Regression-Adjusted Small Area Estimates of Functional Dependency in the Noninstitutionalized American Population Age 65 and Over

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ABSTRACT

Health planning efforts for the population age 65 and over have been hampered continually by the lack of reliable estimates of the noninstitutionalized long-term care population. Until recently national estimates were virtually nonexistent, and reliable small area estimates remain unavailable. However, with the recent publication of several national surveys and the 1990 Census, synthetic estimates can be made for states and counties by using multivariate methods to model functional dependency at the national level, and then applying the predicted probabilities to corresponding state and county data.

Using the 1984 National Health Interview Survey's Supplement on Aging and the 1986 Area Health Resources File System, we have produced log-linear regression models that include demographic and contextual variables as predictors of functional dependency among the noninstitutionalized population age 65 and over. Age, sex, race, and the percent of the 65 and over population who reside in poverty were found to be significant predictors of functional dependency. Applying these models to 1986 Medicare Enrollment Statistics, regression-adjusted synthetic estimates of two levels of functional dependency were produced for all states and—as examples of how the rates can be used to produce additional synthetic estimates—the largest county in each state. We also produced point estimates and standard errors for the national prevalence of functional dependency among the noninstitutionalized population age 65 and over. (*Am J Public Health* 1990;81:335–343)

Introduction

Bivariate correlates of functional dependency suggested in previous work include age,[1–11] being female,[3,4,6–10,12] being of a race other than White,[3,10] being unmarried or residing with family members,[6,7,10] living alone,[13] having a low income,[7,10,11] and being at the low end of the social class continuum.[7] However, Feller[1] found no significant difference in rates of dependency by gender; Dawson, Hendershot, and Fulton[5] found gender differences to disappear when age structure was taken into account; and Jette and Branch[13] found that among those who lived with others, level of income was inversely related to increasing disability.

A few researchers have also investigated the relationship of functional dependency to other factors with the use of multivariate methods. Among these age,[10,14,15–17] physical performance,[10,14] number of chronic conditions,[14,15] sex,[14] race,[14] emotional performance,[14] health status,[14] prior functional abilities,[10] social class,[15] income,[15] and education[16] have been shown to be significantly related to level of functional dependency.

Yet, health planning efforts for the population age 65 and over continue to be hampered by the lack of reliable data and methods for making population-based estimates at subnational levels. Unger and Weissert's[17] research, which used 1977 data to produce synthetic estimates of the functionally dependent noninstitutionalized age 65 and over population, was forced to rely upon a data set with much more limited measures of dependency than those available on more recent national surveys.

Although several methods exist to produce synthetic estimates, none has been found to be uniformly superior. One well suited method uses a fitted regression model to predict outcomes from correlates of the trait or characteristic of interest. This approach has been widely used.[17–29]

This paper presents log-linear regression models as well as regression-adjusted synthetic estimates of the noninstitutionalized dependent age 65 and over population in each state and its largest county. With appropriate caution the rates generated by the models can be applied to the number of noninstitutionalized age 65 and over individuals in various age, sex, race, and poverty subgroups living in other counties to produce synthetic estimates of the prevalence of dependency for those counties.

Methods

Data Sources and Definitions

Data were drawn from the 1984 National Health Interview Survey's Supplement on Aging, the 1986 Area Resource File System, *State, Regional, and Na-*

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tional Monthly and Seasonal Heating Degree Days,[30] and 1986 Medicare Enrollment Statistics.

The 1984 Supplement on Aging, based on a multistage area probability sample, provides self-reported characteristics (such as conditions and impairments, living arrangement, and functional abilities) for 11,497 civilian noninstitutionalized people age 65 and over. A more detailed description of the survey is provided by Fitti and Kovar.[31]

Contextual variables were drawn from two sources: the 1986 Area Resources File System and *State, Regional, and National Monthly and Seasonal Heating Degree Days*. The 1986 Area Resource File System is a county-specific data base containing more than 7,000 variables concerning a wide range of social, economic, and health resource characteristics, and is described in detail elsewhere.[32] The use of one additional contextual variable, heating degree days (which is available from the National Oceanic and Atmospheric Administration) was examined.

Using the geographic identifiers available on the 1984 Supplement on Aging, corresponding contextual variables from the above two sources were attached at the Standard Metropolitan Statistical Area (SMSA) for individuals residing in one of 31 large self-representing SMSAs. Individuals on the data set who resided outside these 31 areas were assigned the corresponding regional (northeast, north central, south, or west) and urbanity (SMSA or nonSMSA) average for their type of residence. The result was 39 distinct geographic areas: 31 self-representing SMSAs, and four urban and four nonurban regional areas.

Synthetic estimates are produced by multiplying the regression-adjusted national rates by population data. Because any explanatory variable included in the national model must also be available in the small area population data, Medicare Enrollment Statistics were used for small area population data. Enrollment data by age, sex, and race for each state and county in the United States are available from the Bureau of Data Management and Strategy at the Health Care Financing Administration.[33]

Model Specification

Unit of Analysis

The unit of analysis for this study was the individual participant in the 1984 Supplement on Aging. Although the weighted sample size of the 1984 Supplement on Aging is over 26 million, we normalized the provided survey weight variable to sum to the actual sample size of 11,497 so as not to exaggerate significance levels in model evaluation.

Dependent Variable

The dependent variable for our analysis was a three level hierarchical measure which classified individuals into their highest level of dependency defined as follows.

ADL Dependent: Individuals residing in the community who, because of a health or physical problem, reported that at the time of the survey they had difficulty with and received human assistance with eating, transferring, toileting, dressing, or bathing.

Mobility/IADL Dependent: Individuals residing in the community who, at the time of the survey, were not ADL dependent, but because of a health or physical problem reported difficulty with and received human assistance with inside mobility, outside mobility, meal preparation, grocery shopping, money management, housework (light and heavy), or telephone usage.

Independent: Individuals residing in the community who, at the time of the survey, were neither ADL nor IADL dependent.

Explanatory Variables

Coupling the constraints of the Supplement on Aging and Medicare county data, the following explanatory variables were available for use:

- Sex (coded 1 if female and 0 if male);
- Race (coded 1 if other and 0 if White);
- Age Group (coded as a zero-centered variable equal to the midpoint age in five-year intervals from 65 to 85 and over minus 77.5, divided by 5, i.e. −2, −1, 0, 1, or 2);
- Age-Squared (coded as the square of the "age group" variable, i.e. 4, 1, 0, 1 or 4); and
- Pairwise Interactions (coded as the product of the pair).

In addition, a number of contextual variables were hypothesized to affect the rate of functional dependency among the noninstitutionalized population age 65 and over. These included:

- the number of nursing home beds per 1,000 population age 65 and over;
- the number of unoccupied nursing home beds per 1,000 people age 65 and over;
- the number of acute care hospital beds per 1,000 people age 65 and over;
- the per capita income of the population;
- the percent of the persons age 65 and over who reside in poverty;
- the number of primary care physicians per 1,000 persons age 65 and over;
- the percent of the poverty population that is covered by Medicaid;
- the age-adjusted mortality rate;
- the population per square mile;
- the population age 65 and over per square mile;
- the percent of the population that resides in an urban area; and
- heating degree days (the annual number of degrees of heating or cooling which would be required to move an area's temperature one degree for one day toward 68 degrees Fahrenheit).

Each of the contextual variables was evaluated for entry into the models both continuously and categorically. For the categorical analysis the variables were collapsed into three levels: high, medium, and low—coded −1, 0, and 1, respectively.

Statistical Methods

Given the multinomial nature of the dependent variable, a multicategory extension of logistic regression which provides a general structure was used. (The structure imposed on the data by an ordered logistic regression model was evaluated and found to be inappropriate.) The log-linear model was fit using a SAS supported procedure designed for categorical data modeling, PROC CATMOD.[34] For log-linear model analysis, CATMOD uses maximum likelihood estimation. Given the three category dependent variable, two sets of parameter estimates were produced: one for the logged ratio of not dependent to ADL dependent, and one for the logged ratio of IADL dependent to ADL dependent. Working with these two equations simultaneously yielded a formula for each category of the dependent variable: 1) not dependent; 2) IADL dependent; and 3) ADL dependent.

Because failure to account for the complex sampling design of surveys such as the Supplement on Aging can lead to underestimated variances of the regression coefficients, the magnitude of the design effects was tested with RTILOGIT.[35] Results confirmed previous findings that design effects on the Supplement on Aging

TABLE 1—Regression Results: Predictors of Functional Dependency among the American Noninstitutionalized Age 65 and Over Population[a]

Variables	Log (Prob. not dependent/ Prob. ADL dependent) Coefficient	Standard Error	Log (Prob. IADL dependent/ Prob. ADL dependent) Coefficient	Standard Error	Chi-Square[b] (d.f. = 2)
Race	−.41	.12	−.02	.13	28.56
Sex	−.17	.08	.71	.09	217.76
Age group	−.59	.03	−.20	.03	654.65
Age group-squared	−.11	.02	−.07	.02	29.23
Poverty	−.35	.07	−.15	.08	36.66
Intercept	2.51	.08	.44	.09	1920.81

[a]Lack of fit chi-square = 128.13, d.f. = 108, p = .0906. Model chi-square = 959.14, d.f. = 10, p = .001.
[b]p < .001

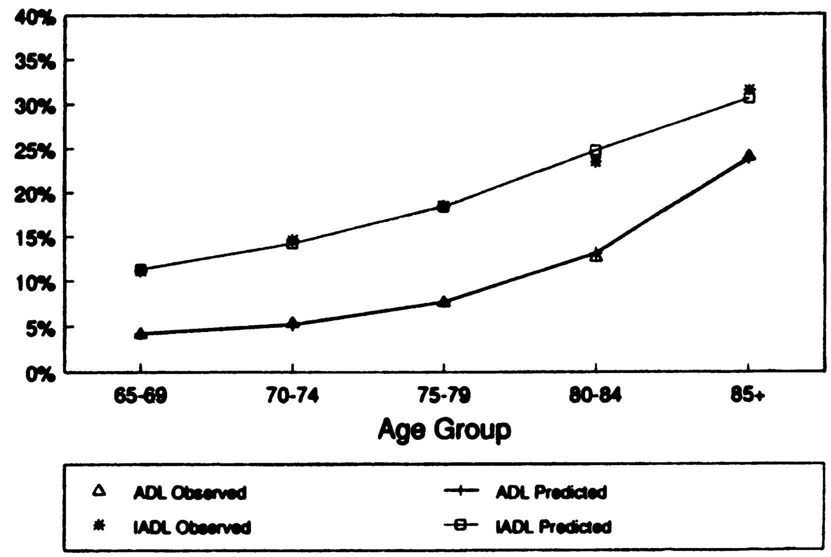

FIGURE 1—Observed and Predicted ADL and IADL Dependency Rates

are relatively small,[31] and estimates produced by complex sample methods such as RTILOGIT would not alter results or conclusions.

For model testing, the data base was randomly divided in half within each primary sampling unit. In the first half of the data base candidate models were fit for the dependent variable. Once model development was completed, the goodness-of-fit of the model was validated in the other half of the data base as described in the Appendix.

Results

Direct Estimates

Direct estimates from the 1984 Supplement on Aging show that in 1984 approximately 2.0 million (7.3 percent) of the noninstitutionalized population age 65 and over in the United States suffered from at least one ADL dependency, and an additional 4.2 million (16.4 percent) suffered from at least one IADL dependency. National prevalence and percentage estimates by race, sex, and age and their accompanying standard errors are presented in Appendix Tables A1-A4.

Regression-Adjusted Results

Table 1 presents the survey-weighted results of the log-linear regression analysis. Five variables were selected to form the final model: race, sex, age, age-squared, and one contextual variable, the categorical variable reflecting the percent of the population age 65 and over who reside in poverty. Each was a significant predictor of functional dependency in the overall model.

Other contextual variables were eliminated from the model. Three of these variables (when entered as the sole contextual variable in the model) had p-values < .02 (the number of heating degree days, the ratio of Medicaid recipients to the population below poverty, and the number of unoccupied nursing home beds per 1,000 elderly). However, all p-values became nonsignificant (p > .05) when entered in the model in combination with the poverty variable.

While theoretical considerations would argue for inclusion of these and the other contextual variables in the model, inclusion complicates the calculation of synthetic estimates. Since the goal of our study was to provide a practical and easily administered tool for producing synthetic estimates we elected to omit nonsignificant variables from our model.

Similarly, although the continuous form of the poverty variable might seem preferable from a statistical perspective, differences in conclusions between the continuous and the categorical form of the variable were negligible, and as results and examples could more easily be presented with the categorical variable, results presented are for the latter.

The fit of this model was evaluated with the log-likelihood ratio chi-square statistic. Since the statistic was nonsignificant, the use of the model was supported. The need for pairwise interactions of the variables was evaluated and determined to be unnecessary.

Further evaluation of the fit of the model was done as described in the Appendix, and by plotting the observed age-specific rates of dependency and the regression-predicted rates of dependency. Both ADL and IADL predicted rates closely approximate the observed rates (Figure 1). However, when the population

TABLE 2—Percentages of ADL Dependent Americans Age 65 and Over Living in the Community by Age, Sex, and Race: Regression-adjusted Estimates

Race	Sex	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over
Low (<8%) Poverty Community							
White	Male	2.5	3.2	4.9	9.1	18.8	4.3
	Female	2.8	3.4	5.1	9.0	17.4	5.6
	Both	2.7	3.4	5.1	9.0	17.7	5.1
All Others	Male	3.7	4.6	7.0	12.4	24.1	6.5
	Female	3.9	4.8	7.0	11.7	21.1	6.1
	Both	3.8	4.8	7.0	11.8	23.0	6.2
All races	Male	2.7	3.3	5.1	9.3	19.9	4.5
	Female	2.9	3.6	5.3	9.3	17.5	5.6
	Both	2.8	3.5	5.2	9.3	18.1	5.2
Moderate (8–15%) Poverty Community							
White	Male	3.5	4.4	6.7	12.1	23.9	6.4
	Female	3.8	4.7	6.9	11.7	21.5	7.2
All Others	Male	5.1	6.3	9.4	16.2	29.7	7.9
	Female	5.3	6.4	9.1	14.8	25.5	9.0
	Both	5.2	6.4	9.3	15.3	26.4	8.5
All Races	Male	3.7	4.6	6.9	12.4	24.0	6.5
	Female	3.9	4.8	7.0	11.9	21.7	7.3
	Both	3.8	4.7	6.9	12.0	22.4	7.0
High (>15%) Poverty Community							
White	Male	4.9	6.1	9.1	15.9	29.7	8.4
	Female	5.2	6.3	9.1	14.9	26.2	9.0
	Both	5.1	6.2	9.1	15.3	27.3	8.8
All Others	Male	7.0	8.5	12.5	20.7	35.9	11.4
	Female	7.1	8.4	11.8	18.4	30.2	11.3
	Both	7.1	8.5	12.0	19.0	32.3	11.3
All Races	Male	5.2	6.4	9.7	16.4	30.6	8.9
	Female	5.5	6.7	9.5	15.5	26.7	9.4
	Both	5.3	6.6	9.6	15.8	28.0	9.2

is divided into smaller subgroups, such as females of a race other than White, the model fits somewhat less well, but this could be due to the greater variability in those cases from reduced sample size.

Table 2 presents regression-adjusted estimates of the prevalence of ADL dependency, and Table 3 of IADL dependency. Because the poverty variable has three values—less than 8 percent (low); between 8 and 15 percent (moderate); and over 15 percent (high) of the population age 65 and over residing in poverty—three sets of estimates were produced.

Results showed the relative likelihood of both ADL and IADL dependency increases quadratically with age, is higher if of a race other than White, and increases with an increasing percent of the population age 65 and over residing in poverty. The likelihood of IADL dependence is higher if female, but the relative likelihood of being ADL dependent if female varies across age, race, and poverty groups. Although it is in general higher for females than males until age 80 in communities of low and moderate levels of poverty, and until age 75 for those in high poverty communities, after these ages the percent of noninstitutionalized males with an ADL impairment is either equal to or greater than that of females.

Regression-Adjusted Synthetic Estimates

Although Medicare Enrollment Statistics were the best available population data, two adjustments had to be made. First, because approximately 5 percent of the population age 65 and over is not enrolled in Medicare, the numbers were inflated to reflect the total population age 65 and over. The percent of the population age 65 and over enrolled in Medicare varies little across sex or family income groups, but does differ across race groups,[36] therefore the number of White Medicare enrollees was inflated by 4.4 percent, and the number of all other enrollees was inflated by 13.5 percent.

Second, because Medicare Enrollment data include both the noninstitutionalized and institutionalized age 65 and over population, and rates produced from our analysis are applicable for the noninstitutionalized population only, the numbers therefore were deflated to remove the noninstitutionalized age 65 and over population.

Using the 1985 National Nursing Home Survey and the 1985 National Health Interview Survey, a logistic regression equation was produced to estimate rates of institutionalization among the age 65 and over population at the national level. Candidate explanatory variables for inclusion in the model included those available on the merged data set for which corresponding population data existed. Given this constraint, age (in five-year intervals from 65 to 85 and over), sex, race (White and all others), and geographic region (northeast, north central, south, and west), as well as their pairwise interactions and transformations were available for use. Region was included because the supply of nursing home beds varies geographically.[37] The model found to best fit the data included age, age-squared, sex, and an indicator variable reflecting whether or not the individual resided in the north central region of the country. Estimates produced from the model were used to deflate the state and county population data to be representative of the noninstitutionalized age 65 and over population (results are available from the authors).

By applying the regression-adjusted rates of dependency to the adjusted Medicare data, synthetic estimates of the functionally dependent noninstitutionalized age 65 and over population were produced for each state, and the largest county in each state (Tables 4 and 5).

These estimates are based upon three assumptions. First, that the race, sex, age, and poverty-specific disability rates from the 1984 Supplement on Aging did not change between 1984 and 1986. Second, that the relationship between dependency and race, sex, age, and the percent of the population age 65 and over residing in poverty is the same for each state and its largest county as it is for the nation. And third, that race, sex, age, and the percent of the population age 65 and over residing in poverty are the only important predictors of functional dependency. Thus, the estimates will err to the extent that the relationship between dependency and race, sex, age, and poverty in a community has changed over time; the extent that the relationships vary from national averages; and the extent to which other known or unknown factors

TABLE 3—Percentages of IADL Dependent Americans Age 65 and Over Living in the Community by Age, Sex, and Race: Regression-adjusted Estimates

Race	Sex	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over
Low (<8%) Poverty Community							
White	Male	5.2	6.6	8.9	12.5	17.3	7.3
	Female	11.7	14.4	18.8	25.2	32.5	17.5
	Both	8.7	11.5	14.5	22.0	29.4	13.5
All Others	Male	7.5	9.3	12.3	16.7	21.7	10.3
	Female	16.2	19.7	25.0	32.0	38.7	21.1
	Both	12.0	17.0	17.7	29.3	27.7	16.7
All Races	Male	5.5	6.8	9.2	12.7	18.2	7.6
	Female	12.2	15.2	19.2	25.9	32.8	17.9
	Both	9.1	12.2	14.7	22.7	29.2	13.8
Moderate (8–15%) Poverty Community							
White	Male	6.3	7.8	10.4	14.4	18.9	9.0
	Female	13.8	16.9	21.7	28.2	34.8	19.9
	Both	10.4	13.1	17.3	23.5	29.9	15.5
All Others	Male	8.9	11.0	14.3	18.8	23.1	11.8
	Female	18.9	22.7	28.2	35.0	40.4	25.2
	Both	13.8	17.6	21.4	28.9	36.6	19.1
All Races	Male	6.5	8.1	10.7	14.6	19.1	9.2
	Female	14.1	17.3	22.0	28.6	35.1	20.2
	Both	10.6	13.4	17.5	23.8	30.2	15.7
High (>15%) Poverty Community							
White	Male	7.5	9.3	12.2	16.3	20.3	10.5
	Female	16.2	19.6	24.7	31.1	36.5	22.1
	Both	12.4	15.2	19.7	25.9	31.1	17.3
All Others	Male	10.5	12.8	16.3	20.8	24.1	14.1
	Female	21.7	25.8	31.4	37.6	41.3	28.3
	Both	17.3	21.1	25.5	33.5	35.0	23.1
All Races	Male	7.9	9.8	12.9	16.8	20.9	11.0
	Female	17.0	20.8	25.9	32.3	37.1	23.2
	Both	13.1	16.2	20.7	27.1	31.6	18.3

which are not in the model strongly influence functional dependency.

Discussion

Using log-linear models, regression-adjusted synthetic estimates of the rates of two levels of functional dependency among the noninstitutionalized age 65 and over population were produced. Age, sex, race, and the percent of the population age 65 and over who reside in poverty were found to be significant predictors of ADL and IADL dependency among the noninstitutionalized population age 65 and over.

Introduction of a contextual variable into the regression model appears overdue given that estimated rates are substantially affected by the poverty variable. The results here, which are consistent with other researchers' work, suggest that just as poverty is a strong correlate of many unwanted problems in youth and adulthood, so too its sequelae are present in old age, manifesting as higher dependency rates.

Results here also confirm the strong relationship reported by other researchers between dependency and age, as well as the variation in age-specific rates of dependency between men and women, and Whites and all other races. While explication of the underlying determinants of these variations is beyond the scope of this paper, reconfirming their importance suggests the need for policies and research agendas sensitive to these relationships and variations. Of particular importance is the quadratic relationship between age and dependency, meaning that with each passing five-year interval rates of dependency increase at an increasing rate—a sobering prospect given the rapid expansion of the oldest old population.

The percentages generated with the regression models (Tables 2 and 3) can be multiplied by corresponding population estimates for specific geographic areas of interest to generate regression-adjusted synthetic estimates of dependency (similar to those in Tables 4 and 5) among the noninstitutionalized age 65 and over population.

Such estimates are likely to be most useful as a gauge of the size of the long-term care population in subnational areas. They may also be of use as initial building blocks for estimating demand for formal long-term care services. While functional dependency estimates will not translate directly to service demand without other important measures (i.e. income, price, preferences, and other need measures such as social support), previous research has shown that utilization of formal health care services is closely related to need.[38,39] Furthermore, the usefulness of the methods outlined here will be greatly enhanced by the 1990 US Census, which will make age, sex, race, and poverty data widely available.

Finally, it should be noted that while the analysis supports the use of these equations to produce small area estimates of functional dependency among the noninstitutionalized age 65 and over population, the quality of the small area estimates produced by them still needs to be evaluated in future research using geographic indicators (not presently available for public use) which permit comparison of synthetically produced estimates with direct estimates from adequately large samples for the same small areas. □

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TABLE 4—1986 Dependent Noninstitutionalized Population Age 65 and over by State: Regression-adjusted Synthetic Estimates

State	Percent Dependent			Number Dependent		
	Total	ADL	IADL	Total	ADL	IADL
District of Columbia	33.3	11.4	21.9	23,805	8,134	15,671
Mississippi	30.1	10.4	19.7	89,953	31,064	58,889
Louisiana	29.3	10.1	19.2	125,130	42,983	82,147
Alabama	28.9	9.8	19.1	136,220	46,280	89,940
Georgia	28.6	9.6	19.0	163,071	54,646	108,425
South Carolina	28.2	9.4	18.8	95,562	31,845	63,717
Missouri	28.2	9.7	18.5	180,495	61,902	118,593
Arkansas	28.1	9.7	18.5	90,470	31,139	59,331
Oklahoma	28.1	9.7	18.5	107,760	37,049	70,711
Tennessee	28.1	9.5	18.5	154,822	52,591	102,231
South Dakota	28.0	9.8	18.2	26,148	9,186	16,962
Virginia	28.0	9.5	18.6	158,247	53,509	104,738
North Carolina	28.0	9.4	18.6	195,934	65,655	130,279
Texas	27.8	9.5	18.3	409,903	139,822	270,081
Kentucky	27.7	9.5	18.2	115,895	39,612	76,283
Maine	27.6	9.5	18.1	41,482	14,291	27,191
North Dakota	27.5	9.7	17.9	22,777	7,993	14,784
West Virginia	27.3	9.3	18.0	65,472	22,317	43,155
New Mexico	26.7	9.2	17.5	36,127	12,405	23,722
Idaho	26.3	9.1	17.2	27,933	9,641	18,292
Hawaii	25.8	8.3	17.5	27,006	8,674	18,332
Nebraska	24.0	7.7	16.4	47,939	15,291	32,648
New York	24.0	7.5	16.6	521,526	162,389	359,137
Kansas	23.9	7.6	16.3	72,273	22,868	49,405
Iowa	23.7	7.5	16.2	91,976	29,141	62,835
Minnesota	23.6	7.5	16.1	114,774	36,478	78,296
Massachusetts	23.6	7.3	16.3	177,057	55,050	122,007
Maryland	23.5	7.2	16.3	103,331	31,767	71,564
Illinois	23.5	7.3	16.2	300,132	92,840	207,292
Rhode Island	23.3	7.2	16.1	31,443	9,707	21,736
Vermont	23.2	7.3	15.9	14,244	4,470	9,774
Indiana	23.1	7.1	15.9	141,704	43,800	97,904
Delaware	23.0	7.1	15.9	15,969	4,920	11,049
Connecticut	23.0	7.1	15.9	92,857	28,771	64,086
Wisconsin	23.0	7.2	15.8	136,679	42,885	93,794
New Jersey	23.0	7.1	15.9	215,410	66,269	149,141
Ohio	23.0	7.1	15.9	284,862	87,738	197,124
Pennsylvania	23.0	7.1	16.0	376,538	115,873	260,665
New Hampshire	22.9	7.1	15.8	26,237	8,155	18,082
Colorado	22.9	7.2	15.7	63,173	19,751	43,422
Michigan	22.9	7.0	15.8	229,029	70,624	158,405
Florida	22.7	7.1	15.6	426,861	133,050	293,811
Wyoming	22.6	7.1	15.5	8,928	2,814	6,114
Oregon	22.6	7.1	15.5	77,330	24,273	53,057
Washington	22.6	7.1	15.5	111,303	34,826	76,477
Montana	22.5	7.1	15.4	20,813	6,567	14,246
Utah	22.3	7.0	15.3	27,495	8,577	18,918
Arizona	21.8	6.7	15.1	82,697	25,501	57,196
Alaska	21.5	6.6	14.8	3,676	1,138	2,538
Nevada	20.4	6.2	14.2	19,249	5,845	13,404
California	19.4	5.5	13.9	521,891	147,505	374,386

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TABLE 5—1986 Dependent Noninstitutionalized Population Age 65 and over by County: Regression-adjusted Synthetic Estimates

County	Percent Dependent			Number Dependent		
	Total	ADL	IADL	Total	ADL	IADL
New Orleans, LA	31.5	10.8	20.7	19,335	6,630	12,705
Fulton, GA	31.1	10.5	20.6	18,991	6,416	12,575
Hinds, MS	30.6	10.5	20.2	8,150	2,787	5,363
Shelby, TN	30.4	10.4	20.0	23,878	8,138	15,740
Jefferson, AL	30.2	10.3	19.9	25,716	8,756	16,960
Baltimore City, MD	30.1	10.2	19.9	31,189	10,547	20,642
Philadelphia, PA	29.7	10.0	19.7	71,559	24,182	47,377
Pulaski, AR	29.0	9.8	19.1	10,363	3,520	6,843
Dade, FL	28.9	10.0	18.9	66,997	23,245	43,752
Oklahoma, OK	28.2	9.6	18.6	18,351	6,231	12,120
Greenville, SC	27.4	9.1	18.3	9,490	3,144	6,346
Marion, IN	27.3	7.8	19.6	16,774	4,757	12,017
Honolulu, HI	25.9	8.2	17.6	19,656	6,263	13,393
Denver, CO	24.5	7.7	16.8	15,395	4,838	10,557
Queens, NY	24.4	7.5	16.8	61,693	19,097	42,596
Wayne, MI	24.2	7.5	16.7	59,915	18,469	41,446
Douglas, NE	24.1	7.5	16.6	9,993	3,109	6,884
Jefferson, KY	24.1	7.4	16.7	19,164	5,889	13,275
Multnomah, OR	24.1	7.6	16.5	19,274	6,069	13,205
Hennepin, MN	24.1	7.6	16.6	25,701	8,071	17,630
Mecklenburg, NC	24.0	7.3	16.7	10,008	3,041	6,967
Los Angeles, CA	24.0	7.5	16.5	184,822	57,601	127,221
Cass, ND	23.8	7.6	16.2	2,056	655	1,401
Cook, IL	23.8	7.3	16.5	135,009	41,486	93,523
Polk, IA	23.7	7.3	16.4	7,964	2,464	5,500
Harris, TX	23.7	7.2	16.4	38,936	11,922	27,014
Providence, RI	23.6	7.3	16.3	20,369	6,300	14,069
Chittenden, VT	23.5	7.3	16.2	2,276	704	1,572
Minnehaha, SD	23.5	7.4	16.1	3,007	947	2,060
Cumberland, ME	23.5	7.3	16.2	6,954	2,171	4,783
Cuyahoga, OH	23.4	7.2	16.3	47,719	14,604	33,115
New Castle, DE	23.2	7.1	16.0	10,037	3,083	6,954
King, WA	23.2	7.2	15.9	34,343	10,715	23,628
Sedgwick, KS	23.1	7.1	16.0	9,250	2,848	6,402
New Haven, CT	23.1	7.2	16.0	24,590	7,607	16,983
Laramie, WY	23.0	7.3	15.7	1,303	411	892
Hillsborough, NH	23.0	7.1	15.9	7,336	2,259	5,077
Kanawha, WV	22.8	7.0	15.8	6,925	2,121	4,804
Salt Lake City, UT	22.5	7.0	15.5	11,630	3,613	8,017
Yellowstone, MT	22.3	7.0	15.4	2,552	794	1,758
Henrico, VA	22.3	6.7	15.6	2,813	848	1,965
Ada, ID	22.3	6.9	15.4	4,059	1,261	2,798
Bernalillo, NM	22.2	6.8	15.3	9,109	2,800	6,309
Maricopa, AZ	22.0	6.8	15.2	46,918	14,419	32,499
Anchorage, AK	20.2	6.0	14.2	1,168	346	822
Clark, NV	20.2	6.1	14.1	11,017	3,321	7,696
Middlesex, MA	20.1	5.7	14.4	32,144	9,062	23,082
Milwaukee, WI	19.9	5.6	14.3	24,335	6,812	17,523
St. Louis, MO	19.4	5.4	14.0	21,853	6,088	15,765
Bergen, NJ	18.9	5.3	13.6	21,774	6,080	15,694

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APPENDIX

To assess goodness-of-fit the model was first applied to the second half of the data set, and its goodness-of-fit was evaluated with the chi-square statistics associated with the individual parameters and with the lack-of-fit statistic.

Second, the model was applied to the entire sample to test the fit of the estimated coefficients. This was done by including an indicator variable representing the half of the data set from which each observation came, as well as all of its pairwise interactions with the other variables in the model.

Third, goodness-of-fit of the model was evaluated by comparing the similarity of the model-predicted dependency rates with their observed counterparts in the other half of the data set. In so doing, the candidate models were used to determine the predicted values of the probability of dependence for individuals in the other half of the data base. The differences between these predicted values and their true value gives a residual value for that individual. The closeness of the averages of the residuals to zero for various subgroups of individuals (e.g. males, females, different age groups, etc.) and lack of correlation of the residuals with characteristics of individuals are indicative of goodness-of-fit. In addition, Pearson correlations were evaluated for the residuals and each of the explanatory variables, and their low values supported the fit of the model.

TABLE A-1—Direct Point Estimates of the Number of Noninstitutionalized Americans Ages 65 and over Who Were Functionally Dependent in 1984 by Age, Sex, and Race

		Personal Care Dependent[a]						Mobility or Household Activity Dependent[b]					
Race	Sex	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over
White	Male	164,644	143,520	147,240	87,750	111,319	654,473	255,589	238,009	185,456	121,775	114,223	915,052
	Female	157,176	190,273	192,626	234,942	286,274	1,061,291	608,833	629,901	668,388	479,112	422,742	2,808,976
	Both	321,820	333,793	339,866	322,692	397,593	1,715,764	864,422	867,910	853,844	600,887	536,965	3,724,028
Other	Male	20,095	15,920	27,803	17,060	12,628	93,506	34,700	35,507	12,834	12,037	6,461	101,539
	Female	27,466	29,173	32,021	24,656	30,263	143,579	88,035	129,402	93,806	60,226	33,796	405,265
	Both	47,561	45,093	59,824	41,716	42,891	237,085	122,735	164,909	106,640	72,263	40,257	506,804
All Races	Male	184,739	159,440	175,043	104,810	123,947	747,979	290,289	273,516	198,290	133,812	120,684	1,016,591
	Female	184,642	219,446	224,647	259,598	316,537	1,204,870	696,868	759,303	762,194	539,338	456,538	3,214,241
	Both	369,381	378,886	399,690	364,408	440,484	1,952,849	987,157	1,032,819	960,484	673,150	577,220	4,230,832

[a]Personal care dependent includes bathing, dressing, toileting, transferring, or eating. Individuals classified as personal care dependent may also be dependent in mobility or household activities but are counted only as personal care dependent.

[b]Mobility or household activity includes inside mobility, outside mobility, meal preparation, grocery shopping, money management, housework (heavy and light), and telephone usage. Individuals already classified and counted in this table as personal care dependent are excluded from this category.

SOURCE: 1984 National Health Interview Survey's Supplement on Aging.

TABLE A-2—Direct Point Estimates of the Percent of Noninstitutionalized Americans Ages 65 and over Who Were Functionally Dependent in 1984 by Age, Sex, and Race

		Personal Care Dependent[a]						Mobility or Household Activity Dependent[b]					
Race	Sex	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over
White	Male	4.45	5.29	7.70	9.68	20.49	6.70	7.1	9.0	9.9	13.8	21.6	9.6
	Female	3.46	5.08	6.63	13.44	23.55	7.50	13.7	17.1	23.5	27.9	36.1	20.3
	Both	3.91	5.17	7.05	12.16	22.61	7.17	10.7	13.7	18.1	23.1	31.6	15.9
Other	Male	5.29	5.63	12.40	20.11	30.64	9.23	9.5	13.0	6.4	15.4	15.7	10.4
	Female	5.87	6.39	11.51	13.00	31.38	9.65	19.7	29.5	34.3	32.3	38.1	28.3
	Both	5.61	6.10	11.91	15.20	31.16	9.48	15.1	23.2	21.9	27.3	31.0	21.1
All Races	Male	4.53	5.32	8.19	10.58	21.20	6.93	7.3	9.3	9.5	13.9	21.2	9.7
	Female	3.69	5.22	7.06	13.40	24.13	7.70	14.2	18.4	24.5	28.3	36.2	21.0
	Both	4.06	5.26	7.51	12.44	23.23	7.34	11.1	14.6	18.5	23.5	31.5	16.4

[a]Personal care dependent includes bathing, dressing, toileting, transferring, or eating. Individuals classified as personal care dependent may also be dependent in mobility or household activities but are counted only as personal care dependent.

[b]Mobility or household activity includes inside and outside mobility, meal preparation, grocery shopping, money management, housework and laundry, or taking medications. Individuals already classified and counted in this table as personal care dependent are excluded from this category.

SOURCE: 1984 National Health Interview Survey's Supplement on Aging.

(continued)

APPENDIX (cont.)

TABLE A-3—Standard Errors for Direct Point Estimates of the Number of Noninstitutionalized Americans Ages 65 and over Who Were Functionally Dependent in 1984 by Age, Sex, and Race

		Personal Care Dependent[a]						Mobility or Household Activity Dependent[b]					
Race	Sex	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over
White	Male	22,089	17,716	19,053	16,788	15,575	44,178	28,512	35,599	19,739	16,863	15,080	51,398
	Female	61,455	20,109	23,692	21,521	25,062	24,852	41,039	34,866	52,187	28,654	31,635	97,799
	Both	30,234	32,062	31,102	27,462	30,537	81,762	52,840	44,439	60,723	30,779	37,923	114,393
Other	Male	6,615	6,695	9,789	6,726	6,028	15,914	9,992	11,011	6,021	5,462	4,759	18,232
	Female	19,032	8,025	8,729	9,101	7,743	8,847	14,699	18,944	16,384	13,098	9,883	38,966
	Both	9,418	11,479	12,331	10,894	11,348	26,045	19,473	24,630	16,333	15,095	10,408	50,672
All Races	Male	23,550	19,188	22,393	18,136	16,076	47,292	29,841	26,794	21,340	18,231	15,813	53,851
	Female	21,067	23,577	25,280	26,080	26,048	62,634	42,659	37,894	55,004	31,530	31,851	102,984
	Both	33,080	32,690	36,685	28,888	31,919	86,074	56,564	49,549	63,438	35,726	38,704	124,479

[a]Personal care dependent includes bathing, dressing, toileting, transferring, or eating. Individuals classified as personal care dependent may also be dependent in mobility or household activities but are counted only as personal care dependent.
[b]Mobility or household activity includes inside mobility, outside mobility, meal preparation, grocery shopping, money management, housework (heavy and light), and telephone usage. Individuals already classified and counted in this table as personal care dependent are excluded from this category.
NOTE: Standard errors calculated using SAS supported procedure PROC SESUDAAN.[40]
SOURCE: 1984 National Health Interview Survey's Supplement on Aging.

TABLE A-4—Standard Errors for Direct Point Estimates of the Number of Noninstitutionalized Americans Ages 65 and over Who Were Functionally Dependent in 1984 by Age, Sex, and Race

		Personal Care Dependent[a]						Mobility or Household Activity Dependent[b]					
Race	Sex	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over	Ages 65–69	Ages 70–74	Ages 75–79	Ages 80–84	Ages 85 & Over	Ages 65 & Over
White	Male	.60	.61	.94	1.97	2.73	.45	.71	.91	.10	.19	2.70	.47
	Female	.45	.64	.69	1.23	1.68	.40	.84	.91	1.59	1.67	2.01	.62
	Both	.37	.48	.59	.98	1.48	.31	.58	.65	1.16	1.23	1.75	.41
Other	Male	1.80	2.32	4.22	6.84	11.67	1.43	2.50	3.75	2.64	6.09	9.27	1.62
	Female	1.81	2.02	3.26	3.78	8.08	1.16	2.68	3.04	4.27	5.12	8.24	1.90
	Both	1.23	1.61	2.23	3.48	7.06	.91	2.09	2.69	2.70	4.32	6.48	1.52
All Races	Male	.58	.60	.98	1.96	2.66	.43	.67	.87	.97	1.79	2.62	.45
	Female	.44	.55	.74	1.17	1.60	.37	.82	.85	1.51	1.49	1.85	.58
	Both	.37	.44	.62	.94	1.43	.30	.57	.63	1.08	1.13	1.61	.40

[a]Personal care dependent includes bathing, dressing, toileting, transferring, or eating. Individuals classified as personal care dependent may also be dependent in mobility or household activities but are counted only as personal care dependent.
[b]Mobility or household activity includes inside and outside mobility, meal preparation, grocery shopping, money management, housework and laundry, or taking medications. Individuals already classified and counted in this table as personal care dependent are excluded from this category.
NOTE: Standard errors calculated using SAS supported procedure PROC SESUDAAN.[40]
SOURCE: 1984 National Interview Survey's Supplement on Aging.