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A NEW HEALTH STATUS INDEX FOR CHILDREN

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ABSTRACT

This paper is primarily an attempt to use a latent variable technique to measure health status in a system of health care demand equations. The structural model we will develop contains both causal equations and a set of health indicators, or need measures. More specifically: the need measures, such as days ill, activity limitations, subjective health rating and particular disease categories, are specified to be proportional to an overall health-status measure, which in turn is assumed to be a function of the age and sex of the child and a number of household characteristics. The need measures then enter the utilization equations indirectly through the overall health status measure. The endogenous overall health status measure can be estimated for each observation in the sample. In principle, this measure can be used for health-care planning purposes, for improving the geographical distribution of health-care services and for improving the equity of health-care utilization.

A New Health Status Index for Children

A good deal of previous research in health-related fields has been plagued by the lack of appropriate measure(s) of health status. Volumes have been written on indices (e.g. Berg, 1973) searching for the appropriate measure. Such measures would facilitate health planning, demand analysis, production-function work and distributional work. It may be that measures of health status are best designed for the specific purpose at hand--in our example for utilization analysis. The purpose may dictate whether a single or multiple measure is better suited; for example, utilization of mental health-care providers may require an index other than a broad-based health measure. For many purposes (such as health-care planning or the study of the production of health) a single measure which provides an overall view of health is clearly attractive.

A STRUCTURAL MODEL OF HEALTH-CARE UTILIZATION FOR CHILDREN

Structural Versus Reduced Form Models

The literature (see Hyman, 1971, and Feldstein, 1974, for overviews) dealing with the explanation of differences in health-care utilization--among individuals, between regions or over time--usually employs a regression model, with health-care utilization as the dependent variable and a set of other variables as exogenous explanatory variables.

An important weakness of such an approach can probably be best illustrated in the following example:

Let us assume we are interested in the income elasticity of health-care demand, and we estimate:

$$D = \alpha + \beta Y + \delta' Z$$

where D = the demand for health care

Y = income

Z = a vector of other variables

α, β and δ' are parameters.

If we find β to be positive, we conclude that health care is a "normal" good; but if β turns out to be negative, or close to zero, alternative explanations are suggested. For instance: income is positively related to health, and healthier people seek less health care. The addition of measures of health status to utilization equations is one way partially to remedy this problem.[1] However, satisfactory health measures that measure that component of someone's health status relevant for health-care utilization are generally not available, or the number necessary to measure health status would be large, and the different measures would be highly correlated.

Recently a number of authors have suggested a way to overcome the ambiguity in these types of analysis based on reduced form equations. They specify a health-care demand model as:

$$H^* = \gamma' X$$

$$D = \alpha + \beta Y + \delta' Z + \mu H^*$$

where H^* = "health," a unobservable variable (as indicated by the asterisk*)

X = a vector of variables relevant for the "production" of health[2]

μ and γ are parameters.

If measures of income (or income-related variables) are included in X, β can unambiguously be interpreted as the income effect on health-care demand. And from estimates of μ and γ the impact of income on health can be derived. Of course we do not have to restrict ourselves to analyzing the role of income. Many other variables may have an impact both on health and on health-care utilization. Thus, the quality and usefulness of health-care demand analysis can be improved if structural models are used that explicitly deal with this complication.

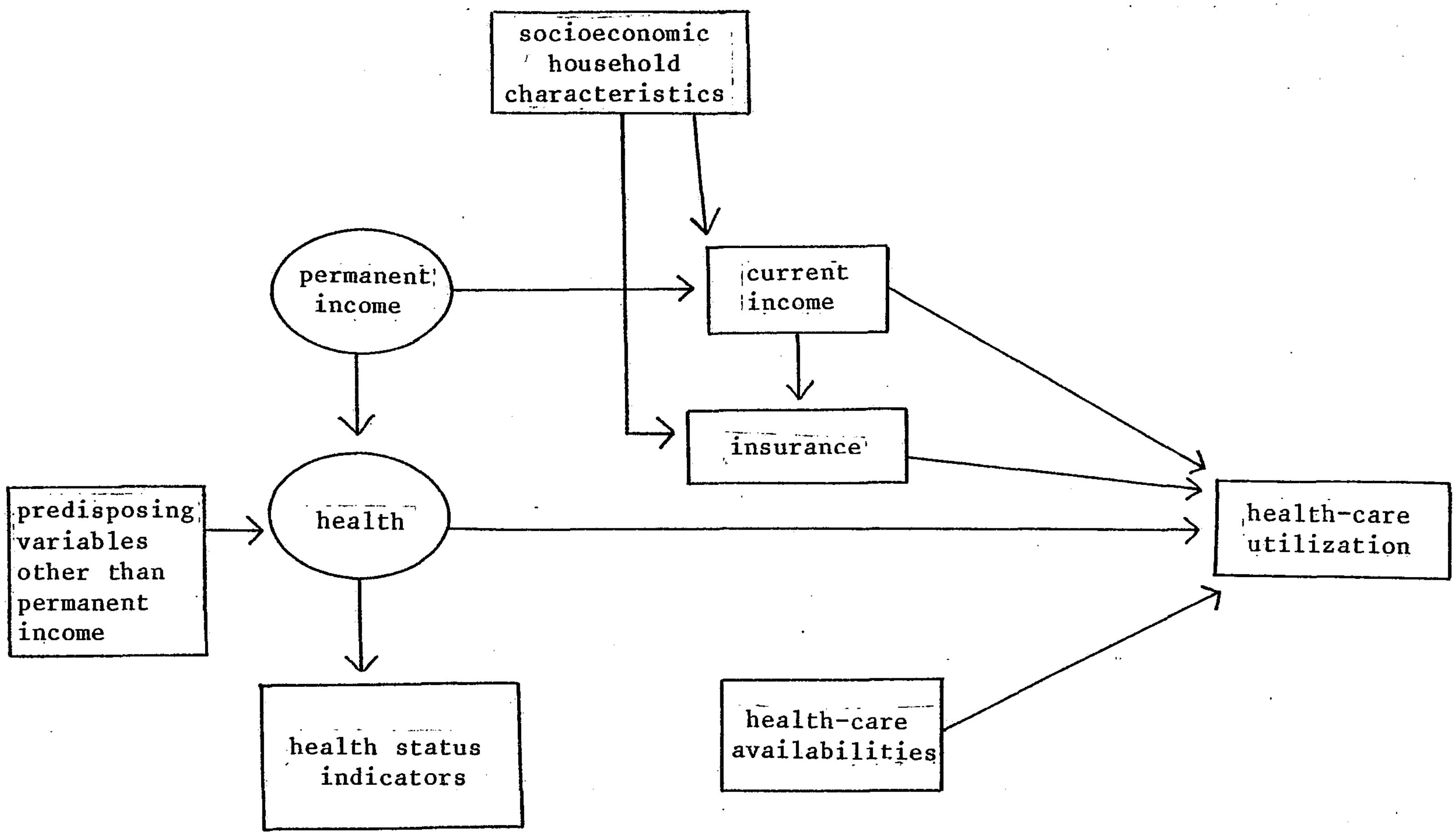
We develop a structural model of children's health-care utilization in which health status and permanent income are unobservables. Figure 1 gives a simplified pictorial presentation of the model. Socioeconomic factors ("predisposing variables") are determinants of health. These factors include age, sex, family size, and race. We have seven imperfect measures of health (need variables) to serve as indicators of the unobservable overall health status. Each of these indicators is specified to be proportional to the overall measure of health status.

Utilization is used as another indicator of health status. Utilization, however, is also determined by enabling variables, such as income, health insurance and the availability of care.

Permanent income (unobservable), representing the continuing socioeconomic level influencing someone's health, is estimated using a quasi-earnings function. Current income serves as an indicator for permanent income. It is also the relevant income variable in the utilization equations, as it represents the income flow during the period of analysis.

Health insurance is treated as endogenous in the model, thus shedding more light on the complicated role income plays in the utilization of health care. However, we avoided the complication of having health insurance be influenced by health status. This is probably less

Figure 1. Simplified scheme of the health-care utilization model.



restricted than it seems, since we restrict our analyses to observations on children of age 1-17 only.

This restricted sample has the further advantage that we do not have to deal with the possible simultaneity between health and income. Two caveats regarding the model should be mentioned in advance. First, the model puts some severe restrictions on the data. For example: since age only enters the utilization equations through the variable health, the age-utilization profiles are the same in each demand equation, apart from a multiplicative constant. Our analyzing data only on children between the ages of 1 and 17 may make this restriction less severe, but does not eliminate it.

Second, we do not specify health to be influenced by health-care utilization. Such an extension of the model calls for a dynamic model, in which present health status is influenced by past utilization, in order to avoid reversed causality problems.

Thus, this paper is but the first stage in a larger effort to estimate health-status measures from health-care demand models.

A total of seventeen equations compose the model: one for health status, seven for the health indicators, three insurance equations, four health-care demand equations, one quasi-earnings function and an indicator equation for income.

In the next sections we will present these equations in more detail.

Factors Affecting Children's Health-Care Utilization

Grossman has developed an economic model of the demand for health. The main feature of his model is that it explicitly recognizes that "what consumers demand when they purchase medical services are not these services *per se* but rather good health" (Grossman, 1972a, xiii). His theoretical model, which emphasizes the investment aspect of medical care utilization, has formed the basis for a large number of empirical studies, showing the importance of this distinction for modelling the demand for health care and for the interpretation of the estimation results.

Starting from a different angle, Andersen (1968) developed a framework within which health-care utilization can be studied. Both approaches lead to similar empirical work (see Andersen et al., 1975).

We will adopt Andersen's stratification of the data to ease the exposition of our model. Our estimation results will be discussed with reference to Grossman's and related work.

Enabling variables. The set of enabling variables include all variables that represent financial or other barriers for the utilization of health services: income, prices, insurance, and the availability of services as measured by travel time, distance, etc. Unfortunately, no prices of health-care services are available in the data. However, since we limit our empirical work to one SMSA, we do not expect this to be a large limiting factor. Measures of the enabling variables that are included in our model are given in Table 1, together with some summary statistics.

Acknowledging the fact that many of the variables that enter the demand equations for health care will also have an impact on the demand for health insurance, we treat the three insurance variables as endogenous in our model.

The insurance variables available include only type of insurance, rather than depth of coverage. We distinguish between private insurance, HMO and Medicaid coverage. To the extent insurance purchase is volun-

Table 1. Enabling Variables

Symbol	Definition	Mean	Variance
LINC	Log of total family income	4.97	.37
	Proxy variables for health-care availability:		
HOSP	Travel time to nearest hospital, in minutes	11.36	38.34
HMO	Travel time to nearest HMO-clinic	11.54	72.20
XHMO	Travel time to nearest non-HMO-clinic	14.65	64.65
PHYS	Physician/population ratio[a]	.08	.01
	Dummy variables for health-care insurance:		
INSHMO	= 1 if insured for HMO-clinic; = 0 elsewhere	.07	.07
INSPRIV	= 1 if private insurance; = 0 elsewhere	.89	.10
MCAID	= 1 if covered by Medicaid; = 0 elsewhere	.08	.08

[a]The physician/population ratio is the number of family doctors per 1000 population in the census tract, plus a weighted sum of these ratios for all other census tracts. As weights we used the travel time, in 15-minute intervals, squared.

tary, it is likely to be determined by factors related to expected medical care utilization in addition to the price of insurance; Medicaid is somewhat different since a family must meet certain criteria to be eligible.

Work-related variables are included in the health insurance demand equations to reflect the "price" of insurance; most insurance is group insurance, purchased or received as fringe benefits through an employer. Thus, we expect a mother's working to add to the availability of insurance packages which reduces the cost and thus has a positive association with private insurance and HMO insurance. Occupational variables are less clear since we expect low status occupations but also self-employed occupations to have less insurance available.

Higher income permits the purchase of more insurance, so a positive association with income is expected. More education is thought to be associated with a longer time horizon, which may suggest more insurance purchases.

In terms of expected utilization, age may represent greater need and thus be associated with greater probability of insurance purchase.[3] Greater family size, particularly given the standard package of rates for insurance, is likely to show a positive relationship. Not being married may either reduce the numbers who would use insurance and so decrease the probability of insurance purchase, or it may represent less availability (only 1 worker). In either case a negative effect of not being married is expected. Nonwhites are likely to have less insurance than whites, either because of limited availability through employment, historic patterns of less availability of medical care reducing expected utilization, or perhaps through norms regarding insurance. If some of the income is received in the form of welfare or child support, private insurance purchases are expected to be less.

The Medicaid demand equation is one that combines eligibility criteria--income, marital status, family size--with price proxies for private insurance. Income is included as a linear spline reflecting eligibility criteria; the first slope measures income up to the public assistance level, the second, income up to the medical assistance level, and the last, income above these levels. The eligibility levels are matched to families on the basis of family size (Menchik, 1977, p. 174). We expect the first two slopes to be negative and the last flat, so that those above the medical assistance level show no association with Medicaid. The first two slopes should indicate decreasing probability of Medicaid coverage as income increases, reflecting the transitory component of the income measure. Children in families without a father are most likely to receive welfare--and also Medicaid, so the expected sign is positive. Mother's working may both reduce welfare and Medicaid but also increase the availability of private insurance, so the coefficients should be negative.

In a short-hand notation we write the demand equations for health insurance as follows:

$$\eta_{1i} = \gamma'_{1i}\,\xi_1 + \varepsilon_{1i} \qquad i = 1,3 \tag{1}$$

with $\eta_1 = (\eta_{11}, \eta_{12}, \eta_{13})$ a (3x1) vector of insurance demand (INSHMO, INSPRIV, MCAID; see Table 1);

ξ_1 a (15x1) vector of exogenous variables (see Table 2; a constant term is added);

γ_{1i} a (15x1) vector of parameters, i = 1,3, some of which are *a priori* set equal to zero; and

Table 2. Household Variables Explaining Health Insurance

Symbol	Definition	Mean	Variance
LINC	Log of total family income in 00's	5.00	.33
	A linear spline in income:		
INC	Total family income (in 00's)	169	4096.30
INC-P.A.	Maximum (income-public assistance eligibility level, 0)		
INC-M.A.	Maximum (income-medical assistance eligibility level, 0)		
	Mother's employment status:		
MFULL	= 1 if mother works full-time; = 0 elsewhere	.21	.17
MPART	= 1 if mother works part-time; = 0 elsewhere	.20	.16
	Other parental variables:		
NOTMAR	= 1 if single parent; = 0 elsewhere	.13	.11
MSCHOOL	Years of schooling completed by mother	12.65	6.69
MOCC	Bogue socioeconomic index of mother's occupation	49.29	58.47
FOCC	Bogue socioeconomic index of father's occupation = 0 if father not present	49.20	461.92
MAGE	Mother's years of age	35.79	65.92
	Race of household head:		
NWHITE	= 0 if white; = 1 elsewhere	.13	.11
	Children:		
NSIB	Total number of children in the household	2.54	1.46
	Welfare recipient:		
WELF	= 1 if household receives support = 0 elsewhere	.15	.13

ε_{1i} a disturbance term, $i = 1,3$.

Predisposing variables. The set of predisposing variables contains those variables that show a clear relationship with health-care utilization (e.g., age, sex), but are themselves no reason for seeking care. Clearly the impact of these variables on health-care utilization is indirect, via the variable health. Consequently we specify the following relationship between health and a set of predisposing variables.

$$\eta_2^* = \beta_1 \eta_3^* + \gamma_2' \xi_2 + \varepsilon_2 \tag{2}$$

where η_2^* is the unobservable variable health (HEALTH*)

η_3^* is an unobservable predisposing variable ("permanent income," to be discussed below)

ξ_2 is (12x1) vector of the other predisposing variables (to be discussed below; see also Table 3)

β_1 is a parameter and

γ_2 is (12x1) vector of parameters, and

ε_2 is a disturbance term.

This equation has a twofold interpretation. First, it can be viewed as a demand equation for health. For example: since someone's health status influences the time available in the market place, the demand for good health will generally increase with someone's wage rate.

Second, Equation 2 can be interpreted as a production function of health. For instance: the efficiency of the production of good health will differ at different age levels.

Even in our restricted sample (children of age 1-17 only) a clear distinction between both interpretations cannot be made. It is unlikely that a child's demand for health care is a function of his or her price of market time, but parents have a major impact on a child's demand for health. This suggests that in families with severe time constraints (e.g., two-earner households), or with expensive market time (high wage rates) the demand for a child's health will be relatively high. On the other hand, if a parent's time does enter the production function of a child's health, one would expect relatively little time devoted to production of child's health in these families. So in some cases no unambiguous prediction of the explanatory variables on HEALTH* can be given. Regardless of which interpretation one wants to give to this equation, the variable HEALTH* can readily be interpreted as a child's health status, and we will make use of this in the final section.

The exogenous variables that enter the health equation are listed in Table 3. The first variables entering the HEALTH* equation represent the employment status of the mother. As indicated above, the expected impact of a working mother on a child's health cannot be predicted unambiguously. Generally, however, a negative or nonsignificant relationship is found (Edwards and Grossman, 1979). Mother's schooling is expected to be positively related to a child's health. More education is expected to lead to both greater demand for a child's health and more efficiency in producing it. The number of children in the household generally shows a negative impact on health-care utilization, but its effect on a child's health is unknown. To the extent the economic model of fertility is relevant, the expected effect is negative, since parents can substitute quality (health status) for quantity (number of children: Becker and Lewis, 1973).

Table 3. Exogenous Predisposing Variables

Symbol	Definition	Mean	Variance
MSCHOOL	Years of schooling completed by mother	12.48	6.87
NSIB	Total number of children in household	3.09	1.83
	<u>Race of household head</u>:		
NWHITE	= 0 if white; = 1 elsewhere	.14	.12
	<u>Mother's employment status</u>:		
MFULL	= 1 if mother works full-time; = 0 elsewhere	.19	.15
MPART	= 1 if mother works part-time; = 0 elsewhere	.19	.16
	<u>Low mother's age</u>:		
LMAGE	= 1 if age of mother below 19 when child was born; = 0 elsewhere	.07	.07
	<u>Age of child</u>:		
AGE4	= 1 if age 1-4; = 0 elsewhere	.27	.20
AGE1015	= 1 if age 10-15; = 0 elsewhere	.30	.21
AGE1617	= 1 if age 16-17; = 0 elsewhere	.08	.08
	<u>Sex of child</u>:		
SEX	= 1 if female; = 0 if male	.49	.25
	<u>Marital status of mother</u>:		
NEVMAR	= 1 if never married; = 0 elsewhere	.02	.01
PREVMAR	= 1 if previously married; = 0 elsewhere	.11	.10

We include a dummy variable representing a low age of the mother (less than 19 years) when the child was born. Following Edwards and Grossman (1978) we expect this to have a negative impact on health. Age and sex and race of the child are also represented by dummy variables. So is marital status. Since all the children are beyond infancy, age is likely to be generally insignificant. Based on the literature, we expect nonwhites to have poorer health. Following infant mortality differences, we expect girls to be healthier. Finally, we expect children of currently married parents to be healthier, reflecting either greater resource availability (time) or perhaps less previous family strife.

An important variable entering the production (or demand) function of children's health is income, or, more generally, economic well-being of the households. Current observed income is in this case not an appropriate measure of economic well-being, because of possibly large, transitory components. We therefore estimated a quasi-earnings function that, apart from variables representing the parents' employment status and schooling, includes the variable homeownership, to represent a household's "permanent" economic well-being. In all households in the sample the mother is present. The variables related to the father interact with a dummy variable equal to 1.0 if the father is present and equal to 0.0 otherwise. Observed income serves as an indicator for permanent income. So we have:

$$\eta_3^* = \gamma_3'\xi_3 \qquad (3)$$

$$\eta_4 = 1.0\ \eta_3^* + \varepsilon_4$$

with η_3^* an index of the household's economic well-being ("permanent income")

η_4 observed household income

ξ_3 a (10x1) vector of exogenous variables entering the quasi-earnings function (see Table 4),

γ_3 a (10x1) vector of parameters, and

ε_4 a disturbance term ("transitory income").

Need variables. The data set available has a large number of health measures on children which can be used as proxies for a child's need for health care. Table 5 gives definitions and summary statistics of these measures.

Usually measures like the ones listed are added to health-care utilization equations "to control for health status". However, to the extent that these health measures are themselves a function of age, sex, income, etc., this approach is unsatisfactory.

Instead of specifying for each measure a function that explains their variation among the children, we treat the need variables as indicators of the overall health measure specified in Equation 2. More precisely, we assume that, apart from a random measurement error, each need variable is proportional to a child's overall health status.

$$\eta_{5i} = \beta_{2i}\eta_2^* + \varepsilon_{5i} \qquad i = 1,7 \tag{4}$$

with η_{5i} a need variable i = 1,7 (see Table 5)

β_{2i} a parameter, i = 1,7, and

ε_{5i} a disturbance term, i = 1,7.

Demand equations. In a model with latent variables, the unobservable variables are completely determined by their causes and indicators. As

Table 4. Exogenous Variables Entering the Quasi-Earnings Function

Symbol	Definition	Mean	Variance
	Employment status father:		
FFULLT	= 1 if father works full-time = 0 elsewhere (including father not present)	.79	.16
FPART	= 1 if father works part-time = 0 elsewhere (including father not present)	.01	.01
FOCC	Bogue socioeconomic index of father's occupation = 0 if father not present	48.46	476.90
	Mother's employment status:		
MFULLT	= 1 if mother works full-time; = 0 elsewhere	.19	.15
MPART	= 1 if mother works part-time; = 0 elsewhere	.19	.16
	Other parental variables:		
FSCHOOL	Years of schooling completed by father = 0 if father not present	11.77	28.16
MSCHOOL	Years of schooling completed by mother	12.48	6.87
HOME	= 1 if owned home; = 0 elsewhere	.83	.14
MAGE	Years of age of mother	35.67	50.38
	Race of household head:		
NWHITE	= 0 if white; = elsewhere	.14	.12

Table 5. Need Variables

Symbol	Definition	Mean	Variance
HRATE	Parents' rating of child's health (1 = excellent; 2 = good; 3 = fair; 4 = poor)	1.47	.40
DAYSILL	Days ill during past year	5.10	88.70
DAYSBED	Days in bed during past year	2.39	19.62
	Presence of several health distortions:		
LIMIT	= 1 if child has physical limitations; = 0 elsewhere	.02	.02
MAJOR	= 1 if child has some health distortion other than LIMIT; = 0 elsewhere	.53	.25
PROBLEM	= 1 if parents report a problem with the child's behavior; = 0 elsewhere	.13	.12
ALLERG	= 1 if child has an allergy; = 0 elsewhere	.23	.18

we have seen above, as causes of the latent variable health, we use the set of predisposing variables.

As indicators of a child's health status we use two sets of variables. First, we use the need variables as indicators of a child's health, measured with error (Equation 4). Second, we will use the utilization of health-care facilities as indicators of a child's health status. In other words, we specify a child's use of health-care facilities as a function of his or her health (η_2) and the set of enabling variables: insurance, η_1, income, η_4 and availability, ξ_4. We finally include a variable representing a household's attitude with respect to seeking professional medical care. This variable is the average number of doctor visits by the parents in the previous year (AVPR; mean 2.29, variance 6.4). So we have:

$$\eta_{6i} = \beta_{3i}\eta_1 + \beta_{4i}\eta_2^* + \beta_{5i}\eta_4 + \gamma_{4i}'\xi_4 + \varepsilon_{4i} \qquad i = 1,4 \qquad (5)$$

with $\eta_6 = (\eta_{61}, \eta_{62}, \eta_{63}, \eta_{64})$ a (4x1) vector of health-care utilization variables (HOSPVS, HCVS, SCHOVS, PRIVVS; see Table 6) and

ξ_4 = a (6x1) vector of four availability measures (as described in Table 1), AVPR, and a constant term.

β_{4i} and β_{5i} are parameters, i = 1,4,

β_{3i} and γ_{4i} are respectively (3x1) and (6x1) vectors of parameters, i = 1,4, some of which are a priori set equal to zero, and

ε_{4i} is a disturbance term, i = 1,4.

Table 6. Health-Care Utilization

Symbol	Definition	Mean	Variance
HOSPVS	Number of visits to a hospital outpatient clinic	.12	.47
HCVS	Number of visits to a health center or nonhospital clinic	.27	.91
SCHOVS	Number of contacts with the school physician	.08	.08
PRIVVS	Number of visits at a private practice	1.4	3.17

Availability is matched on an equation-by-equation basis: in the first equation, explaining the number of visits to a hospital out-patient clinic, the availability of care is measured as the travel time to the nearest hospital. In the second equation, explaining visits to health centers, the distances to the nearest HMO clinic and non-HMO clinic are added as availability measures.

To the last two equations, dealing with visits to the school doctor and to a private physician respectively, the physician population ratio is added.

In all but one of the cases we assume a positive impact on utilization from the availability of health care facilities. The exception is in the third equation where we expect an ample supply of physicians to be a substitute for medical care provided at schools.

In the estimation, one parameter β is set equal to -1.0 (for health in the equation for private visits) to standardize the health index, that is, a one-unit increase in HEALTH* will correspond to one visit less to a private practice.

We assume all disturbances to be normally distributed and independent across equations.

The data used to estimate this model stem from the Rochester Community Child Health Studies, Child Health Survey, 1975. It is a very rich data source, limited to one county containing a large city and the surrounding area. Observations on 675 households with 1589 children are used in this study. Data from this survey are more fully described in Wolfe (1980).

ESTIMATION RESULTS

Maximum likelihood estimates of the entire model can be obtained using the assumption that the disturbance terms are normally distributed (e.g., see Jöreskog and Sorbom, 1978). However, in order to reduce the amount of computer time needed to find an optimum for such an extensive model, we estimated the three insurance equations separately by least squares on 675 household observations. We then obtained maximum likelihood estimates of the parameters in the remaining 14 equations using observations of the 1,589 children. Since the insurance module is recursive to the rest of the model, all parameter estimates presented are consistent.

The estimation results of Equations 1, 2, 3 and 5 are given in Table 7.

The Demand for Health Insurance

Most of the signs of the estimates for private insurance are as expected: positive for income, mother working, mother's schooling and mother's age; negative for being nonwhite and not being currently married. The negative coefficient on family size is puzzling; perhaps rather than being a factor reflecting expected utilization, it primarily represents greater demands on income. The negative signs on occupational prestige after controlling for income suggest it is likely to pertain to self-employed professionals who face higher prices.

The estimation results of the HMO insurance equation show little, perhaps because few families have such insurance. Older families are less likely to have HMO coverage, perhaps reflecting tastes or greater

Table 7. Estimation Results

Dependent Variables	Equations (1) INSPRIV	Equations (1) INSHMO	Equations (1) MCAID	Equation (2) HEALTH*	Equation (3) PINC*
Independent Variables:					
PINC*				-.24	
INC	.23	-.01 NS			
MFULL	.12	.03 NS	-.08	-.04	.33
MPART	.05	.03	-.03	-.09	- .03 NS
FFULT					.83
FPART					.84
MSCHOOL	.01	-.01 NS		.02	.12
Linear Inc. Spline:					
INC			-.01 NS		
INC-Public Asst.			-.02		
INC-Medical Asst.			.03		
WELF	.01	-.05 NS	.14		
FSCHOOL					.07
MOCC	-.003	-.00 NS			
FOCC	-.003	-.00 NS			.01
HOME					.30
MAGE	.001	-.004			.03
NWHITE	-.10	-.09 NS	.03	-.13	.07 NS
NSIB	-.02 NS	.01 NS	.08	-.03	
LMAGE				.04 NS	
AGE4				-.09	
AGE1015				.02 NS	
AGE1617				-.02 NS	
SEX				-.07	
NOTMAR	-.24	-.01 NS	.17		
NEVMAR				-.43	1.09
PREVMAR				-.23	1.17
CONSTANT	-.23	.41	.31		

	HOSPVS	HCVS	SCHOVS	PRIVVS
	Equations (5)			
INSHMO	-.11	.70	-.02	- .60
INSPRIV	-.13	-.25	-.03 NS	.03 NS
MCAID	.14	.50	-.02	- .70
HEALTH*	-.30	-.47	.07	-1.00
AVPR	.01 NS	.01 NS	.00 NS	- .00 NS
INC	-.10	-.08	.02	.41
HOSP	.01 NS			
HMO		-.01 NS		
XHMO		-.01		
PHYS			-.04	- .37
CONSTANT	.35	.32	.11	-1.48

Coefficients marked NS are not significant at 5% level.

experience with the traditional fee-for-service arrangements. The insignificance of income is at first glance surprising. We expect a positive sign reflecting ability to purchase more insurance. The explanation may be that those with lower income wish for more extensive coverage, with everything paid for; the location of HMO facilities or the stronger preference of high-income families to use traditional fee-for-service care may also be behind this result.

The Medicaid equation contains all the expected signs. The income spline suggests a small reduction (-0.1) in probability of coverage as income increases to the public assistance level. Beyond this income level and up to the medical assistance level, we observe a further reduction (-.03), and, as expected, beyond that level no further association is observed (-.01 -.02 + .03 = 0.0). Nonwhites, larger families and those with single parents are more likely to have Medicaid coverage (the last two variables are related to eligibility criteria). Finally, labor force participation reduces the probability of Medicaid coverage, possibly because of greater availability of private insurance.

The Demand for Health Care

Most variables behave as predicted in our demand equations. For example, the type of insurance seems to be very important with respect to the type of health care chosen: those with HMO insurance tend to go to health clinics and not to a private practice, etc. It is less obvious, however, that, given the type of health insurance, income has an important direct impact both on the choice and on the total amount of health care: the results suggest that an increase in income, *ceteris paribus*, will result in an important increase in the number of visits to a private physician, and a slight decrease in the visits to a hospital outpatient clinic or HMO clinic.

A child's health status has the expected negative impact on health-care utilization, i.e., better health results in less utilization, except for school doctor visits. Perhaps this measure of health-care utilization is not an adequate indicator of health status, given the mostly preventive character of care provided at schools (check-ups, immunization). Also, the average number of visits to a school doctor is very small (Table 6). The impact of the availability of care on a child's demand for health-care is generally as expected but small.

We finally mention that our measure of attitude towards seeking medical care (AVPR) never has a significant impact on children's health-care demand. This is not too surprising, since AVPR is an imperfect measure of parental attitudes toward seeking medical care. It is influenced by other factors, and parents' attitudes may differ regarding appropriate care for children compared to care for themselves.

Children's Health

The focus of this study is on the measurement of a child's health status. Since the method we employed is relatively new, the congruence of our results with the ones obtained using more conventional methods does shed some light on the validity of our approach. A child's health is specified as a function of a number of predisposing variables. Most of them show the expected significant influences on health. If the mother in the household is employed, we observe a negative impact on a child's health, perhaps reflecting less time input. (Edwards and Grossman, 1978, found a similar negative impact only for health measures related to nutrition.) Perhaps surprisingly, this impact is larger for part-time working mothers than for full-time workers. Possibly full-time working mothers find more adequate substitutes to take care of their children than part-time working mothers.

Mother's schooling has, *ceteris paribus*, a positive effect on a child's health. This result is consistent with the analysis of others including Shakotko (1980).

Permanent income (PINC*) shows an important negative effect on health. The latter is not surprising--similar results have been found for adults (Auster et al.). It has been argued that variables associated with higher income, such as better nutrition and better housing, result in better health. However Edwards and Grossman (1978, 1979) found little association between income and a number of dimensions of child health, but for certain health measures--blood pressure, allergies and tension--they found a negative effect similar to the one reported here. For the sample used here, simple correlations between the seven need variables and both log income and median income show negative correlations for DAYSBED, LIMIT, MAJOR and ALLERGY. And, in a simplified version of the model using median income of the census tract as a proxy for economic status, the results showed a similar significant negative effect between health and income. These results from our model using an estimate of permanent income as the explanatory variable in the health equation may indicate either a belief that medical care can be purchased to "repair" the damage from consumption of high priced 'junk' food, or, as suggested by Edwards and Grossman's findings and found by Haggerty et al. (1975), using earlier data from this survey, they may indicate an association between income and the new morbidity. New morbidity incorporates health problems other than traditional physical health problems such as acute diseases. It includes the presence of allergies, behavioral problems and mental health distortions. The negative relation between income and health cannot simply be explained by assuming that better schooled parents (in higher income classes) can better detect health distortions, since mother's schooling also enters the health equation. The negative income effect thus calls for a closer look at the causal relationship between children's health and the economic status of the household.

Apart from PINC*, two other variables play an important role with respect to HEALTH*: NEVMAR and PREVMAR.[4] These reflect a time constraint so we expect a negative effect. The child of a mother who has never been married has, ceteris paribus, .43 units less HEALTH* than the child of a married woman. This corresponds with .43 x 1.00 = .43 more visits to the private doctor (on an average of 1.4), .43 x .30 = .13 more visits to a hospital clinic (average .12) and .43 x .47 = .20 more visits to a HMO clinic (average .27). If the mother has been previously married, the effects are similar, but smaller.

We finally mention the negative coefficient of NWHITE with respect to HEALTH*, and that the effect of the variable SEX is, contrary to our expectations, negative. The result with respect to race contrasts somewhat with Edwards and Grossman's results. They find significant differences by race which are more robust than for income. However, the direction of racial differences depended on the particular health measure used. The results here are more general since we link race to an overall health status measure. Thus, the predisposing variables, in general, performed as expected.

Another source of validation is through the correlations between one latent variable health and the observed health measures. Recall that HEALTH* as specified in our model has seven need measures as indictors, as specified in Equation 4. We now present the estimation results of these equations (Table 8). Each column represents one equation. We see that if HEALTH* goes up, HRATE decreases (the lowest rating: 1 = excellent health) and so does the numbers of days ill or days in bed, and the probability of having one or another health distortion.

Our new health measure thus relates to all conventional need variables as expected. Again, we believe this evidence supports the usefulness and validity of our methodology.

DISCUSSION

In the previous sections we developed a structural model for children's health-care utilization. Because of the structure of the model we also obtained an overall index for a child's health status. This single health measure has a number of advantages over the measures usually employed (like the need variables in this paper): it gives clear policy implications in identifying which socioeconomic groups have lower health status; it can serve as an outcome measure for the utilization of health services; it is a broad measure that incorporates multidimensional aspects of health, including the physical, the mental and the behavioral; and it is an operational measure that incorporates the effects of socioeconomic variables and capitalizes on the impact of health on health care utilization. Thus, it fits well into the call for an index that permits the evaluation of the effectiveness of health service delivery

Table 8. Estimation Results of Equation (4)

	HEALTH*
HRATE	-1.17
DAYSILL	-4.45
DAYSBED	-2.08
LIMIT	- .02
MAJOR	- .43
PROBLEM	- .11
ALLERGY	- .19

systems. It can be used on an individual level, for instance, to predict the health status changes likely to result (ceteris paribus) from demographic changes such as reduced fertility or increased labor force participation of mothers. Similarly, it can be useful in predicting health-care utilization as a result of such changes.

It can also be used on an aggregate or population level to compare populations such as racial and/or income groups. It moves beyond the work of Levine and Yett (Berg, 1973), since it directly relates to socioeconomic factors of health-care utilization, as well as to more direct measures of health status.

Our index incorporates a number of the measures of health status used in scales developed for the Health Insurance Study (HIS) currently being conducted by the Rand Corporation for the Department of Health and Human Services (Eisen et al., 1979). For example, the measures used to assess physical health rely largely on items similar to LIMIT in our scale. The HIS measure, however, contains more detail on the nature of the limitation. An additional HIS scale tries to capture mental health. We capture this in a single combined item--PROBLEM--which includes behavioral or school problems. Finally, the HIS general health rating is similar to the self-rating measure used in this study. The HIS scales are a simple algebraic sum of scores of items which satisfy certain scaling criteria. Again, the index we have developed goes beyond this work since it is weighted by and directly relates to both health-care utilization and socioeconomic factors. The HIS measures are more comprehensive, however.

To give an indication of the potential usefulness of this method, we computed the health status of various socioeconoic groups using our results.

In Table 9 we see that no clear income gradient can be observed: the negative impact of PINC*, as estimated in the model, seems to be offset by related positive effects of, for instance, mother's schooling. However, when we make a comparison across neighborhoods, we see a U-shaped relation with income (as measured by the median income of the neighborhood): the children in neighborhoods with a medium income between \$10,000 and \$15,000 are on average the healthiest.

There are important differences in health status if children are grouped by race, sex, marital status of the mother, family size or age. Nonwhite children, on average, are less healthy than white children. Children living with parents who are currently married are generally healthier than those living in alternative settings.

A number of caveats are in order. As stated before, the model puts some severe restrictions on the data. These restrictions are the direct results of the specification of the equations. The estimation results may prove quite sensitive to changes in these specifications, and consequently more research is needed regarding the stability of our results.

The need measures employed were chosen for the sole reason that they were available; the addition of more extensive measures of mental health would have been desirable. Furthermore, the data were reported by parents, and were not collaborated by medical authorities. In addition, all data are collected in one relatively small geographical area only, so our results should not be generalized to all children in the U.S.

Finally it should be mentioned that, since many of the endogenous variables are restricted either to be positive (health care utilization) or to take the values 1 or 0 (some need variables), the assumption of independent normally distributed disturbance terms may be violated.

Table 9. Health Status by Socio-Economic Group

	Mean	Standard Deviation	Number of Observations
Total sample	-1.20	.15	1587
Household income <4000	-1.15	.23	50
4000-8000	-1.23	.16	131
8000-12000	-1.17	.17	258
12000-16000	-1.14	.14	389
16000-20000	-1.18	.13	325
>2000	-1.26	.13	434
Median income of neighborhood <7000	-1.37	.08	18
7000-10000	-1.22	.19	236
10000-12000	-1.18	.16	283
12000-15000	-1.16	.14	658
15000-18000	-1.24	.12	239
>18000	-1.25	.13	153
Marital status: previously married	-1.43	.08	173
never married	-1.26	.14	23
married	-1.19	.15	1391
Number of siblings: 0-1	-1.17	.15	601
2-3	-1.20	.15	763
>4	-1.25	.16	223
Race: white	-1.18	.14	1368
nonwhite	-1.34	.13	219
Sex: male	-1.16	.15	812
female	-1.23	.15	775
Age: 1-4	-1.23	.17	294
5-9	-1.18	.15	575
10-15	-1.19	.15	587
16+	-1.24	.14	131

Despite these caveats, we believe our approach is a useful one both to study health-care utilization and to obtain a comprehensive index for the health status of children. A single index has the following clear advantages: it permits evaluation of the differences in health status among subgroups of the population; it permits evaluation of the quality of health services; and it offers the possibility that it may lead to the discovery of underlying relationships. By using weights, the multidimensionality of health status can be incorporated. Previous work by van de Ven and van der Gaag (1979) and Lee (1979) suggests that this type of approach can be usefully employed to study health-care utilization and the health status of adults. The evidence presented here makes the approach seem like a useful one for studying health status and health-care utilization among children. Clearly extensions to all age groups and to more comprehensive data bases would be necessary for many policy purposes.

NOTES

[1]An additional problem arises if health and income are determined simultaneously.

[2]See the next section for a further explanation of this.

[3]Ideally one would like to include a health status-measure here. However, since health-care insurance is generally purchased by a household, this calls for a "household health status index". Since the construction of individual health indices is problematic enough, we use a number of proxy variables.

[4]The estimation results of the PINC* equation are generally as expected. The large positive effects of NEVMAR and PREVMAR are on first sight surprising, but they should be looked at in combination with the effects of the variables FFULLT, FPART, FSCHOOL and FOCC. These four variables are all set to be zero if no father is present. So, if we compare a two-parent household with a full-time working father with 12 years of schooling and occupational status 48, and a fatherless household (NEVMAR), the average difference in log income in our sample is $+1.09 -(.83 - .07 \times 12 - .01 \times 48) = -.49$.

REFERENCES

Andersen, R. 1968. A behavioral model of families' use of health services. Research Series No. 25. Chicago: Center for Health Administration Studies, University of Chicago.

Andersen, R., Kravits, J., and Anderson, O. W. 1975. Equity in health services. Cambridge, Mass.: Ballinger.

Auster, R., Leveson, I., and Sarachek, D. 1969. The production of health: An exploratory study. Journal of Human Resources, 4, 411-436.

Becker, G. S., and Lewis, H. G. 1973. On the interaction between the quantity and quality of children. Journal of Political Economy, 81.

Berg, R. L., ed. 1973. Health status indexes. Chicago: Hospital Research and Educational Trust.

Edwards, L. N., and Grossman, M. 1978. Children's health and the family. New York: National Bureau of Economic Research, Working Paper No. 256.

Edwards, L. N., and Grossman, M. 1979. Income and race differences in children's health. New York: National Bureau of Economic Research, Working Paper. No. 308.

Eisen, M., Ware, J., Donald, C., and Brook, R. 1979. Measuring components of children's health status. Medical Care, 17, 9.

Feldstein, M. S. 1974. Econometric studies of health economics. In M. D. Intriligator and D. A. Kendrick, eds., Frontiers of quantitative economics, Vol. 2. Amsterdam: North-Holland.

Grossman, M. 1972. The demand for health: A theoretical and empirical investigation. New York: Columbia University Press.

Haggerty, R. J., Roghmann, K., and Pless, I. 1975. Child health and the community. New York: John Wiley.

Hyman, J. 1971. Empirical research on the demand for health care. Inquiry, 8, 61-71.

Jöreskog, K. G., and Sorbom, D. 1978. Estimation of linear structural equation systems by maximum likelihood methods: A Fortran IV program. Chicago: International Education Services.

Lee, L. F. 1979. Health and wage: A simultaneous equation model with multiple discrete indicators. University of Minnesota, Department of Economics, Discussion Paper No. 79-127.

Menchik, M. D. 1977. Hospital use under Medicaid in New York City. Santa Monica, Cal.: Rand Corporation, Report R-1955-NYC.

Shakotko, R. A. 1980. Dynamic aspects of children's health, intellectual development, and family economic status. New York: National Bureau of Economic Research, Working Paper No. 451.

van de Ven, W. P. M. M., and van der Gaag, J. 1979. Health as an unobservable: A MIMIC-model for health-care demand. Madison, Wis.: Institute for Research on Poverty, Discussion Paper No. 544-79.

Wolfe, B. 1980. Children's utilization of medical care. Medical Care (December), 33-44.