1985-2060, by Three Age Groups and Disability Levels (number of thousands)							
Year	Non-Disabled ¹	Community-Based Disabled ²					Institutionalization ³
		IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total	
Aged 65-74							
1985	14,137	848	651	319	281	2,098	212
2000	15,972	910	699	344	308	2,261	224
2020	26,983	1,567	1,173	583	522	3,815	393
2060	28,147	1,596	1,216	609	548	3,970	418
Aged 75-84							
1985	6,280	836	768	336	321	2,261	505
2000	8,693	1,147	1,033	453	443	3,076	669
2020	10,658	1,392	1,241	547	543	3,724	790
2060	16,333	2,129	1,884	824	830	5,668	1,215
Aged 85+							
1985	1,171	282	408	181	236	1,106	593
2000	1,935	465	668	299	393	1,826	970
2020	1,733	663	947	425	558	2,593	2,412
2060	6,160	1,434	2,035	915	1,202	5,585	2,884
Aged 65+							
1985	21,588	1,965	1,826	836	837	5,465	1,310
2000	26,600	2,522	2,401	1,096	1,144	7,163	1,863
2020	39,374	2,592	2,260	1,555	1,624	10,131	4,202
2060	50,640	5,160	5,135	2,348	2,581	15,223	4,517
1. SOURCE: Social Security Administration, Office of the Actuary: Social Security Area Population Projections: 1987, Actuarial Study No.99. SSA Pub.No.11-11546, 1987. 2. SOURCE: 1984 National Long-Term Care Survey. 3. SOURCE: 1985 National Nursing Home Survey. Totals may reflect rounding error.							

The basic quantities to be projected are the number of elderly persons in specific age, sex, marital status, disability and institutional states for the years 1985, 1000, 2010, and 2060. These dates are chosen to reflect critical points in the growth of the U.S. elderly population identified by determining when very large birth cohorts will pass certain critical ages, i.e., 65 and 85. Thus, the post-World War II "baby-boom" cohorts will largely have passed age 65 by 1020 and age 85 by 2060. Thus the selected projection dates capture the most significant points of change in the growth of the U.S. elderly population.

In the projections, disability intensity is coded into five levels: (1) no chronic disability; (2) at least one IADL impairment but no impairment in ADL; (3) 1 or 2 ADL impairments; (4) 3 to 4 ADL impairments; and (5) 5 to 6 ADL impairments. The

projected population values at these five disability levels and for the institutionalized population are presented in Table 1 using the SSA projections (adjusted for U.S. residence) based upon the medium variant assumptions about the rate of decline of mortality rates.

In the table we set that the total number of community-based disabled elderly with any level of chronic disability in 1985 was estimated to be 5.465 million, with 2.1 million aged 65 to 74, 2.3 million aged 75 to 84, and 1.1 million aged 85+. The estimate of 5.465 million persons is based upon the acceptance of the criterion of a condition being chronic (i.e., lasting or expected to last 90 days or more at the time the Medicare-eligible population is screened for disability) and the sets of ADL and IADL impairments used to define disability. Other definitions of disability could be used to give somewhat different estimates and, because the estimates are based on survey data, they are subject to sampling variability. Alternate definitions of disability would not alter the projected rates of growth of the disabled population (only the absolute level) and would probably not significantly affect the conclusions. In particular, persons with significant disability (e.g., with 3 or more ADL impairments) would almost certainly emerge as impaired under any reasonable classification. As a consequence changes in the definition of disability primarily affect only the "threshold" level for defining the population.

In addition to the community-based disabled population we have also projected the institutional population which tends to have very high levels of impairment. Indeed, recent changes in Medicare reimbursement for acute care hospitalization seem likely to increase the medical acuity and functional impairment of institutionalized persons. The number of institutionalized persons over age 65 has increased from 1.1 million in 1977 (Manton and Soldo, 1988) to 1.3 million in 1985. Of these 1.3 million, 212,000 were aged 65 to 74, 505,000 were aged 75 to 84, and 593,000 were aged 85+. Thus, the institutional population was proportionately much older than the community-based disabled elderly population. Though there was a significant increase in the risk of institutionalization with age, more persons with 3 or more ADL impairments are estimated to be resident in the community in 1985 (1.67 million) than in institutions (1.31 million).

Assuming constant age, sex and marital status specific disability rates, the size of the elderly chronically disabled and institutionalized populations is projected to increase considerably due to the projected aging of the U.S. population and greater life expectancy at advanced ages. The total number of chronically disabled persons grows by 31 percent to 7.16 million persons by the year 2000. The growth of the most severely disabled persons (i.e., those with 5 to 6 ADL impairments) to the year 2000 is even faster--36.7 percent. The growth of the institutionalized population was faster yet, 42.2 percent. These growth rates may be contrasted with the growth of the non-disabled population which was only 23.2 percent.

By the year 2060, when the baby boom cohorts will have passed age 85, we see that the rapid increase of the disabled and institutional population is projected to have

continued. The institutionalized population has grown by 145 percent, the total disabled population has increased 179 percent, the community-based population with 5 to 6 ADL impairments has increased 208 percent while the non-disabled elderly population has grown only 134 percent. As a consequence the ratio of the non-disabled elderly population to the disabled elderly population will decrease from 3.2 to 1 in 1985 to 2.6 to 1 in 2060. Thus, there will be fewer non-disabled elderly to provide informal care to an increasing disabled elderly population. The relative numbers of younger persons available to take care of the disabled elderly population will decline even faster suggesting that the relative availability of informal care resources is likely to decline significantly in the future.

These demographic dynamics not only cause the total number of elderly disabled and institutionalized persons to increase but also have significant effects on the demographic composition of the disabled populations as different age and sex groups with very different levels of disability are projected to grow at very different rates. For example, as described above the most rapidly growing component of the community-based disabled elderly population are those with 5 to 6 ADL limitations, i.e., those with the most severe disability levels (an increase of 208 percent). Those with only IADL impairments, in contrast, increase least rapidly (163 percent). The institutionalized population is projected to grow most rapidly (245 percent). The reason for these differences is the rapid growth of the oldest-old population with their much higher risks of disability and institutionalization. We see that while the community-based disabled elderly population aged 65-74 less than doubled, those aged 85+ are projected to increase fivefold. For persons aged 85+ with 5 to 6 ADL impairments there was a 409 percent increase compared to a 95 percent increase for persons aged 65 to 74 with this level of disability. The growth of the institutional population aged 65 to 74 was 97 percent while for those aged 85+ the growth was 386 percent. Thus, in addition to the rapid growth of the disabled elderly population, the more highly disabled components of that population are growing more rapidly causing the disabled elderly population, on average, to become more disabled.

The projected rate of growth of the disabled population varies strongly by sex as well as age because of large sex differences in the rate of improvement in mortality among males and females. This is illustrated in Table 2.

We see that the rate of increase of disabled persons in the community is higher both for persons aged 75 to 84 (196 percent vs. 129 percent) and age 85+ (469 percent vs. 380 percent) for males than females. This is due to males' lower initial life expectancy levels in 1985 so that, as mortality declines up to age 85, it has further to decline (and declines more rapidly) for males. Despite the more rapid increases in the size of the older male population in the community, the female groups remain absolutely much larger at all ages and disability levels. As a consequence the problem of disability among the elderly will remain one that disproportionately affects women.

The projections provided above are subject to several sources of uncertainty. Two sources are uncertainty about the rate of future mortality improvement and

uncertainty about the future pattern of institutional versus home health care. In Table 3 we consider how much these two sources of uncertainty could affect our projections. An additional source of uncertainty is the possibility of changes in the underlying health status of the population, i.e., the change in the age-specific relation of the curves in Figure 1 and Figure 2. That type of uncertainty will be explored in greater detail in the next section.

TABLE 2. Projections of the Community-Based Disabled Elderly Population, 1985-2060, by Three Age Groups, Sex and Disability Level (numbers in thousands)										
Year	Males					Females				
	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	3-4 ADL Limitations	Total
Aged 65-74										
1985	337	228	127	131	822	511	423	191	150	1,276
2000	376	254	142	146	918	534	445	201	163	1,343
2020	680	447	254	255	1,625	869	726	329	267	2,190
2060	709	470	272	268	1,178	887	746	338	281	2,251
Aged 75-84										
1985	274	218	99	126	717	562	550	237	194	1,543
2000	394	315	141	181	1,031	753	719	312	262	2,046
2020	500	397	181	232	1,310	892	844	366	312	2,414
2060	813	655	289	369	2,126	1,317	1,229	535	462	3,542
Aged 85+										
1985	87	106	48	63	304	195	302	133	172	802
2000	142	166	78	106	492	323	502	222	286	1,333
2020	213	248	116	159	736	450	699	309	399	1,857
2060	500	587	273	372	1,732	934	1,448	642	829	3,853
Aged 65+										
1985	698	551	274	320	1,844	1,267	1,275	562	517	3,621
2000	912	735	361	433	2,441	1,610	1,666	735	711	4,722
2020	1,381	1,092	551	647	3,670	2,211	2,269	1,004	977	6,561
2060	2,021	1,712	833	1,009	5,576	3,138	3,423	1,515	1,572	9,647
SOURCE: 1984 National Long-Term Care Survey Totals may reflect rounding error										

In Table 3 we present, for the total elderly population and for different age groups, a.) the upper and lower bounds to the growth of the institutional and community-based disabled elderly population based on the high and low mortality assumptions made in the SSA projection series (i.e., where mortality rates are assumed to decline one half as fast and twice as fast as the middle projection series used in Table 1 and Table 2), and b.) the change in the community-based disabled population resulting from a 50 percent reduction in the growth rate of institutionalization (i.e., a reduction from a growth rate of the institutionalized population from 2.1 percent per annum which was observed from 1977 to 1985 to 1.05 percent per annum).

TABLE 3. Projections of the Community-Based Disabled, Institutionalized, and Non-Disabled Elderly Population, 1985-2060, by Disability Level Assuming Upper and Lower Bounds on Population Growth Rates, and 50 Percent Reduction in Institutionalization Rates (numbers in thousands)							
Year	Non-Disabled ¹	Community-Based Disabled ²					Institutionalization ³
		IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total	
UPPER BOUNDS							
Aged 65-74							
1985	14,137	848	651	319	281	2,078	212
2000	15,971	910	701	344	312	2,267	219
2020	26,972	1,539	1,187	587	545	3,857	362
2060	28,456	1,479	1,144	571	546	3,739	340
Aged 75-84							
1985	6,280	836	768	336	321	2,261	505
2000	8,620	1,173	1,052	463	455	3,143	675
2020	10,431	1,482	1,296	579	587	3,945	796
2060	15,565	2,549	2,040	925	1,026	6,540	1,111
Aged 85+							
1985	1,171	282	407	181	236	1,106	593
2000	1,738	500	716	321	422	1,958	1,035
2020	1,999	803	1,036	513	677	3,128	1,611
2060	3,517	2,043	2,761	1,309	1,745	7,859	3,253
Aged 65+							
1985	21,588	1,965	1,826	836	837	5,465	1,310
2000	26,329	2,583	2,468	1,128	1,189	7,368	1,929
2020	49,238	2,824	3,619	1,679	1,808	10,933	2,770
2060	47,537	6,072	5,944	2,805	3,318	18,138	4,705
LOWER BOUNDS							
Aged 65-74							
1985	14,137	848	651	319	281	2,098	212
2000	15,975	909	697	343	304	2,253	229
2020	26,984	1,538	1,164	581	504	3,786	421
2060	27,845	1,712	1,278	646	541	4,176	514
Aged 75-84							
1985	6,280	836	768	336	321	2,261	505
2000	8,774	1,117	1,012	442	430	3,002	662
2020	10,854	1,317	1,181	520	508	3,537	781
2060	16,584	2,002	1,830	782	762	5,376	1,256

TABLE 3 (continued)							
Year	Non-Disabled ¹	Community-Based Disabled ²				Total	Institutionalized ³
		IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations		
Aged 85+							
1985	1,171	282	407	181	236	1,106	593
2000	2,142	430	619	277	363	1,688	901
2020	3,425	551	792	354	463	2,160	1,153
2060	8,128	1,085	1,559	695	907	4,247	2,254
Aged 65+							
1985	21,588	1,965	1,826	836	837	5,465	1,310
2000	26,891	2,457	2,328	1,062	1,097	6,943	1,792
2020	41,262	3,406	2,147	1,455	1,475	9,483	2,356
2060	52,558	4,799	4,667	2,123	2,210	13,799	4,023
50% REDUCTION IN INSTITUTIONALIZATION RATES							
Aged 65-74							
1985	14,137	848	651	319	281	2,098	212
2000	15,971	912	707	357	325	2,301	185
2020	26,984	1,543	1,193	617	564	3,916	291
2060	28,146	1,605	1,246	660	611	4,123	266
Aged 75-84							
1985	6,280	836	768	336	321	2,261	505
2000	8,693	1,154	1,056	493	492	3,195	550
2020	10,658	1,405	1,280	616	638	3,928	586
2060	16,333	2,156	1,969	973	1,013	6,111	772
Aged 85+							
1985	1,171	282	407	181	236	1,106	593
2000	1,935	476	701	367	464	1,998	798
2020	2,782	684	1,015	543	703	2,945	1,011
2060	6,161	1,498	2,238	1,268	1,635	6,637	1,831
Aged 65+							
1985	21,588	1,965	1,826	836	837	5,465	1,310
2000	26,599	2,542	2,464	1,207	1,280	4,794	1,533
2020	40,423	3,632	3,487	1,775	1,895	10,789	1,889
2060	50,641	5,259	5,453	2,900	3,260	16,871	2,868
1. SOURCE: Social Security Administration, Office of the Actuary: Social Security Area Population Projections: 1987, Actuarial Study No.99. SSA Pub.No.11-11546, 1987. 2. SOURCE: 1984 National Long-Term Care Survey. 3. SOURCE: 1985 National Nursing Home Survey. Totals may reflect rounding error.							

We see that the extreme mortality assumptions, though having large absolute effects, do not significantly alter the basic conclusions about the magnitude of the growth of the disabled and institutionalized elderly populations. By 2060 there is a 41.5 percent difference in the size of the projected disabled and institutionalized populations aged 85+ based upon the high and low mortality assumptions--the group most sensitive

to mortality assumptions. For the disabled and institutionalized populations aged 65 to 74 in 2060 the difference due to the extreme mortality assumption is only 15 percent.

Even under the lowest assumed mortality rate decline the total disabled community-based elderly population will increase 153 percent by 2060. This can be compared to 232 percent under the fastest mortality declines. This difference in growth produces a 31 percent difference in the projected size of the total disabled population in 2060. For persons over age 85 the mortality assumptions have an even larger impact. The growth of the disabled population over age 85 is 611 percent under the most optimistic mortality assumptions and 284 percent under the most pessimistic mortality assumptions. Even though the growth rates of various age, sex and disability level specific populations vary significantly in all cases there is significant growth of the disabled population. Furthermore, since most of our discussion is based upon the intermediate (Series II) mortality assumptions, the differences between the projection we evaluate, and those produced under the most extreme assumptions, is only about half of the range of potential variability.

Though having a large effect on the size of the institutional population (by 2060, a 36.5 percent decline from 4.52 million (Table 1) to 2.87 million persons), an assumed 50 percent reduction in the current per annum. rate of increase of the institutionalized population, with those persons being transferred to the community population according to the distribution of disability reported in the 1985 NNHS, has a relatively minor impact on the rate of increase of the community-based disabled population. This is because of the much smaller size of the institutionalized population. Though relatively small (a total of 1.65 million persons versus the 19.7 million persons projected to be disabled or institutionalized by 2060, Table 1) it does tend to be concentrated at advanced ages (e.g., a 18.8 percent increase in the number of disabled persons over age 85) and for the highest disability levels (among those aged 85+ with 5 to 6 ADL limitations, the projected increase would be 36 percent). Thus, the promotion a policy of "deinstitutionalization" of the elderly disabled population could lead to a sharply increased need for home health and other community-based services unless the deinstitutionalization policies were strongly targeted to the least disabled persons in institutions.

Though the projections described above deal with the increase of the disabled elderly in terms of demographic and health service variables alone, it should be kept in mind that even that limited set of variables has considerable qualitative implications for the level and types of care required by the disabled population (Manton and Soldo, 1987). For example, persons with IADL dependencies only will tend to require primarily nonmedical services--needs which may often be met by improved housing, the provision of equipment and other non-medical caregiver services. In contrast, persons with 5 to 6 ADL impairments are largely bed-bound and have high levels of need for formal (trained) caregiver, nursing, and medical services. Likewise, differences in those rates for males and females, are indications of major differences in the availability of informal care services with males typically having more care available from spouses

whereas females are at higher risk of not having adequate social resources to keep them out of institutional settings (Manton and Soldo, 1987).

THE EFFECT OF CHANGES IN HEALTH ON THE FUTURE INCREASE OF THE DISABLED ELDERLY POPULATION

One aspect of the growth of the disabled elderly population that has generally not received adequate attention in health policy and health service research is the potential impact of fundamental changes in health and functioning at later ages--and the strategies by which such changes might be achieved. There has been considerable qualitative debate over whether increases in life expectancy at later ages have been achieved by improving health and function--or achieved simply by delaying the age at death (e.g., Gruenberg, 1977; Fries, 1980; Feldman, 1983). Certain evidence suggests that, acute lethal processes (typified by the health processes represented in Figure 1) may be modified somewhat independently of the chronic degenerative processes (see Figure 2). Other evidence suggests that a.) the improvement of life expectancy to date has been achieved by intervention in the acute lethal processes--thus tending to increase the duration of the life span spent in a disabled state (e.g., Wilkins and Adams, 1983; Nihon University, 1982; Robine et al., 1988), and b.) we do not currently know what risk factors must be modified to alter the risk of chronic degenerative processes.

This does not mean that intervening in the acute lethal processes has **no** effect on the chronic degenerative processes. Reducing obesity at advanced ages and eliminating smoking may reduce the risk of osteoarthritis and osteoporosis while simultaneously reducing the risk of lung cancer and heart disease. Controlling hypertension reduces the risk of both lethal strokes and strokes that can produce significant long-term disability as well as dementia due to multiple cerebrovascular infarcts. However, few population risk factor intervention programs to date have been explicitly targeted at reducing disability. Consequently, most programs; have more efficiently reduced *mortality* than *disability* rates. Though this is what appears to have happened to date this does not prove that a comparable effort at identifying and controlling disability risk factors could not be equally effective.

To explore the potential impact of such programs for the growth of the disabled elderly population we show the projected effect of two types of interventions in population morbidity and disability processes. In Table 4 we present the projections of the disabled elderly population under the assumption that disability rates could be reduced as rapidly as mortality rates. Such projections represent the assumption that an intervention program would affect the general health and functional status of the elderly population and, instead of reducing the incidence of any single disease, delay the age at onset of multiple disease processes. Such general improvements in health have been argued by Brody (1985) to have been responsible for recent increases in life expectancy at advanced ages. Cause-specific mortality changes provide some evidence for this in that the mean age at death from most major acute, lethal and chronic diseases has increased significantly (Manton, 1985). There is also evidence to suggest that early

differences in lifestyle and health factors between birth cohorts may produce persistent differences in health and functioning when those cohorts reach advanced age (e.g., Manton and Myers, 1987).

TABLE 4. Projections of the Community-Based Disabled Elderly Population, 1985-2060, by Three Age Groups and Disability Level, Assuming Disability Rates Reduce as Mortality Rates (number of thousands)					
Year	Disability Level				
	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total
Aged 65-74					
1985	848	651	319	281	2,098
2000	809	622	305	273	2,010
2020	1,232	942	467	417	3,059
2060					
Aged 75-84					
1985	836	767	336	321	2,261
2000	968	870	352	376	2,596
2020	1,057	939	414	415	2,825
2060	1,378	1,216	531	542	3,666
Aged 85+					
1985	252	407	181	236	1,156
2000	415	596	267	350	1,628
2020	567	810	363	477	2,217
2060	1,083	1,539	690	906	4,217
Aged 65+					
1985	1,965	1,826	836	837	5,465
2000	2,192	2,089	954	1,000	6,234
2020	2,856	2,691	1,245	1,310	8,102
2060	3,563	3,594	1,641	1,825	10,623
SOURCE: 1984 National Long-Term Care Survey. Totals may reflect rounding error.					

We see that this scenario reduces disability by 13 percent in 1000, 20 percent in 2020 and 30 percent in 2060. Thus, if we were to target the reduction of disability among the elderly as a major federal health policy--and if we were as successful as we are projected to be in reducing mortality--we could significantly reduce the disability impact of population aging, though the community-based disabled elderly population would still nearly double.

The above projections were based on two assumptions. First, that the progress in reducing mortality could be produced by actions to reduce disability independently of changes in mortality. Second, that with the requisite research and policy actions we could achieve the same degree of progress in reducing disability at advanced ages that

we can achieve in reducing mortality at advanced ages. In order to determine how realistic such assumptions might be we consider two further pieces of evidence.

The first type of evidence represents the two-year transition rates between disability levels among the elderly after those rates have been adjusted for mortality. These are presented in Table 5 a separately for males and females for two age groups (those age 65 to 74 and those age 85 and over).

TABLE 5. 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		IADL Limitation		1-2 ADL Limitations		3-4 ADL Limitations		5-6 ADL Limitations		Institutional		Deceased	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	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	8.24	3.79
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	26.27	19.25
IADL Limitation														
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	16.54	8.19
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	33.41	19.31
1-2 ADL Limitations														
65-74	4.32	9.02	20.12	22.79	39.38	45.56	20.47	12.35	9.01	5.48	6.71	4.83	20.67	12.61
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	32.13	21.18
3-4 ADL Limitations														
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	28.29	11.88
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	47.90	24.78
5-6 ADL Limitations														
65-74	1.94	1.55	9.53	12.41	15.21	13.49	15.61	14.60	49.17	46.95	8.77	10.99	35.12	30.40
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	53.60	44.49
Institutional as of 4-1-82														
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	35.08	23.71
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	62.46	44.97
'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	61.10	30.91
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	72.22	42.02
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	38.85	35.95
85+	0.00	2.39	0.00	0.00	10.00	0.00	10.00	0.00	0.00	4.79	80.00	92.84	60.00	43.85
SOURCE: 1982 & 1984 National Long-Term Care Survey. Includes those not disabled on screener or detailed interview.														

We see that at all levels of disability there is a significant probability of regaining function in the long term. For example, at ages 65 to 74, men and women with 5 to 6 ADL impairments, and who survive two years, have similar chances of long-term (two-year) functional improvement (42 percent). At age 85 among survivors, the probability of improving functional level is less--though still significant (about 25 percent for females and 27.7 percent for males). Of course much of the similarity in these transitions is produced by the adjustment for mortality level which varies considerably by age and sex

(e.g., a two-year mortality probability for females aged 65 to 74 who are not disabled of 3.8 percent versus 30.4 percent for females of the same age with 5 to 6 ADL limitations).

For all persons with 5 to 6 ADL impairments there is a 22.2 percent chance of reducing the disability level over a two-year interval if we do not adjust for mortality. With 3 to 4 ADL impairments 23.6 percent manifest a long-term (two-year) improvement in functional status. If we adjust those probabilities for survival (37.2 percent of those with 5 to 6 ADL limitations and 24.0 percent of those with 3 to 4 ADL limitations die in two years) this increases to nearly 35.4 percent, i.e., that among two-year survivors, as in Table 5, with the highest level of disability, nearly 35.4 percent will manifest stable improvements in function. This level of improvement occurs even without a systematic national program for the prevention of disability and rehabilitation among the elderly--and with social norms that tend to accept increasing disability with age.

While the incidence of disability, unadjusted for mortality, is the same for males and females (Manton, 1988), females at all disability levels (and for all ages) have much higher survival rates than males (e.g., two-year mortality for persons aged 65 to 74 with 5 to 6 ADL limitations is 35.1 percent for males and 30.4 percent for females). Thus, though disability occurs at the same rate, females tend to live longer with disability. This is probably because females have higher risks of a number of chronic degenerative conditions like osteoporosis, diabetes and rheumatoid arthritis. Therefore, targeting these chronic degenerative diseases is likely to have a greater effect on females--the group with the highest levels of disability and the fewest social and economic resources to cope with that disability.

To describe the potential quantitative effects of such programs we conducted an alternate set of projections. We examined the conditions that elderly reported as most important in causing their disability in the 1984 NLTCs specific to age, sex, marital status and disability level. Then, both for 1985 and for future years, we estimated the total effect, separately for males and females of selected conditions on disability. To illustrate the different impact of acute and chronic conditions we conducted these projections for four conditions--two which we viewed as acute lethal conditions (cancer, ischemic heart disease) and two which we viewed as chronic degenerative conditions (dementia, and arthritis and other skeletal problems). The results are presented in Table 6.

We see that far more disability is attributed to arthritis and skeletal problems and dementia, with their effects increasing with time as the population ages. For example, the total number of cases of disability attributed to cancer and ischemic heart disease by 2060 is about 600,000 compared to a total community-based disabled elderly population of a little over 15 million. In contrast, the total number of persons with disability attributed to dementia is 1.6 million. About 5.2 million persons report arthritis and skeletal problems as the prime determinant of their disability. Together these two conditions are reported as causing approximately half of the total disability. Furthermore, we see that the effect for these diseases is proportionately greater for

females than males. While the effect of cancer and heart disease is relatively greater for males than females, the absolute size of the effect is still much smaller than for the chronic conditions.

TABLE 6. Projections of the Community-Based Disabled Elderly Population, 1985-2060, by Sex, Age Group and Disability Level, for Four Conditions Reported Most Important in Causing Disability

Year	Males					Females				
	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	3-4 ADL Limitations	Total
A. CANCER										
Aged 65-74										
1985	9,994	4,178	6,490	2,316	22,974	10,784	7,648	5,610	6,334	30,376
2000	11,142	4,672	7,234	2,582	25,630	11,398	8,160	5,964	6,792	32,314
2020	18,690	8,800	12,136	4,330	43,954	18,602	13,352	9,748	11,120	52,822
2060	18,784	9,816	12,194	4,350	45,144	19,192	13,888	10,106	11,612	54,798
Aged 75-84										
1985	4,326	2,564	4,194	1,420	12,506	2,924	5,508	5,718	7,152	21,300
2000	6,224	3,796	6,102	2,058	18,180	3,982	7,472	7,648	10,742	29,848
2020	7,886	4,528	7,542	2,570	22,526	4,748	8,896	9,058	13,238	35,942
2060	12,884	8,460	13,028	4,342	38,714	7,068	13,212	13,356	20,600	54,240
Aged 85+										
1985	---	4,460	3,682	4,026	12,168	994	1,666	1,538	2,814	7,012
2000	2	7,108	6,056	7,780	20,946	1,662	2,786	2,566	4,602	11,616
2020	2	10,618	9,060	11,710	31,390	2,302	3,860	3,554	6,512	16,232
2060	4	25,070	21,248	26,646	72,968	4,698	7,880	7,262	14,230	34,068
Aged 65+										
1985	14,318	11,204	14,362	7,764	47,646	14,704	14,820	12,864	16,298	58,688
2000	17,370	15,576	19,392	12,420	64,756	17,042	18,420	16,180	22,136	73,778
2020	26,578	23,944	28,738	18,612	97,872	25,652	26,108	22,366	30,870	104,994
2060	31,670	43,344	46,472	35,338	156,826	30,954	35,980	30,728	46,446	143,106
B. HEART DISEASE										
Aged 65-74										
1985	19,274	5,788	1,080	4,384	30,522	10,018	7,602	1,388	---	18,414
2000	21,492	6,458	1,208	4,886	34,048	10,430	7,926	794	2	19,146
2020	36,346	11,186	2,482	8,196	58,208	16,964	12,900	1,278	---	31,136
2060	36,822	11,600	2,952	8,236	59,604	17,278	13,152	1,250	---	31,674
Aged 75-84										
1985	10,274	1,976	3,574	4,126	19,950	17,564	11,374	2,842	2,456	34,236
2000	14,722	2,924	5,114	5,850	28,612	21,588	15,466	4,100	3,304	44,458
2020	18,810	3,486	6,548	7,648	36,492	24,728	18,424	4,986	3,928	52,060
2060	30,152	6,516	10,444	11,612	58,722	34,706	27,392	7,624	5,801	75,524
Aged 85+										
1985	1,006	906	1,106	2,638	5,652	756	3,312	2,458	1,492	7,018
2000	1,352	1,218	1,484	5,096	9,152	1,264	5,536	2,434	2,492	11,726
2020	2,004	1,802	2,200	7,672	13,678	1,750	7,674	3,376	3,454	16,252
2060	4,912	4,424	5,398	17,456	32,190	3,572	15,660	6,890	7,048	33,170

TABLE 6 (continued)										
Year	Males					Females				
	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total	IADL Limitation	1-2 ADL Limitations	3-4 Limitations	5-6 ADL Limitations	Total
Aged 65+										
1985	30,550	8,670	5,756	11,148	56,122	28,338	22,290	5,094	3,944	59,668
2000	37,570	10,600	7,808	15,832	71,750	33,282	28,926	7,328	5,792	75,330
2020	57,158	16,476	11,230	23,516	108,378	43,444	38,994	9,638	7,370	99,444
2060	71,884	22,540	18,792	37,302	150,518	55,552	57,204	15,766	12,846	140,368
C. DEMENTIA										
Aged 65-74										
1985	11,892	814	1,812	2,858	17,372	16,162	6,560	2,386	7,258	32,364
2000	13,282	908	2,018	3,192	19,400	16,410	7,016	2,558	7,658	33,660
2020	23,898	1,520	3,386	5,836	34,638	26,542	11,484	4,224	12,494	54,746
2060	25,652	1,526	3,400	6,348	36,926	26,430	11,968	4,436	12,874	55,708
Aged 75-84										
1985	23,532	12,858	6,414	7,024	49,830	67,022	41,280	9,490	18,972	136,764
2000	33,874	18,454	9,182	10,124	71,634	85,574	53,208	11,662	24,012	174,458
2020	42,868	23,508	11,758	12,782	90,916	99,538	62,126	13,356	27,834	202,858
2060	70,240	37,946	18,740	21,056	147,980	143,02	89,744	18,742	39,780	291,276
Aged 85+										
1985	14,162	18,322	5,724	13,494	51,704	43,162	50,326	28,424	43,962	165,876
2000	24,118	28,026	9,138	20,054	81,336	71,848	83,872	47,722	73,148	276,290
2020	36,128	41,782	13,652	29,858	121,420	99,932	116,534	65,818	101,788	384,072
2060	84,156	119,516	32,220	71,566	287,456	206,464	239,862	134,968	210,624	791,918
Aged 65+										
1985	49,584	31,996	13,948	23,380	118,906	126,346	98,166	40,298	70,192	335,002
2000	71,274	47,388	20,338	33,372	172,370	173,832	144,098	61,660	104,816	484,410
2020	102,892	66,812	28,796	48,476	246,974	226,016	190,142	83,400	142,116	641,672
2060	180,044	138,988	54,360	98,968	472,360	375,898	341,574	158,148	263,282	1,138,902
D. ARTHRITIS & OTHER SKELETAL DISEASES										
Aged 65-74										
1985	80,758	100,844	48,724	24,990	255,332	208,914	214,400	77,150	42,584	543,050
2000	91,288	112,610	43,320	27,906	285,126	218,122	225,746	81,862	46,420	572,150
2020	161,764	200,114	95,396	49,780	507,052	355,072	368,180	133,740	76,282	933,276
2060	171,302	212,454	101,890	53,026	538,674	362,550	378,666	138,448	80,714	960,378
Aged 75-84										
1985	57,910	79,366	35,896	18,354	191,528	186,348	231,294	110,018	67,592	595,252
2000	83,298	114,694	51,438	46,286	275,716	251,776	303,298	144,640	92,684	792,390
2020	105,586	143,940	65,724	33,632	348,880	299,252	356,450	170,164	110,746	936,592
2060	172,368	240,394	105,328	53,732	571,824	443,488	519,918	248,558	165,368	1,377,332
Aged 85+										
1985	25,282	38,810	13,582	8,336	86,010	50,774	134,850	50,598	37,368	255,590
2000	43,026	61,522	21,806	15,186	141,540	84,466	193,908	84,188	62,112	424,674
2020	64,452	91,874	32,582	22,808	211,714	117,558	270,520	117,148	86,514	591,740
2060	150,150	217,158	76,804	52,452	496,564	234,414	564,644	242,372	179,608	1,230,040

TABLE 6 (continued)										
Year	Males					Females				
	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total	IADL Limitation	1-2 ADL Limitations	3-4 Limitations	5-6 ADL Limitations	Total
Aged 65+										
1985	164,946	219,024	97,216	51,628	532,868	446,038	562,544	237,764	147,542	1,393,896
2000	217,614	288,826	126,564	69,378	702,382	554,366	722,942	310,692	201,214	1,789,214
2020	331,800	435,928	193,702	106,218	1,067,648	771,866	995,148	421,052	273,542	2,461,606
2060	493,820	670,006	284,026	159,210	1,607,060	1,049,448	1,463,228	629,380	425,694	3,567,750
SOURCE: 1984 National Long-Term Care Survey										

What this suggests is that if effective strategies could be found to eliminate or significantly modify the degenerative processes of arthritis and dementia a significant proportion of the projected increase in the disabled elderly population could be prevented. Furthermore, because persons typically survive with these diseases for a lengthy period of time, the reduction of the risks of these diseases would have a significant effect on the amount of time the individual could expect to spend free of disability. This is significant for the design of health service systems and national health policy because the length of time that a person has a disability could have a significant impact on his exhaustion of economic resources (e.g., a lengthy institutionalization could produce the "Medicaid spenddown" phenomenon--for either the disabled person or a non-institutionalized spouse) and on the capacity of informal caregivers to maintain the person in the community.

The strategies and technologies developed to eliminate or control these diseases might be based upon a generically different logic than are disease prevention programs at younger ages. Thus, instead of eliminating the disease one must consider how to delay the age at onset of significant impairment from the disease. Thus, for the chronic diseases secondary and tertiary prevention strategies are likely to play greater roles. Interestingly, the prevalence of impairment from a number of these degenerative diseases, because they have rapid increases in risk with age, could be significantly reduced by even relatively modest increases in their age at manifestation. For example, Brody (1985) has postulated that a five-year delay in the age at onset of dementia could reduce its prevalence by 50 percent--assuming that there was no concomitant increase in life expectancy. Large reductions could also be achieved if the age-related rise in disease incidence were slowed by interventions. These alternatives are illustrated in Figure 4.

In the figure there are two panels. The first describes the change in the risk of a chronic, degenerative disease with age. The second describes the age distribution of the cases that would be generated by each of the age specific risk functions in the first panel. Thus, in panel one the two curves labelled "Proportional Delay" represent the effect of the five-year shift in the risk function described by Brody. This corresponds to the two, identically shaped distributions of cases in panel two showing that the shift of the distribution to later ages would result in a similar distribution of the age at onset of the condition--except that more persons would die before manifesting the disease because the average mortality risks are higher for the second curve.

In the second scenario, labelled "Disease Modification" the physiological mechanism of the disease is modified in a way that its dependence on time is altered so that the shape of the age specific disease hazard function is altered, i.e., it is made flatter. This produces a much different distribution of age at onset of the disease in panel two.

Of course, to be effective both types of interventions assume that the correlation between the age at onset of the condition and the distribution of the ages at death is small. If the correlation is positive and large a delay in the average age at onset of the disease will be associated with an upward shift in the distribution of the age at death with possibly little gain in active life expectancy.

To determine how such interventions might be achieved we must a.) understand the mechanisms of the disease, its progression and natural history, b.) identify the risk factors affecting the different stages of disease, and c.) develop intervention strategies and technologies to effectively control those risk factor inputs.

There is now significant scientific evidence on several of the most disabling chronic degenerative diseases to suggest that significant interventions may be developed in the near future. For example, our knowledge of the factors contributing to osteoporosis is becoming much better so that prevention programs for that condition can be developed. We know, for example, that females are at much higher risk of osteoporosis (and associated skeletal problems like hip fracture) and that much of the risk occurs because of hormonal changes at menopause. Prevention programs would presumably involve different pre and post-menopausal strategies. Pre-menopausally one wishes to adopt behaviors that will maximize bone density at menopause. Risk factors decreasing bone density are smoking, alcohol consumption, extreme exercise (and consequential low body weight leadin to low estrogen production) while moderate exercise, good nutrition and adequate calcium intake are protective. Post-menopausally, calcium supplementation, exercise, adequate vitamin D supplementation and, possibly exogenous estrogen can retard the loss of bone density. Exactly how those interventions would alter the distribution of the age at onset is currently unclear. For example, by maximizing bone density at menopause one might shift the incidence curve to the right while by taking exogenous estrogen the disease process might be altered so that the shape of the incidence curve might be modified. The exact age "kinetics" of these disease processes are currently unknown and are necessary to understand the precise effects of a given intervention on the distribution of disability in the elderly population. Additionally, it is unclear the extent to which such interventions in osteoporosis would affect life expectancy--especially at extreme ages where hip fracture and other major skeletal failures caused by advanced osteoporosis are responsible for a significant number of deaths (Manton, 1986a). Resolution of this problem requires ancillary data and biological insight into the disease processes to be able to effectively model the biological dependency of both multiple disease risks and multiple causes of death.

Such detailed knowledge of the basic disease mechanisms is beginning to be developed for other chronic diseases. For example, our knowledge of the genetic, viral and immunological basis of rheumatoid arthritis is improving. Consequently, for the first time, rheumatologists are discussing medical therapies that are truly disease modifying (e.g., long term, low dose methotrexate, gold salts, cyclosporine). Considerable research is being initiated on the determinants of Alzheimer's disease and possible medical interventions being identified for clinical evaluation (e.g., nerve growth factors). Research on Alzheimer's disease is at a very early stage. However, the absolute numbers of cases that could be affected by effective therapy is so large that even if only a small proportion of the total effect of the disease or disability is realized, such efforts will likely be cost effective.

SERVICE PATTERNS AMONG THE DISABLED ELDERLY

In the prior sections we illustrated the current and future magnitude of the problem of disability among the elderly and estimated how much of that problem might be resolved by further research on disease mechanisms, the development of disease modifying therapies and effective prevention strategies. Our conclusion, based upon an assessment of the recent rate of scientific progress, was that a significant proportion of the degenerative processes responsible for much of the disability at later ages might be subject to significant control or modification within 10 to 20 years by appropriately targeted biomedical and public health efforts. This is certainly well within the time horizon of our projections. However, even under the most optimistic scenarios a significant increase in the size of the disabled elderly population is likely to occur. This seems particularly likely for the very elderly who tend to have a high prevalence of multiple chronic conditions so that elimination of one condition would still leave individuals with other conditions to cause impairment--though possibly at lower levels.

In this section we turn to the question of assessing not simply the number of disabled elderly, but the number who remain in need of certain types of services. The determination of the need for services is complex because, in addition to ascertaining intrinsic levels of disability, one must evaluate the efficacy of different strategies for responding to those disabilities. For example, one could have needs unfulfilled if one did not have either appropriate equipment or personal care available to respond to specific types of functional impairment. In some cases there may be the possibility of substituting one for the other. The adequacy of the level of services is itself a function of a.) the adequacy of current techniques to resolve the impairment, and b.) current social values and governmental policy regarding the commitment to meet different needs (e.g., we currently would be more likely to publicly provide services to respond to physical impairments than to provide alternate housing services). Furthermore, there is a broad range of daily actions that are affected by functional disability. One could feel that adequate medical care was not available for a number of reasons--including impairments in mobility. Or one could suffer problems because of housing deficiencies or characteristics of residential location.

In Tables 7-10 below, we examine need defined in terms of personal care needs required because of ADL and IADL impairments, lack of equipment or the need for basic health services. It is perhaps this level of current unmet and future service needs which truly defines the magnitude of the nature of national health policy questions raised by the projected growth in the numbers of disabled elderly.

The first dimension of need we will examine is lack of personal care and equipment to deal with each of six possible ADL limitations. These are presented in Table 7.

TABLE 7. Number and Percent of Community-Based Disabled Elderly Population with ADL Limitation Unmet Needs, by Disability Level and Type of ADL Unmet Need (numbers in thousands)							
Disability Level	Number of Persons Reporting ADL Unmet Needs	ADL Limitation Unmet Need					
		Eating	Getting Up	Getting Around	Dressing	Bathing	Toileting
1-2 ADL Limitations	459 (28.08)	7 (0.43)	10 (0.63)	8 (0.48)	17 (1.01)	130 (7.98)	358 (21.91)
3-4 ADL Limitations	312 (42.24)	6 (0.86)	11 (1.47)	8 (1.05)	26 (3.52)	107 (14.49)	238 (32.25)
5-6 ADL Limitations	441 (53.97)	36 (4.39)	64 (7.77)	53 (6.51)	38 (4.68)	81 (9.88)	379 (46.37)
Total	1,212 (34.65)	49 (1.40)	85 (2.43)	69 (1.97)	81 (2.31)	318 (9.09)	976 (27.89)

Numbers in parentheses are percent of persons at disability level with specific unmet need.
SOURCE: 1984 National Long-Term Care Survey.
 Totals may not sum due to rounding error.

For the first four basic self-care functions the number of community resident, disabled elderly persons who lack either equipment or personal care is less than 2.5 percent. For either bathing or toileting we see that the limitations are far more prevalent (9.09 percent and 27.89 percent). The 976,000 persons with chronic ADL impairments who report unmet needs with toileting represent the difficulty in defining need. Much of the need arises because persons report "wetting" or "soiling" themselves on a regular basis. Current technology to respond to these problems (e.g., using diapers) may not prevent this. Hence, even if the best current technology were employed, the need may remain. Of course, it could be argued that innovative surgical or other interventions could eliminate the problem in a number of cases. In any case the difficulties in estimating unmet need levels are clear.

Though about 35 percent (about 1.2 million persons) report current need in terms of ADL functions, most of that unmet need results from two of the ADL impairments--impairments at the low levels in the Katz hierarchy (Katz and Akpom, 1976). This is not surprising since, persons who are not able to satisfactorily perform a function like as eating are probably institutionalized in relatively short order. The level of unmet need resulting from the lack of care to respond to ADL impairments, as shown in the table, is strongly correlated with disability level. The total level of unmet need nearly doubles (28.1 to 54 percent) from persons with 1 or 2 ADL impairments to those with 5 to 6 ADL impairments. It also varies strongly by age (not here reported) with the oldest-old having the highest level (35.3 percent) of unmet need.

We can also examine unmet needs in terms of specific types of IADL impairment. These proportions are presented in Table 8.

TABLE 8. Number and Percent of Community-Based Disabled Elderly Population with IADL Limitation Unmet Needs, by Disability Level and Type of IADL Unmet Need (numbers in thousands)

Disability Level	Number of Persons Reporting Any IADL Unmet Need	IADL Limitation Unmet Need								
		Heavy Work	Light Work	Laundry	Preparing Meals	Grocery Shopping	Getting Around Outside	Going Places	Managing Money	Taking Medicine
IADL Limitation	514 (27.32)	1,343 (71.37)	115 (6.13)	107 (5.70)	58 (3.06)	184 (9.79)	189 (10.06)	115 (6.11)	57 (3.04)	27 (1.42)
1-2 ADL Limitations	690 (38.39)	1,391 (76.84)	226 (12.59)	122 (6.78)	102 (5.70)	151 (8.43)	276 (15.35)	194 (10.78)	79 (4.39)	22 (1.20)
3-4 ADL Limitations	468 (58.96)	717 (90.38)	282 (35.51)	36 (4.49)	52 (6.58)	68 (8.55)	173 (21.77)	145 (18.24)	43 (5.38)	20 (2.54)
5-6 ADL Limitations	671 (77.08)	764 (87.76)	592 (67.96)	18 (2.01)	31 (3.58)	25 (2.82)	312 (35.84)	258 (29.62)	24 (2.77)	14 (1.65)
Total	2,343 (43.86)	4,206 (78.70)	1,215 (22.75)	282 (5.28)	244 (4.56)	428 (8.01)	950 (17.78)	711 (13.31)	203 (3.80)	83 (1.55)

Numbers in parentheses are percent of persons at disability level with specific unmet need.

SOURCE: 1984 National Long-Term Care Survey.

Totals may not sum due to rounding error.

We see that the level of unmet need varies strongly by type of IADL. Not surprisingly most (~79 percent) have unmet needs regarding heavy work. The proportions with cognitively-based tasks unmet (i.e., managing money, taking medicine) is relatively small. Mobility functions have intermediate levels of unmet need. As for ADL unmet needs, the level of need increases with age but the association with impairment level is not as clear. For certain IADLs the estimation of unmet need is made difficult by possible sex bias in the functions. That is, males, at any level of functioning, may be less skilled at laundry, preparing meals and grocery shopping.

Another dimension of need related to functional impairment is the ability to make a doctor's appointment. In Table 9 we present the distribution of reason for not being able to make an appointment with a medical doctor.

Only 3.8 percent of disabled persons were unable to attend a doctor's appointment because of financial problems. Overall about 13.9 percent could not make a doctor's appointment for any reason.

TABLE 9. Number and Percent of Community-Based Disabled Elderly Population Unable to Make Appointment with Medical Doctor, by Disability Level and Reason (numbers in thousands)										
Disability Level	Number of Persons Unable to Visit Medical Doctor for Any Reason	Reason Person Unable to Make Medical Doctor Appointment								
		Lacked Money	Lacked Time	Medical Doctor Not Available	Lacked Transportation	Not Free to Leave Residence	Medical Problem Not Serious Enough	Afraid to Find /Out What is Wrong	Bad Weather	Other Reason
IADL Limitation	265 (14.11)	84 (4.45)	9 (0.50)	30 (1.62)	53 (2.82)	2 (0.09)	34 (1.82)	11 (0.58)	5 (0.29)	91 (4.81)
1-2 ADL Limitations	288 (16.02)	73 (4.04)	13 (0.73)	37 (2.04)	46 (2.57)	4 (0.24)	47 (2.62)	12 (0.68)	2 (0.09)	121 (6.72)
3-4 ADL Limitations	123 (15.52)	29 (3.67)	7 (0.92)	17 (2.18)	32 (4.09)	4 (0.44)	15 (1.84)	7 (0.89)	2 (0.28)	53 (6.70)
5-6 ADL Limitations	67 (7.67)	18 (2.09)	2 (0.24)	10 (1.15)	14 (1.61)	0 (0.00)	5 (0.59)	2 (0.25)	0 (0.00)	28 (3.17)
Total	743 (13.91)	204 (3.81)	32 (0.60)	94 (1.77)	146 (2.73)	10 (0.18)	101 (1.89)	32 (0.61)	9 (0.17)	292 (5.47)

Numbers in parentheses are percent of persons at disability level unable to make appointment for specific reason.
SOURCE: 1984 National Long-Term Care Survey.
 Totals may not sum due to rounding error.

A third dimension of need is that for specific equipment. Some persons report having no need for specific equipment (e.g., handrails) and, among those reporting a need, some may have the equipment. Table 10 presents the numbers of persons who have special equipment versus those who do not but who do report that having the equipment would make them more comfortable or aid them.

TABLE 10. Number of Community-Based Disabled Elderly Persons Who Have Special Equipment and Those Who Report They Need But Do Not Have Special Equipment, by Disability Level and Type of Equipment							
Disability Level	Status	Type of Equipment					
		Pushbars Doors	Handrails	Ramps	Elevators	Extra-Wide Doors	Raised Toilet
IADL Limitation	Have	20,127	212,533	29,586	60,966	59,609	28,912
	Need	12,882	261,416	24,161	43,233	12,772	57,265
1-2 ADL Limitations	Have	33,753	535,874	74,097	96,700	113,984	90,644
	Need	16,146	301,220	45,577	75,808	26,330	135,519
3-4 ADL Limitations	Have	16,051	287,791	52,646	66,674	68,080	128,871
	Need	30,551	156,845	50,302	35,098	27,662	83,229
5-6 ADL Limitations	Have	7,032	249,196	90,598	34,512	50,120	130,620
	Need	36,607	183,207	69,061	44,190	69,165	128,767

SOURCE: 1984 National Long-Term Care Survey.

We see that there are about 96 thousand persons reporting needing doors with pushbars in contrast to 77 thousand who report having them. About 1.3 million persons

report a built environment with handrails while a little more than 900 thousand persons say that they would be useful but do not have them. For example, among persons with 5-6 ADL limitations, we find about 250 thousand persons who have handrails and about 180 thousand who do not. About 380 thousand persons report having raised toilets and about 400 thousand do not have them. Thus there is reported a considerable need for special equipment in the built environment to help compensate for a number of impairments--roughly half of the equipment needs of the community based population is being met.

An additional component of need involves the demand for acute and LTC health services. This need, current and future, can be represented by two measures. One is the demand for various types of medical and auxiliary health professional manpower. The second is the change in the demand for informal care. In addition one could examine the tradeoff between informal and formal care.

In Table 11 we examine projections for three classes of health care workers to meet future levels of demand for institutional and home health services (Manton, 1986b).

TABLE 11. Projection of Number of Physicians, Nurses, and Home Health Worker Required to Maintain Current Levels of Service for the Elderly Population				
	1985	2000	2020	2040
1. Physicians	110,000	137,830	206,030	267,760
2. Nurses	390,000	488,740	730,650	949,333
3. Home Health Workers				
a. Aides	198,900	249,258	372,640	484,059
b. Nurses	22,100	27,695	41,404	53,797
SOURCE: Manton, KG: Preliminary Report on Ways of Adjusting Public and Private Reimbursement Mechanisms for Promoting the Training of Geriatric Manpower. Presented at the National Institute on Aging, Dece. 11-12, 1986, Table 11.				

We see that the number of physicians required to continue current levels of services for the elderly population increases nearly 150 percent--far more than the increase of the total U.S. population. There are similar increases in the projected future demand for nurses and home health workers. Thus there will have to be a more rapid increase in the requirements for medical manpower than would be expected based on simple population growth. Furthermore, because much of this growth occurs in meeting the needs of an elderly, disabled population there will be a need for special geriatric training of these health professionals.

In Table 12 we present the number of caregivers required, and number of days spent by caregivers to maintain current levels of informal care.

TABLE 12. Number of Caregivers and Caregiver Days for the Community-Based Disabled Elderly Population, 1985-2060, by Three Age Groups and Disability Level (numbers in thousands)										
Year	Caregivers					Caregiver Days				
	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	5-6 ADL Limitations	Total	IADL Limitation	1-2 ADL Limitations	3-4 ADL Limitations	3-4 ADL Limitations	Total
Aged 65-74										
1985	1,297	1,142	688	733	3,860	3,998	3,711	2554	3,171	13,433
2000	1,383	1,222	737	800	4,142	4,308	4,014	2,766	3,476	14,563
2020	2,333	2,043	1,245	1,352	6,973	7,299	6,698	4,689	5,881	24,566
2060	2,416	2,113	1,300	1,416	7,245	7,588	6,927	4,916	6,176	25,607
Aged 75-84										
1985	1,414	1,540	797	908	4,660	3,891	4,759	2,578	3,858	15,086
2000	1,920	2,064	1,067	1,249	6,300	5,395	6,484	3,476	5,315	20,669
2020	2,317	2,468	1,282	1,528	7,595	6,605	7,820	4,202	6,496	25,124
2060	3,524	3,743	1,920	2,329	11,516	10,176	11,976	6,321	9,926	38,398
Aged 85+										
1985	521	951	454	703	2,629	1,575	2,857	1,627	3,096	9155
2000	859	1,557	750	1,168	4,334	2,610	4,657	2,695	5,137	15,100
2020	1,219	2,210	1,066	1,663	6,158	3,737	6,629	3,837	7,317	21,520
2060	2,626	4,756	2,301	3,594	13,278	8,167	14,371	8,310	15,833	46,681
Aged 65+										
1985	3,232	3,633	1,939	2,344	11,148	9,463	11,327	6,759	10,125	37,374
2000	4,162	4,844	2,553	3,218	14,776	12,313	15,155	8,937	13,927	50,331
2020	5,869	6,720	3,594	4,543	20,726	17,641	21,147	12,728	19,695	71,211
2060	8,567	10,612	5,520	7,339	32,039	25,931	33,274	19,547	31,934	110,686
SOURCE: 1984 National Long-Term Care Survey Totals may not sum due to rounding error										

We again see that the number of caregivers increases much more rapidly than the general growth of the U.S. population. This means that to maintain current levels, the intensity of caregiving will have to increase on a per capita basis and probably implies that, in the future, more of this care will have to be provided by paid caregivers.

What we have not fully explored in the analysis of need above is the issue of "multiple jeopardy", i.e., the fact that certain disabled subpopulations may have multiple needs unfulfilled. This would require a different, multivariate analysis rather than our demographic projections. What is clear is that certain subpopulations do have multiple needs unmet and that these persons have the highest risks of institutionalization. They also represent one of the most critical target populations for innovative LTC systems--although the current evidence suggests that many existing LTC demonstrations did not target, nor were very effective in managing, such populations (Vertrees et al., 1989).

SUMMARY

In the above we considered the magnitude and quality of the problem of disability for the community resident disabled and institutionalized U.S. elderly populations. An analysis of the impact of disability on this population is more difficult than for other disabled groups in the sense that previously, in both the popular and scientific literature, there was the assumption that the prevalence and severity of disability was a natural consequence of the aging process. More so than in other disabled groups, functional loss and impairment is considered a "natural" state for the elderly. Such a perspective has implications not only for initiatives to improve the health and functional states of the elderly population but also for the perception of the level of disability and handicaps associated with it and the types of services that might be provided.

This image of the natural emergence of frailty with age is now undergoing challenge in a number of studies. The extreme heterogeneity of functional status in even the oldest-old (85+) population is evidence that functional impairment among the elderly is not a natural consequence of aging and must be evaluated on an individual basis.

There is also increasing evidence that the physiological processes generating impairment are subject to intervention and in some cases, may even be partly reversed and function regained. Recent research has begun to identify the risk factors for such processes and to explicate the mechanisms of these processes so that more effective interventions can be developed.

Whatever interventions may be introduced, the demographic aging of the population will cause a major increase in the number of disabled elderly. This is a national problem whose magnitude will depend upon the degree to which the broadly defined needs of this population are or not being met. We considered these needs on a number of levels. In terms of basic self-care only bathing and toileting are currently unmet to a considerable degree. Among IADL impairments transportation and mobility were most problematic. An analysis of limits on the access to primary medical care (i.e., physician visits) showed significant proportions (about 14 percent) of disabled elderly persons reporting problems. The most serious deficiencies on a relative basis were noted in needs for physical equipment and changes in the built environment

All of these factors contribute to a general assessment of changes in the size, structure and needs of the disabled elderly population. It is clear that no single response will suffice to meet the likely level of the problems. Thus a multidimensional approach involving the private sector and state and federal programs, and coordination, will be needed to develop responses to the problem. Given the dimensions of the problem, however, it is likely that no response will be satisfactory unless some fundamental changes in the socio-cultural perception of the functioning of elderly people, and the provision of family and other social resources to maintaining that functioning, is

developed. This is because with the likely growth of the problem, and the increase in its intensity, current socio-cultural responses will not be sufficient in the future.

One aspect of the problem that is of particular concern is the relative paucity of nationally representative data to monitor the growth of the problem, to characterize the dimensions of the problem, and to monitor the efficacy of different interventions. Only recently has nationally representative longitudinal data appropriate for this table become available. The existing temporal series of such national data, however, are not yet lengthy enough to either identify major cohort differences or accurately assess whether active or healthy life expectancy has increased or decreased as life expectancy at later ages increases. This will be a serious hinderance to the development of effective policies to meet the problems of a rapidly aging population.

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