RESEARCH REPORT

Social dynamics of health inequalities: a growth curve analysis of aging and self assessed health in the British household panel survey 1991–2001

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Objectives: To study how social inequalities change as people age, this paper presents a growth curve model of self assessed health, which accommodates changes in occupational class and individual health with age.
Design: Nationally representative interview based longitudinal survey of adults in Great Britain.
Setting: Representative members of private households of Great Britain in 1991.
Participants: Survey respondents (n = 6705), aged 21–59 years in 1991 and followed up annually until 2001.
Main outcome measure: Self assessed health.
Results: On average, self assessed health declines slowly from early adulthood to retirement age. No significant class differences in health were observed at age 21. Health inequalities emerged later in life with the gap between mean levels of self assessed health of those in managerial and professional occupations and routine occupations widening approaching retirement. Individual variability in health trajectories increased between ages 40 and 59 years so that this widening of mean differences between occupational classes was not significant. When the analysis is confined to people whose occupational class remained constant over time, a far greater difference in health trajectories between occupational classes was seen.
Conclusions: The understanding of social inequalities in health at the population level is enriched by an analysis of individual variation in age related declines by social position.

M any studies have examined changes in population health inequalities over time,[1–11] but to date there has been less work looking at how inequalities in health change as people age. There is evidence that social inequalities in health narrow during adolescence and then widen again during early adulthood.[12 13] In some but not all studies, inequalities seem to remain stable or narrow again after retirement.[13–18] Life course theories on the causation of health inequalities propose that health inequalities are partly attributable to the accumulation of hazard exposures (for example, poor housing, environmental and occupational toxins, risky behaviours).[19] It follows that longer exposure should produce greater inequality. However, the evidence summarised above does not show monotonic increases with age.

The designs of previous studies are not ideal for analysing aging. Both follow up studies of single age cohorts and studies of cross sectional differences are based on two time points at most,[14 15 20–24] and so complicate the separation of the effects of aging, period, and birth cohort.[25] Even given suitable data, there is the additional difficulty of social mobility to consider. At any time point, a social class group will include people who have previously spent time in more or less advantaged classes, as well as those who have always been in that class. Thus social mobility may dilute the relation between social position and health at any single time point.[26–32]

A more dynamic approach is needed that recognises that health changes with age, and that social position may not exert a uniform influence on health in people of the same age.[33 34] To facilitate this approach, we use data from the British household panel survey (BHPS) that provides information on the health and social position of people every year from 1991 to 2001 (inclusive). We use growth curve models (GCM) to investigate change in health inequality over a decade. A GCM is characterised by repeated measures of a dependent variable as a function of time and other covariates. GCM are suitable because they can be used to separate the effects of aging, period, and cohort,[25] and social position can be specified as a time varying influence. Other applications of growth curve models include the acquisition of educational skills, physical weight and height trajectories, the development of substance use, and poverty experiences and health.[35–39]

The use of GCM and longitudinal data represents an advance on previous analyses, which have not modelled the aging process explicitly or have had insufficient repeated measures data to measure age effects. We test two specific hypotheses: (1) social inequalities will increase with age, and (2) social mobility will act to "constrain" the magnitude of social inequalities in self assessed health (SAH).

METHODS

Study population

The BHPS is a representative longitudinal survey of private households in Great Britain containing about 5500 households and 9000 adults. The initial sample was a two stage stratified cluster design, sampling addresses within postcode sectors and interviewing all household members aged 16 and over. The first survey took place in 1991, with annual follow up of panel members wherever they move in the UK. This

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analysis is based on data from adults aged between 21 and 59 years in 1991 survey (n = 6930) followed through until 2001 or until they exceeded the age of 59 years or they dropped out of the survey. Data from all the years that respondents participated in the survey are used: survey drop outs and intermittent non-responders still contribute person years to the GCM. Members who joined households after 1991 are not included in the analysis. Missing data on variables of interest within a survey year reduced the sample to 3229 men and 3476 women (hereafter called the full sample). A stable sub-sample consists of those who remained in the same occupational class throughout the period 1991–2001 or until they reached the age of 60 or dropped out of the study (n = 4933). A supplementary analysis of social mobility is based on survey respondents with complete occupational histories every year from 1991 to 2001 (n = 3959). Information on loss to follow up is available in Taylor *et al*.[40]

Measures
Occupational class
The five class version of the National Statistics Socioeconomic Classification (NS-SEC) based on a person's own occupation is derived for each survey year.[41] The classification allocates occupations on the basis of the degree of autonomy and control at work, job security, and the presence or absence of career opportunities. The five classes are: (1) managerial and professional occupations; (2) intermediate occupations; (3) small employers and own account workers; (4) lower supervisory and technical occupations; (5) semi-routine and routine occupations.[42] Young people in full time education and those who have never had a job are not allocated to an occupational class. The distribution of the NS-SEC classes shown in table 1 is similar to other national data.[41]

Self assessed health
In all years except 1999, respondents were asked "Please think back over the last 12 months about how your health has been. Compared to people of your own age, would you say that your health has on the whole been excellent, good, fair, poor, very poor, don't know?" Answers were taken as an indication of general SAH and coded from 1 (very poor) to 5 (excellent). Fewer than nine people responded "don't know" each year and were excluded from the analysis. In 1999 the question was part of the SF-36 and had slightly different wording. The marginal distribution for this 1999 question suggested that it could not be taken as an equivalent measure of SAH. Thus responses in 1999 were excluded from the analysis.

Statistical analyses
Preliminary analyses are undertaken using Stata 6.0 (Stata, College Station, TX). A pooled cross sectional analysis estimates the mean effect of occupational class on SAH for 1991 to 2001. The pooled analysis allows us to compare the GCM results with those not allowing for time varying occupational class. The pooled cross sectional analysis also ignores the fact that respondents are part of a panel study, contributing to more than one year's data and assumes that after the first survey data are missing completely at random. These shortcomings have implications for the precision and the reliability of the estimates.

The GCM are specified as hierarchical models and fitted using the software package MLwiN (Institute of Education, University of London). Formally, these models are described as two level "repeated measures" multilevel models with occasions of measurement or annual surveys at level 1 nested within people at level 2.[43] For descriptions of GCM within a multilevel framework see Little and Schenker or Leyland and Golstein.[44 45] We fit the GCM to all available data and not just for people who respond every year. The MLwiN estimates are adjusted for non-response if the data are missing at random.

Initial analyses (not described here) showed that a quadratic growth curve for SAH is a better representation of a person's health changes with age than a linear curve. Hereafter we represent the relation of SAH with age as a quadratic

Table 1 Distribution (%) of sociodemographic characteristics and self assessed health for the British household panel survey members (a) aged 21–59 in 1991 and (b) aged 21–59 in 1991 and surveyed in 2001

		1991		2001	
Description		**Men**	**Women**	**Men**	**Women**
Current age (y)	21–25	12	13	0	0
	26–30	15	16	1	<1
	31–35	16	14	14	16
	36–40	13	13	19	20
	41–45	14	15	20	18
	46–50	12	12	17	16
	51–55	10	9	18	18
	56–59	7	7	12	12
Occupational class	Managerial and professional occupations	36	28	41	34
	Intermediate occupations	7	23	7	21
	Small employers and own account workers	15	6	15	7
	Lower supervisory and technical	16	7	13	6
	Semi-routine and routine occupations	27	36	24	33
Self assessed health	Excellent	35	29	28	22
	Good	45	47	47	48
	Fair	14	16	18	20
	Poor	4	6	6	7
	Very poor	2	2	1	2
Number		3229	3476	1666	2011

Table 2 Percentage person years in each NS-SEC class by 1991 class and proportion remaining in 1991 class for 11 years for 3959 British household panel survey members aged 21–59 in 1991 with complete occupational histories from 1991 to 2001

NS-SEC in 1991	Number	Stable*	Percentage of all person years 1991-2001 in class					
			NS-SEC 1	NS-SEC 2	NS-SEC 3	NS-SEC 4	NS-SEC 5	Total
Managerial and professional occupations	1356	51.0	80.5	8.5	3.5	2.7	4.8	34.3
Intermediate occupations	647	26.1	20.5	64.4	2.9	1.7	5.7	16.3
Small employers and own account workers	359	49.3	8.8	3.8	73.7	3.3	10.4	9.1
Lower supervisory and technical occupations	444	21.4	13.1	5.0	4.4	56.6	20.9	11.2
Semi-routine and routine occupations	1153	48.0	5.8	4.8	3.8	7.6	78.1	19.1
Total	3959	42.6	34.9	15.7	9.9	10.0	29.4	100.0

NS-SEC, National Statistics Socio-economic Classification of occupational class. *Proportion of occupational class who remained in the same class for each year during 1991–2001

function, with health deteriorating rather more with each additional year at older than at younger ages. Occupational class is entered into the models as a series of four occasion specific dummy variables, with the semi-routine and routine class as the reference category. Period effects are controlled for by adding nine dummy variables for years 1992 to 2001. Two way interaction terms between the occupational class dummy variables and the age and age^2 terms estimate whether occupational class effects differ at different ages. Sex did not interact with any other independent variables (IVs) in the models, neither did sex specific models show any differences in the pattern of results to those presented here. Random variation in the estimates of the fixed effects of occupational class and age is tested at both individual and occasion specific levels. All the IVs are centred at the median age by subtracting 40 from age at interview before deriving IV terms involving age.[48] Sex is coded −0.5 for men and 0.5 for women so that other parameter estimates are sex neutral.

As we expect people's occupational class to change over time, we fit two sets of models. Firstly, a GCM is carried out on all of the available data, the full sample. This is then contrasted with an analysis that is confined to BHPS members whose occupational class remained stable over time, thus omitting those who moved between occupational classes. It is expected that the first model will show a narrower social gradient in SAH as it includes those who have been socially mobile, so that current occupational class does not represent exposure over the whole period. For the analysis that only includes participants who have remained in the same occupational class, it is expected that greater inequalities in SAH will be shown at older ages, as social disadvantage accumulates over time.

RESULTS

Table 1 shows the different distributions of occupational class and SAH in the years 1991 and 2001, for men and women. There is evidence of similar patterns of upward social mobility and declines in SAH over the 11 years for both sexes. Mean SAH scores ranged from 3.72 (95% CI 3.71 to 3.74) for the least advantaged occupational class to 4.05 (95% CI 4.04 to 4.06) for the most advantaged class based on SAH pooled over years 1991 to 2001.

Only about half the cohort was interviewed in every survey until 2001. Table 2 shows the extent of social mobility among this complete sample. On average, those in managerial and professional occupations in 1991 remained in the same class for nine years, and those who changed occupation were most likely to move into an intermediate occupation. By contrast, those in lower supervisory and technical occupations remained in the same class for six years on average. Members of this class tended to have two distinct mobility patterns, either moving into semi-routine or routine occupations or acquiring a professional or managerial job. This same polarisation is observed for members of the intermediate class, although the chances of moving up or down are reversed. The need for a dynamic model is clearly shown by the extent of mobility in the sample. This mobility is allowed for by treating occupational class as time varying in the GCM.

Table 3 gives mean SAH scores by occupational class predicted by the GCM for the year 1996, midway between the periods 1991 and 2001, for both the full and stable samples. The parameter estimates for these model are provided in table A1 of the appendix. The model predicts that SAH declines slowly with age but the trajectory becomes steeper over time. The difference in mean predicted SAH scores between those

Table 3 Estimated mean self assessed health and 95% confidence intervals by occupational class from the growth curve models of self assessed health 1991–2001

	(A) Full sample			(B) Stable sample		
	Person years	Mean SAH	95% CI	Person years	Mean SAH	95% CI
Managerial and professional occupations	16771	3.99	3.94 to 4.05	14230	4.07	3.98 to 4.15
Intermediate occupations	7330	3.94	3.88 to 4.00	5557	3.98	3.88 to 4.07
Small employers and own account workers	5153	3.92	3.86 to 3.99	4288	3.96	3.86 to 4.06
Lower supervisory and technical occupations	4929	3.90	3.83 to 3.96	3361	3.85	3.73 to 3.96
Semi-routine and routine occupations	14737	3.83	3.79 to 3.87	12416	3.69	3.63 to 3.75
Number	6705			4933		

*For a 40 year old in the year 1996. Estimated by summing the parameters for the intercept, year 1996 and occupational class given in table A1. SAH, self assessed health.
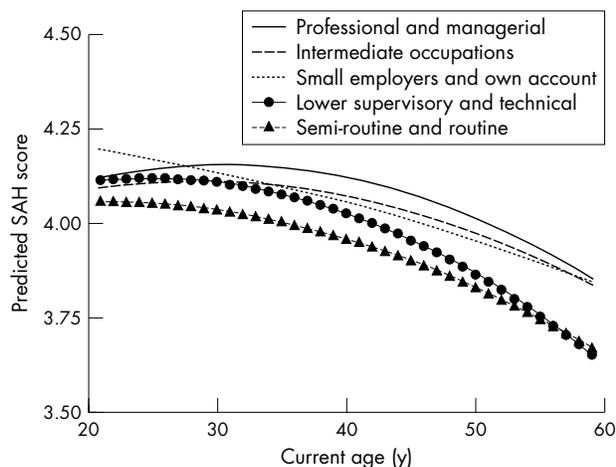
Figure 1 Mean predicted health scores for British household panel survey members aged 21–59 years in 1991 by occupational class.

Figure 2 Mean predicted health scores and 95% CI for British household panel survey members aged 21–59 years in 1991 for managerial and professional occupations (above) and semi-routine and routine occupations (below).

in managerial and professional occupations and those in semi-routine and routine work at age 40 for the full sample is estimated to be 0.16. There is clear evidence supporting the first hypothesis that occupational class affects the health of people more strongly as they age: the interaction of occupational class with age shows a positive increment in the difference between semi-routine and routine occupations and managerial/professional and intermediate occupations for both samples (table A1).

Figure 1 shows the fitted growth curves for BHPS members by NS-SEC. At the start of working life, there is little difference in SAH between the NS-SEC classes. Small employers and own account workers are estimated to have the best SAH and semi-routine and routine workers to have the poorest health. By the age of 40, social inequality in health looks like that traditionally observed in most cross sectional studies. Now, those in professional and managerial occupations have the best SAH on average. Towards the end of working life, the NS-SEC classes separate into two distinct trajectories: those with greater security and autonomy at work and those with less favourable employment conditions. This means that at the start of working life, ratings of SAH are predicted to be between the "excellent" and "good" categories, irrespective of occupational class. At age 60, the SAH of those in advantaged occupations is predicted to have declined to slightly less than "good". By contrast, health ratings of those in less advantaged occupations are predicted to be somewhere approaching the midpoint between "good" and "fair".

In figure 2, the growth curves for NS-SEC 1 and NS-SEC 5 are compared. This permits an examination of the age at which inequalities in health emerge. Significant differences between the two groups emerge as people approach their 30s. The gap between the two curves continues to widen over the life course. An examination of the confidence intervals shows that the growth curve is most reliably estimated in the middle of the age range and is less reliable at the two extremes.

There is significant random variation in the effect of age and occupational class on health. This implies that the effect of being in a particular social position will not be the same for everyone, neither will the aging process affect people's health equally. This could reflect genuine heterogeneity associated with differences in individual social trajectories as well as heterogeneity in individual characteristics. Individual variability in the effect of NS-SEC on health tended to be greater
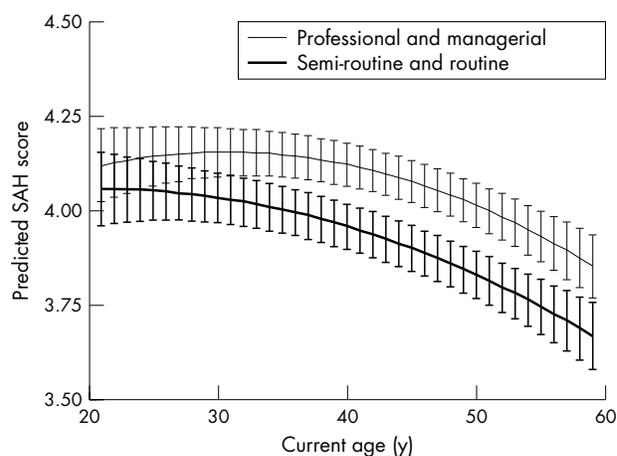
in those classes where employment relations and conditions are poorer. There was also greatest variability in the effect of age on health at older ages and least variability in mid-adulthood (results not shown).

Some additional sensitivity analyses were carried out by estimating the GCM for (A) a sample with complete data for all 11 years, with longitudinal weights to account for sample attrition and (B) the full sample using a binary measure of SAH. The results were practically unchanged from those described above.

DISCUSSION

The dynamic analyses show that social inequalities in health vary over the life course. Consistent with the findings of West,[12 47] there was no evidence of social inequalities in SAH at 21 years, although we found significant differences at later ages that increased in magnitude over the life course. The emergence of social inequalities between 21 and 40 years was not only attributable to a greater separation of mean health between occupational classes but also to greater reliability in the estimates of the health of people within each
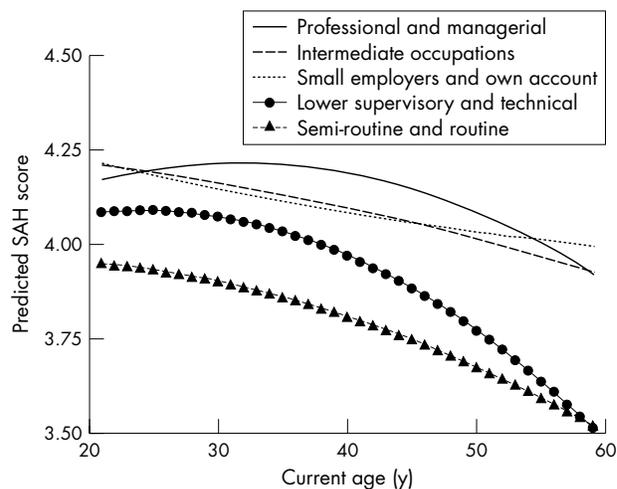

Figure 3 Mean predicted health scores for British household panel survey members aged 21–59 years in 1991 by occupational class for those with stable occupational histories.

What this paper adds

- Health inequalities increase as people age.
- Low autonomy, rewards, and security at work are associated with greater declines in health.
- Social mobility acts to dilute or constrain the social gradient in health
- This is the first analysis of health inequalities where both health and occupational class have been measured annually over 11 years

Policy implications

- Policies that increase autonomy and security at work would reduce the extent of health inequality in men and women.
- The increase with age of health differences between occupational classes could be reduced by improvements in employment relations.
- Policies that increase the openness of the social structure, by encouraging social mobility, would also act to reduce health inequality.

class around 40 years. By contrast, the increasing social inequality after 40 years was observed despite an increase in the random variation within each occupational class as people approach retirement age. At older ages, there are greater differences between persons within occupational classes, but at the same time, the average differences in health between classes increase even more. Our findings are consistent with a recent report of greater variability within socioeconomic strata than that between strata, and of increased individual variability in health with greater socioeconomic disadvantage.[48]

In the full sample analysis, occupational class was allocated each year, so that people were observed moving between classes. It has often been assumed that healthier people are more likely to be upwardly mobile and the less healthy downwardly socially mobile, thus increasing social inequality in health. However, current research has shown that in many cases, social mobility is more likely to dilute health differences between social classes. This is because mobile groups accumulate a more heterogeneous level of "risk exposure" over time. The analysis reported here is consistent with the hypothesis that social mobility in this sample of UK adults acted to dilute the magnitude of social inequalities in SAH. The contrast between mean SAH levels in the full sample and in the stable sub-sample with no mobility shows that if no movement in and out of occupational classes had taken place during the 11 years of the study, health inequality would have been far more pronounced. Those who remained in the same occupational classes over their time in the study accumulated a larger amount of exposure to the favourable or unfavourable conditions in those classes than those whose social position varied.

The growth models show that the general shape of the health trajectories is similar for all the occupational classes except the small employers and self employed group, in which the relation of age to health was linear. It is entirely plausible that SAH arises from quite diverse reasons at different ages. For example, movement into self employment at older ages may be in response to ill health and at younger ages a response to unemployment or entrepreneurial spirit.[49–51] Cross sectional reports on the health of small employers and own account workers have found lower than expected morbidity and mortality compared with other socioeconomic groups.[42] To our knowledge, this is the first analysis of longitudinal changes in health in this employment group.

This is a first step towards understanding the relation between occupational class and health in a dynamic framework. However, some limitations must be acknowledged. SAH is based on a question that asks respondents to assess their health compared with people of their own age. As such, the responses already partially adjust for age and so health trajectories may not be as steep as they might be.[52] We have

assumed that the ordinal measurement of SAH reflects an underlying normally distributed continuum in health. Other studies have tested this assumption and found it acceptable.[39 53] An investigation of sample attrition suggests that poor health in previous years is typically associated with a propensity to drop out of the study that may mean that our findings about the relation between health and occupational class are more conservative than if these people had remained in the study.

CONCLUSIONS

Using GCMs that allow for changes in health and social position over time, no social inequalities in SAH health could be detected at age 21 although they were soon apparent and became more pronounced with increasing age. These dynamic analyses of health inequalities present narrower inequalities than those observed for cross sectional analyses at a single time point. Social mobility, by giving a mixed experience of social conditions over time, acted to dilute or "constrain" social inequality. For people whose class position remained constant over time, inequalities were considerably greater than for cross sectional individual differences pooled over time or full dynamic analyses where differences over time are pooled across people. The health impact of a spell in an occupation with low autonomy, rewards, and job security was not as great when this was preceded by more favourable conditions. This shows that health inequality arises not only from differences in social conditions, but from the tendency for advantage and disadvantage to cluster in the same people over time.

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APPENDIX

Table A1 Parameter estimates (SE in parentheses) for the growth curve models of self assessed health 1991–2001

	Full sample		Stable sample	
	Estimate	SE	Estimate	SE
Fixed effects				
(Individual time independent terms)				
Female	−0.108	(0.017)	−0.076	(0.022)
Intercept	3.958	(0.017)	3.808	(0.025)
(Occasion specific time dependent terms)				
Year 1991	Reference category		Reference category	
Year 1992	−0.048	(0.011)	−0.049	(0.013)
Year 1993	−0.068	(0.012)	−0.067	(0.014)
Year 1994	−0.094	(0.012)	−0.075	(0.015)
Year 1995	−0.103	(0.013)	−0.112	(0.016)
Year 1996	−0.130	(0.013)	−0.121	(0.017)
Year 1997	−0.101	(0.013)	−0.089	(0.018)
Year 1998	−0.131	(0.014)	−0.130	(0.019)
Year 2000	−0.163	(0.015)	−0.155	(0.021)
Year 2001	−0.123	(0.016)	−0.097	(0.023)
Current age	−0.010	(0.001)	−0.011	(0.002)
Current age^2	−0.0003	(0.0001)	−0.0002	(0.0001)
Managerial/professional	0.163	(0.018)	0.378	(0.030)
Intermediate occupations	0.115	(0.021)	0.288	(0.040)
Small employers and own account	0.096	(0.024)	0.274	(0.043)
Lower supervisors and technical	0.068	(0.023)	0.161	(0.051)
Semi and routine occupations	Reference category		Reference category	
Managerial/professional × age	0.003	(0.001)	0.005	(0.002)
Managerial/professional × age^2	−0.0001	(0.0001)	−0.0002	(0.0002)
Intermediate occupations × age	0.003	(0.002)	0.004	(0.003)
Intermediate occupations × age^2	−0.00003	(0.00014)	0.0001	(0.0002)
Small empl and own account × age	0.001	(0.002)	0.006	(0.004)
Small empl and own account × age^2	0.0002	(0.0002)	0.0003	(0.0003)
Lower supervisors and tech × age	−0.002	(0.002)	−0.004	(0.004)
Lower supervisors and tech × age^2	−0.0001	(0.0002)	−.00003	(0.0003)
Semi and routine occupations × age	Reference category		Reference category	
Semi and routine occupations × age^2	Reference category		Reference category	
Random effects				
(Individual time independent terms)				
Current age	0.0009	(0.0001)	0.0007	(0.0001)
Managerial/professional	0.127	(0.021)	0.000	(0.000)
Intermediate occupations	0.102	(0.022)	0.000	(0.000)
Small employers and own account	0.132	(0.028)	0.000	(0.000)
Lower supervisors and technical	0.159	(0.021)	0.000	(0.000)
Error	0.419	(0.015)	0.454	(0.023)
(Occasion specific time dependent term)				
Error	0.378	(0.003)	0.376	(0.004)

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APHORISM OF THE MONTH ....

Community resistance to professional advice may be a sign of good community health

Lowell Levin