

# An Operational Definition of the Homebound

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*Homebound status is a critical eligibility criterion for Medicare reimbursement of some home care services, yet little discussion has been undertaken to establish a valid definition of it. We propose an operational definition of homebound status, and we measure its validity for community-dwelling elderly in the Massachusetts Health Care Panel Study (MHCPS). The MHCPS is a longitudinal study of a cohort of elderly persons (N = 1,625), which began in 1974, with follow-up surveys in 1976, 1980, and 1985. Validity was measured by comparing responses from the operational measure to persons' responses to questions that we judged should be associated with a valid measure of homebound status. This construct validity method resulted in correlations that were significant and in the expected direction, and that suggested that this operational measure is a highly specific, moderately sensitive, valid measure. These results underscore the need for researchers investigating the homebound to discuss the validity and limitations of their homebound measures, and in what context these measures are useful.*

Progress in health services research depends greatly on the development of valid measures of explanatory variables of health services use.

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Homebound status is one such variable, which may predict the need for more intensive and costly services, based on recent changes in Medicare. With the 1980 Omnibus Reconciliation Act, Medicare eligibility and benefits for home health care were expanded. In order to meet eligibility requirements for Medicare home care, a patient who needs skilled services must be considered "homebound" and certified as such by a physician; persons are homebound if leaving home requires a "taxing effort" and necessitates the assistance of another person or supportive device (Social Security Administration 1989). Although research on delivery of home health care has been reported, there has been little discussion or consensus regarding what validly defines homebound status. The purposes of our analyses are to propose an operational definition of homebound status; to measure its validity in a community-dwelling sample of elderly persons, while discussing its limitations; and to describe the characteristics of the homebound over a nine-year period.

## METHODS

Data for these analyses were from the Massachusetts Health Care Panel Study (MHCPS) (Branch 1988). The four-"wave" MHCPS began in 1974-1975 as a statewide survey of noninstitutionalized persons aged 65 years and older living in Massachusetts. A structured questionnaire was administered in respondents' homes to 1,625 persons at wave 1 (response rate of 79 percent). In 1976, 15 months later, 1,317 persons were interviewed in wave 2. In the interim, 102 had died, 27 had entered nursing homes, and 179 were lost to follow-up. In the third wave (year 6), 825 elderly persons were interviewed in their homes; 61 were in nursing homes; an additional 316 had died; and an additional 142 had moved, refused to participate, or otherwise were lost to follow-up. The fourth wave was conducted in 1985 from 540 respondents. From wave 3 to wave 4, 270 had died, 62 were in nursing homes, and 44 were lost to follow-up. The sample taken at wave 1 was representative of elderly households in Massachusetts, and at waves 2 and 3, participants did not significantly differ from those lost to follow-up (Branch 1988; Branch and Ku 1989). By wave 4, persons who participated by interview were significantly younger, more likely to have been married at wave 1, and to have had a higher household income in 1974, when compared to those who had been lost to follow-up (Gilbert, Branch, and Orav 1990).

Beginning in wave 2 and thereafter, respondents were asked, "About how often do you get out of your house/building for any reason?" and were read a six-point scale of frequency: almost every day, a few times a week, once a week, several times a month, less than several times a month but more than just for emergencies, and never or almost never except for emergencies. Those who answered "never or almost never except for emergencies" were operationally defined as "homebound" for the analyses in this report.

The primary intent of these analyses was to assess the validity of this question as a measure of homebound status. However, what constitutes validity is not absolute. To help minimize confusion, the American Psychological Association (APA) (1974) has defined three types of validity: criterion, content, and construct validity. We relied on measures of construct validity in these analyses due to the lack of a single criterion or "gold standard." That is, instead of seeking perfect correlation with a gold standard, we used questions (reported behaviors) that, in our a priori judgment, should theoretically be correlated with the behavior of persons who are truly homebound. We then compared these behaviors against the operational definition.

We calculated contingency coefficients (Kendall and Stuart 1979) and estimates of sensitivity and specificity in order to measure the validity of the operational definition. In our context, sensitivity is defined as the probability of being classified as homebound using the operational definition, when the "criterion standard" is consistent with being "homebound." Specificity is the probability of being classified non-homebound when the "criterion standard" is consistent with being "non-homebound." This construct validity method, at a fundamental level, is an assessment of whether those persons classified as homebound and non-homebound truly acted the way one would expect homebound and non-homebound people to act. They were asked to respond "yes" or "no" to the following questions: (1) "Are you able to do heavy work around the house, like washing windows, walls, or floors without help?"; (2) "Are you able to walk up and down stairs to the second floor without help?"; (3) "Are you able to walk half a mile without help? That's about eight ordinary blocks."; and (4) "Did you go to a senior center or any other place to get hot meals during the last 12 months?" Persons were asked to respond "frequently," "sometimes," "rarely," or "never" to the following questions: (1) "How often do you take walks in good weather?"; (2) "How often do you work in the garden in the spring or summer?"; (3) "At least once a week do you engage in any regular activity like brisk walking, jogging, bicycling, and so forth, long enough to work up a sweat?" Responses to these last

three questions were dichotomized to "some" or "never" before correlation and sensitivity/specificity statistics were determined. One final combined measure was constructed by identifying persons who answered "no" or "never" to all seven of the above indicators of homebound status.

To assess construct validity further, we hypothesized that homebound persons would be more functionally impaired, both in physical function and cognitive function. Two measures of physical function were used: activities of daily living (ADL) (Katz, Ford, Moskowitz, et al. 1963; Branch et al. 1984) and the Rosow-Breslau functional health scale (Rosow and Breslau 1966). ADL status designates persons who report using assistance from another person when performing the activities of bathing, dressing, eating, transferring, toileting, or walking across a small room. The functional health scale identifies those who report that they are unable to walk half a mile, climb stairs, or do heavy housework.

Cognitive function was assessed using tests of immediate memory, attention, and capacity to perform serial mental operations. To test immediate memory, interviewers read respondents a brief story composed of six general ideas, as previously reported by Scherr and colleagues (Scherr, Albert, Funkenstein, et al. 1988) and by Evans and colleagues (Evans, Scherr, Cook, et al. 1987). Persons who reported all of the ideas or were missing only one were scored as "correct." Attention was tested by asking the respondent to repeat immediately a series of five numbers; those unable to repeat five were asked to repeat a series of four numbers. These series were taken from the Wechsler Adult Intelligence Scale (Wechsler 1958). Persons were also asked to count down from 20 by sevens as a measure of capacity to perform serial operations (Pfeiffer 1975). Response to each of the four questions was scored as "correct" or "incorrect," and cognitive status was scored on a 0 to 4 scale.

We hypothesized that more homebound persons correctly classified would deteriorate with time to the point of being admitted to a nursing home or of dying, when compared to the community-dwelling non-homebound. Mortality was uniformly ascertained by searching Massachusetts death records, and by inquiry of knowledgeable relatives. Information regarding nursing home placement at the time of interview was easily obtained, but information on nursing home placement subsequent to the previous interview but prior to death may have been undercounted.

In order to measure the association of homebound status with in-home service use, persons were classified as users of in-home services if

they reported using one or more of the following services within the past 12 months: (1) in-home hot meal service, (2) agency help for household chores, or (3) in-home nursing service.

All analyses reported here were done using the Statistical Analysis System (SAS) in the mainframe (version 5.18) or microcomputer (version 6.03) environments (SAS Institute 1988). Findings of statistical significance were based on  $p$ -values of less than .05.

## RESULTS

Reliability of the question used for the operational definition was ascertained using a telephone-administered retest on 56 persons an average of 99 days after the wave 3 survey. The Spearman's correlation coefficient was .67 for the six-point scale. Because an average of three months elapsed between test and retest, this reliability estimate may be confounded by the temporal lability of homebound status.

Table 1 lists the criterion standards against which we compared our operational definition of homebound status. Our summary measure of association, the contingency coefficient ( $cc$ ), is not shown in this table, but all of the coefficients were in the expected direction and, except for one case ( $p = .055$ , for the "senior center" question), were significantly different from zero. The magnitudes ranged from .08 for the senior center question to .51 for all seven variables combined (the  $cc$  varies inversely with the sample size, and .71 represents perfect association in this sample). The three functional health scale items listed were also asked in waves two and three, and their associations with the operational measure were computed. The results were very similar and are not reported here. Because the homebound sample in wave 4 was the largest, and because the findings in waves 2 and 3 are largely redundant, we have presented results only for wave 4.

Although the  $cc$ 's provided valuable information, they do not fully represent the relation between the operational measure and those questions against which the measure was compared. For example, we observed that even when the  $cc$  was small, as in the senior center question, all of those who were classified as homebound had acted the way homebound persons should act, in our judgment, if they had been correctly classified. Consequently, we used specificity and sensitivity as additional indicators of validity (Table 1). Sensitivities ranged from 8 percent to 60 percent, and specificities ranged from 97 percent to 100 percent. Predictive values positive ranged from 66 percent to 100 percent, and predictive values negative ranged from 8 percent to 96 per-

Table 1: Sensitivity, Specificity, and Predictive Values of an Operational Definition of the Homebound, Wave 4

Construct Validity Variable	Percent Sensitivity* (95% CI)	Percent Specificity* (95% CI)	Percent Predictive Value Positive* (95% CI)	Percent Predictive Value Negative* (95% CI)
Got hot meal at senior center?	8 (6,10)	100 (100)	100 (100)	8 (6,10)
Exercise at least once a week?	9 (7,11)	100 (100)	100 (100)	14 (11,17)
Work in garden?	13 (10,16)	100 (100)	100 (100)	13 (10,16)
Able to do heavy work?	17 (14,20)	99 (98,100)	95 (93,97)	62 (58,66)
Able to walk half a mile?	20 (17,23)	99 (98,100)	93 (91,95)	70 (66,74)
Take walks in good weather?	27 (23,31)	98 (97,100)	83 (80,86)	81 (78,84)
Able to climb stairs?	35 (31,39)	98 (97,100)	76 (72,80)	88 (85,91)
All seven combined	60 (56,64)	97 (96,98)	66 (62,70)	96 (94,98)

\*Values for sensitivity, specificity, and predictive values were calculated according to the following 2 x 2 table and accompanying formulas:

Diagnostic Standard  
(able to . . . ?, do you . . . ?)

	Consistent with Homebound	Consistent with Non-Homebound	
Operational Measure	Homebound	A	B
	Non-Homebound	C	D

Sensitivity =  $A/(A + C)$   
 Specificity =  $D/(D + B)$   
 Predictive value + =  $A/(A + B)$   
 Predictive value - =  $D/(C + D)$

cent. Similar sensitivity/specificity results were obtained with the three functional health scale items in waves 2 and 3, and are not reported here. These sensitivity/specificity results indicated that the operational measure identified the majority of those who reported a behavior consistent with being homebound and, at the same time, those identified as non-homebound almost always reported behaviors that were inconsistent with being homebound. Note that sensitivity increased when a person had to have reported behaviors consistent with being homebound in all of the diagnostic standards.

Table 2 compares characteristics of those classified as homebound with those classified as non-homebound. The homebound were significantly more dependent in both of the measures of physical function. They were also significantly more cognitively impaired, older, and less educated; held fewer assets (stocks and savings); were more incontinent of bladder and bowel; were more likely to be bedbound; and were significantly less likely to live alone. The homebound were also more apt to have used in-home services, to have been hospitalized, or to have visited a physician within the preceding 12 months.

Concerning the hypothesis that the homebound are likely to deteriorate more rapidly over time, Table 3 indicates that 67 percent (20/30) of those homebound at wave 2 were deceased four years later at wave 3, and 90 percent (27/30) were deceased nine years later at wave 4. All but two either stayed homebound or were deceased by wave 4. Of those homebound at wave 3 ( $N = 29$ ), 59 percent (17/29) were deceased five years later at wave 4. Eighty-six percent (25/29) either stayed homebound, were admitted to nursing homes, or were deceased five years later in wave 4. Note that the 29 persons homebound at wave 3 include two persons who were homebound at wave 2 and who survived and remained homebound, and 27 persons who were not homebound at wave 2 but became homebound by wave 3. In order to assess whether the homebound had a greater mortality risk, we used a log-rank test to compare the survival times in the homebound and non-homebound groups. Because of the age differences in the two groups, it was necessary, first, to stratify by age groups (wave 1 ages 65–69, 70–74, 75–79, 80–84, 85+) (Kalbfleisch and Prentice 1980). We found that persons homebound at wave 2 had a significantly greater mortality risk when followed for the subsequent nine years, compared to those who were community-dwelling non-homebound at wave 2 (Table 3). Even after stratification, however, this result might have involved some confounding by age. Similar results were found for those who were homebound at wave 3, when followed for the subsequent four years.

Table 2: Descriptive Statistics of Community-Dwelling Persons in the MHCPS, Wave 4

		<i>Percent</i>	
		<i>Non-Homebound</i>	<i>Homebound</i>
		(N = 499)	(N = 41)
Age*	75-79 years	50	22
	80-84 years	30	27
	85-89 years	15	27
	90+ years	4	24
Sex	Male	34	30
	Female	66	70
Marital status	Never married	9	7
	Currently married	39	37
	Previously married	51	56
Household composition**	Alone	43	27
	Spouse only	32	32
	Spouse/Others	7	2
	Children only	6	20
	Children/Others	4	15
	Others only	6	5
Formal education***	0-8 years	2	0
	9-12 years	31	50
	13+ years	47	45
		22	5
Total amount in stocks, savings (1984)***	< \$1000	18	39
	\$1000-\$4,999	20	22
	\$5000-\$50,000	36	17
	> \$50,000	18	12
Pretax income (1984)	< \$10,000	57	73
	\$10,000-\$50,000	41	24
	> \$50,000	3	3
Activities of daily living*	Independent	76	22
	Dependent in one or more	24	78
Functional health scale*	Independent	54	5
	Dependent in one or more	46	95
Cognitive score***†	0 no deficit	33	12
	1	39	28
	2	24	52
	3	3	4
	4 severe deficit	1	4
Frequency leaked urine in last year*	Every day	8	29
	Once per week	5	15
	Less than once per week	13	12
	Never	74	44

*Continued*



Table 2: Continued

		Percent	
		Non-Homebound (N = 499)	Homebound (N = 41)
Bowel control lost within past few months*	Yes	11	39
	No	89	61
Number days bedbound last 12 months*	None	76	50
	One week or less	16	8
	One week to one month	6	20
	One to three months	2	8
	Four or more months	0	15
Used in-home services in last 12 months*	Yes	20	59
	No	80	49
Hospitalized within the past 12 months**	Yes	26	51
	No	74	49
Number times visited or talked to physician last 12 months	None	12	18
	1-5	65	46
	6-10	17	13
	11+	7	23

\* $p < .0001$ .\*\* $p < .001$ .\*\*\* $p < .01$ .

The two-tailed Fischer exact test was used for the nominally scaled variables, and the Wilcoxon rank sum test for the ordinally scaled variables.

†This is the only item presented in Table 5 that was not asked of proxy respondents. All the other items are observable, and consequently reportable by proxies. Although only 43 proxies were in wave 4, 16 of them provided data for persons homebound at wave 4.

Using this operational definition, there was in general a unidirectional path of decline once someone became homebound. Once community-dwelling non-homebound persons became homebound, rarely did they return to non-homebound status. Rather, they maintained their homebound status, were admitted to nursing homes, or died. There were exceptions to the unidirectional pathway, however, presumably because some persons became only acutely homebound, or were admitted to a nursing home for an interim only. These exceptions were two persons who were homebound at wave 2, but were non-homebound community-dwelling at wave 3 (two others were lost to follow-up). Two of those in nursing homes at wave 2 were community-dwelling at wave 3, and one of these was homebound. Four of the 29

Table 3: Homebound Status, Mortality, and Nursing Home Admission of Persons in the MHCPS\*

<i>Subset of Interest</i>	<i>Percent of Subset at Wave 3</i>	<i>Percent of Subset at Wave 4</i>	<i>Status</i>
Homebound at wave 2 (N = 30)	6.7 66.7 6.7 6.7	6.7 90.0 0 0	Homebound Deceased† In Nursing Home§ Community-dwelling†
Homebound at wave 3 (N = 29)	100%	20.7 58.6 6.9 10.3	Homebound Deceased¶ In nursing home§ Community-dwelling†
In nursing home at wave 2 (N = 27)	3.7 70.4 14.8 3.7	3.7 81.5 7.4 0	Homebound Deceased In nursing home Community-dwelling†
In nursing home at wave 3 (N = 60)	100%	0 63.5 30.0 0	Homebound Deceased In nursing home Community-dwelling†
Community-dwelling non-homebound at wave 2 (N = 1279)	1.9 21.4 4.2 61.1	3.0 41.6 4.7 38.2	Homebound Deceased In nursing home§ Community-dwelling†
Community-dwelling non-homebound at wave 3 (N = 796)	100%	4.4 23.7 5.0 61.4	Homebound Deceased In nursing home§ Community-dwelling†

\*Totals do not add to 100 percent due to loss to follow-up or missing data.

†But not homebound.

‡Persons homebound at wave 2 had a significantly higher mortality rate over the subsequent nine-year period compared to those who were community-dwelling non-homebound at wave 2. Although the analysis was stratified by age group, there still may be confounding due to age ( $p < .001$ , Mantel-Haenszel stratified log rank test, LIFETEST procedure).

§Persons homebound at wave 2 were not at greater risk for nursing home admission at subsequent waves, compared to their community-dwelling non-homebound counterparts (Mantel-Haenszel log rank test), although the majority were censored because of death or loss to follow-up. Persons homebound at wave 3 were not at greater risk for nursing home admission by wave 4 (chi-square test).

¶Persons homebound at wave 3 had a significantly higher mortality rate by wave 4 compared to those community-dwelling non-homebound at wave 3, when stratified by age ( $p < .005$ , Cochran-Mantel-Haenszel general association test, FREQ procedure).

wave 3 homebound were community-dwelling non-homebound at wave 4.

## DISCUSSION

The associations of the operational definition with the criterion standards, the sensitivities and specificities, and the outcomes of nursing home admission and death all support the validity of this operational definition. We have relied primarily on construct validity since no single gold standard exists. We conclude that this measure has construct validity. Further, it is a highly specific measure, and has a moderate sensitivity: almost all of the persons who are not homebound will be classified as such, while most of the truly homebound will be identified as homebound.

We can only speculate on the extent to which the quality of our "diagnostic standards" affected the conclusion regarding sensitivity and specificity. Surely there exist people who are only acutely homebound, possibly because of a recent hospitalization or injury. Since the diagnostic standards all incorporated only chronic aspects, we would not expect these standards to correlate highly with the operational measure in those who are only acutely homebound. Also, presumably, persons exist who are homebound because of severe cognitive impairment, and although none of our sensitivity/specificity criterion standards included mental status measures, the fact that those classified "homebound" were also apt to be more cognitively impaired may support the operational measure's construct validity. We believe that the differences in incontinence prevalences provide similar support. There also may exist those who are homebound because they simply choose not to leave the house due to fear of crime, no need for social interaction, and so forth; we might refer to these as the "socially homebound." A corollary set of questions could be developed to identify separately this subset of homebound persons. This wide range of causes of being homebound underscores the limitations of an index that includes only a single item. One's definition of homebound status should be contingent upon how one intends to make use of the definition. If one is interested in identifying as many as possible of those who are homebound, because one feels that the penalty for missing a case is high (high sensitivity), one can develop a multi-item index that encompasses the multiple dimensions of being homebound. If one is primarily interested in high specificity, and consequently a larger predictive value positive, it is less likely that someone who tests "homebound" will be non-homebound. With the

proposed definition, whether or not someone leaves the house is the *sine qua non* of the content. It does not account for those who are in need of homebound-related services but who are able to get the services they need outside the home with the help of an informal support network. Although the proposed measure is a valid one, it is only a starting point from which to refine more comprehensive definitions. Our intent is to recognize that what validly defines homebound status is a significant issue, and that researchers investigating homebound issues should not presume that a consensual definition exists.

The apparent one-directional path of decline signaled when an older person is designated as homebound is noteworthy. The assumption that older persons are at risk of unidirectional decline used to be common, but recent data relative to ADL functional limitations have indicated that as many as one-fourth to one-third of older persons completely regain independence in ADL functioning (Katz, Branch, Branson, et al. 1983; Manton 1988; Branch and Ku 1989). We speculate that elderly homebound persons have passed a threshold beyond which regained function is unlikely, while elderly people with ADL dependence still have a reasonable likelihood of regaining independence.

Home care used to be advocated as a potentially cost-effective substitute for institutional care. Subsequent investigations and reviews have suggested that home care is neither cost effective nor a substitute for institutional care (Branch, Wetle, Scherr, et al. 1988; Hedrick and Inui 1986; Kemper 1988), primarily because few home care patients are at risk for institutionalization. Researchers have posited the existence of important differences in characteristics between home care clients and nursing home patients (Branch, Wetle, Scherr, et al. 1988; Kane 1988). Some may find this counterintuitive, since both groups are usually characterized by frailty. However, our analyses provide partial support for these contentions: although the homebound are frail and at a greater risk of dying, they do not have a higher risk of nursing home placement. We find additional support for the validity of this definition—and, more importantly, for its utility—from a study done independently in East Boston (Branch, Wetle, Scherr, et al. 1988). The definition of homebound status in that study was identical to the definition in this report (Branch 1989), and was predictive of incident home care use.

The homebound in the MHCPS differed from the non-homebound in a variety of ways. Primarily, they were older and dependent in physical function, but they were also more likely to be cognitively impaired, incontinent, economically disadvantaged, and

users of in-home services, and less likely to be living alone. Kane (1988) has suggested that since home care is not necessarily substitutable for institutionalization, research should now emphasize the effective design and targeting of services to these two different groups of patients. This operational definition of homebound persons validly identifies a subset of community-dwelling persons who are homebound and in need of services.

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