THE HUMAN POPULATION LABORATORY
ALAMEDA COUNTY, CALIFORNIA

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It is a pleasure to be here to talk with you about the Human Population Laboratory (HPL); some of its past activities; what we are doing currently; and what we expect to do in the future. The reason for doing this is not to toot my own personal horn. In fact, I can take little credit for this work as it represents an effort which has been going on for over 20 years, and I've only been involved for a little over 5 months. I am really in the wonderful position of having interesting information to talk about, without having had to do all the work involved in gathering it. The reason for talking about the HPL to this group is that many of our findings have had a significant input on the development of preventive activities as represented in the many health education and risk reduction programs seen at this conference. What I'd like to do is to tell you about where some of this information has come from, some of the findings, some of the problems of interpretation, and some of the challenges which come from these data.

What is HPL? It is a 22-year-old research effort, originally funded by the National Institutes of Health in 1969. Our current funding is almost entirely through the Centers for Disease Control. It is a research effort which has carried out 13 field studies, produced 74 publications, and 6 PH. D. dissertations.

Much of this work has been an attempt to deal with three themes: the first involves the realization that some time ago we moved from the era of infectious diseases into an era of chronic diseases. We have moved from situations where we believed there were simple etiological paths which connected host, agent, and environment. As it turns out, even with infectious disease, it was really not that simple. Chronic disease etiology appears to be very different from the etiology of most infectious diseases. Chronic diseases are highly complex, involving many factors related in complex ways. We cannot isolate with any assurance a single factor which would invariably lead to a particular event. For example, in the cardiovascular area an attempt was made to pool the results of eight or nine large scale prospective studies on cardiovascular disease in the United States. One of the results of this effort was the finding that in over 10 years of followup 90% of the people who had two or more cardiovascular risk factors did not have any cardiovascular disease. Of those who did have some kind of cardiovascular event, 60% had no more than one identified risk factor. So now, even in the cardiovascular area where we think we know much about the etiology of the disease, we are still unable to predict with any great certainty who will experience cardiovascular disease and who will not. Thus, our knowledge even in this area is still rather primitive.

The second theme that occurs in our work reflects the viewpoint that health is something more than the absence of disease; health also includes social, physical, and mental well-being. The HPL has done a good deal of work attempting to quantify and clarify this broader notion of health.

The third theme has to do with the importance of a community base for the study of health issues. To study health and its determinants by looking at people who present themselves as sick in medical settings, or to study special convenient populations, is valuable, but it is important also to study the range of health experience in a community in order to learn the overall epidemiologic patterns related to health.

Thus, part of the HPL's efforts over the last 22 years have been to look at a large number of normal people, in an average community representative of many other communities in the United States, and to study a full range of

health outcomes and independent variables. The full range of health outcomes includes physical health (defined in terms of morbidity and mortality as well as in terms of disability and impairment), mental health, and social health. Much of this work has included the use of a longitudinal, prospective design. As you know, it's absolutely imperative to look at these types of relationships in a prospective way to get around difficult issues involved in interpreting cross-sectional data and to learn the causal nature and patterns of associations. For example, from cross-sectional data we don't know if health outcomes reflect the impact of what people do on their health or instead reflect the impact of their health status on what they do, or both. Prospective, longitudinal studies are the best approach to resolving such issues.

There have been many methodological problems involved in doing this, and much effort at the HPL over the years has been oriented towards developing solutions to the methodological problems raised in consideration of these three themes.

The biggest problem, I suppose, has to do with how you are actually going to study the health of a large group of people. One could take a large group and give them all some sort of medical interview and physical examinations.

Indeed, there are longitudinal studies such as those in the Framingham series which have done so. But this is very costly, and obviously we are going to miss people who don't have any great love for medical studies. There are also a number of issues which relate to the highly selected nature of such groups and resultant bias. Thus, very early, the HPL decided to develop survey interview techniques that could be used in studying health. This is "old hat" now, but back in 1959 and 1960 the use of survey information for studying someone's health was a novel approach with many unknowns. It was considered something that really did not tell you very much about health. Thus, the early HPL work was heavily involved in trying to establish the reliability and validity of survey measures of health. The success of this is shown by the fact that the health data collected in 1965 have been shown to be strongly related to people's health 10 years later. The next problem had to do with who would be studied. Many of the studies which examine the relationship between what people do and their health have suffered from the fact that they tend to deal with convenience samples, that is, the groups studied are easy to study for one reason or another. The HPL investigators tried to arrive at a method which would give a picture that was true for an entire community. In this case, the community was Alameda County, and a concerted attempt was made to get a random, representative sample of adults in Alameda County.

A final problem which plagues survey interviewers is how to get people to cooperate. When you give people a long survey, what you would really like to do is sit there with them while they fill them out, but that's enormously expensive (prohibitively, in many cases). You could send it to them, but the return rates are going to be very low. What the HPL investigators developed, after a number of field studies, was a staged process. First, a particular household is identified as part of the sample. Then the household is enumerated by an interviewer who collects descriptive information such as who lives in the household, family composition, and the names of the people who live there. Then questionnaires are left for all the eligible respondents in that household who are asked to return them by mail. They are sent a post card thanking them for their cooperation. Those who don't respond are sent a letter, and then a telegram. If they have still not responded, they are called. Then, if there is still no response, an interviewer is sent out to find out why they were having some problem completing the questionnaire. Believe it or not, this is much cheaper than going out and interviewing everybody. It also gives you a much better sample in terms of its being representative of the population you are trying to study. The development of this strategy at HPL has led to a survey approach which has a considerable amount of reliability and validity and results in a group of respondents who are much like the community at large.

Now I would like to tell you more of the specifics about one of our main data collection and analysis efforts. In 1965 a group of about 8,000 people were selected in a multi-stage probability sample of Alameda County, created to mirror as closely as possible the characteristics of the county population. The study was restricted to adult residents of the county who were not institutionalized. This means they were slightly healthier than the overall population. Eligible respondents were over age 20 years or over 16 years old if married in 1965. Today, 16

years later, the median age of this population is roughly 55. The 8,083 people were given questionnaires in 1965, and roughly 7,000 returned theirs. This group of 6,928 constitutes the population that has been followed for the last 16 years. One of the questions you may want to ask immediately is, whether the people who responded to the questionnaire were different from those who did not. It turns out they are not very different. The strategy for selecting the people was very successful in getting a group of people who were representative of the county. However, this is only true because of the elaborate 4-stage followup process which was used in going after those people who did not initially return questionnaires. If we had stopped with the people who mailed in interviews after the first stage, these would have been highly unrepresentative data. By following up with multiple attempts at data collection, we can say we ended up with data that truly represented the community.

Now we turn to what were they asked in the questionnaire. The data we have reflect first some general answers about their health, appetite, sleeping habits, energy level, fatigue levels if they have only 3 or 4 hours of sleep, how often they feel worn out. In addition there were questions about preventive health service—when was the last time they went to see a doctor for a general checkup even though they weren't feeling sick, when was the last visit to the dentist, do they have a particular doctor, do they have health coverage of any sort, during the last 12 months how many times did they see a doctor; how many sick days were they in bed, were they hospitalized, were they institutionalized for any reason.

Then there are responses to a list of 16 or 17 conditions, high blood pressure, heart trouble, stroke, chronic bronchitis, asthma, arthritis or rheumatism, chronic nervous trouble, epilepsy, cancer, diabetes, tuberculosis, emotional disorders, drinking problems or alcoholism, stomach ulcer, duodenal ulcer, chronic lung trouble, gall bladder trouble, liver trouble, hernia or rupture. People indicated whether they had that condition during the last 12 months, if it bothered them very much, and when it started.

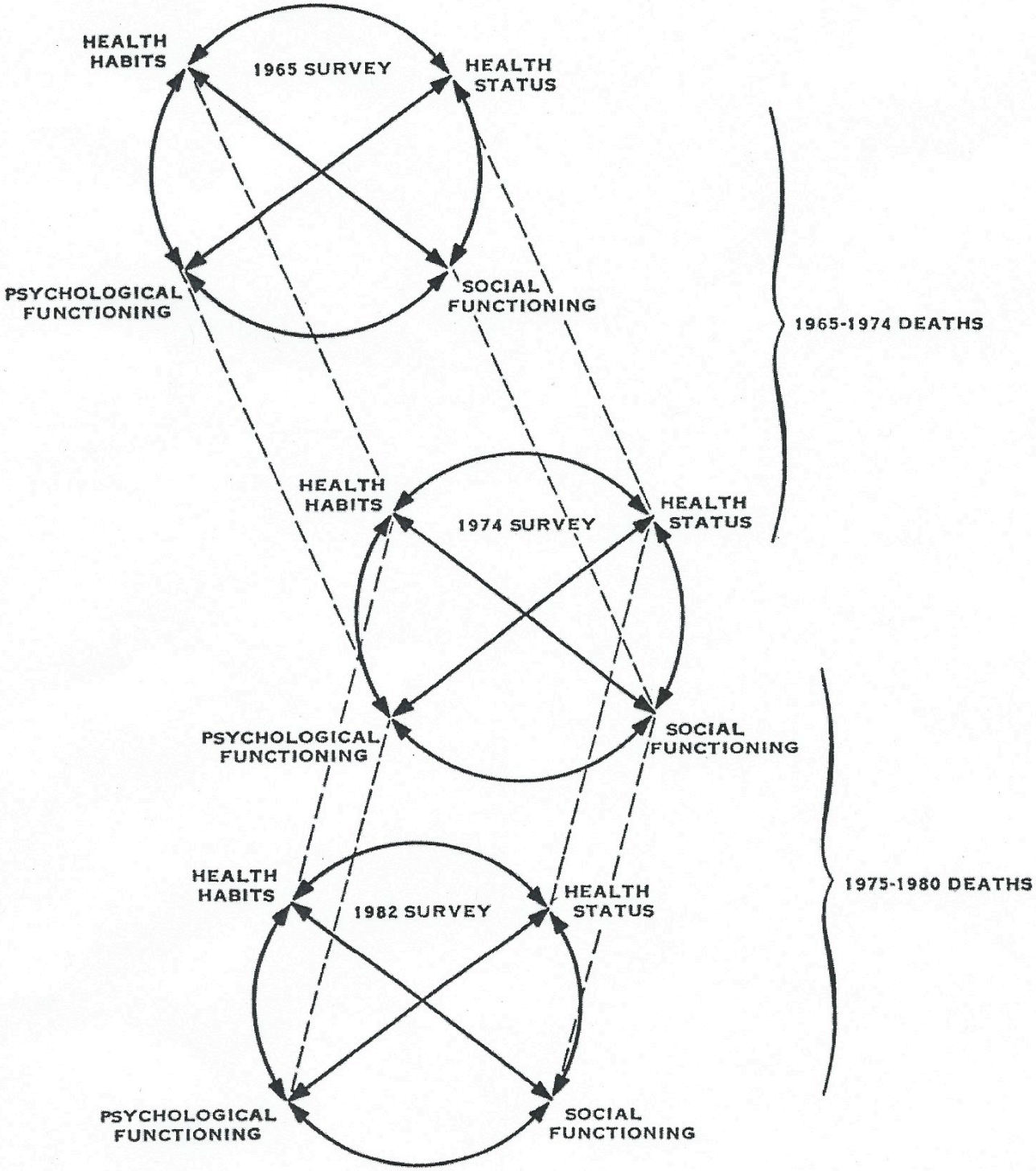
Then there are a series of questions about 11 physical ailments—such as frequent cramps in the legs, pain in the heart, pain in the heart or chest, trouble breathing or shortness of breath, paralysis of any kind, stiffness or any swelling or aching of any joint or muscle, swollen ankles, stomach pain, headaches, back pain, and constant coughing or frequent heavy chest colds. I think you can begin to see that we started with many standard epidemiologic questions. We also asked questions of impairment having to do with the ability to perform activities of daily living, self-care activities, changes in having to cut down in work, etc.; we also asked questions that have to do with whether or not people are employed, self-employed, the kind of work that they do, occupations, type of job, how good they are at what they do, how many different times they have changed jobs, how much hard physical labor they do in their job, and if they worry about keeping the job.

Then we asked questions about health habits. This area has probably received the greatest attention among health education and risk reduction people. It's very important information and, I think, in conjunction with some other information, gives a lot of clues for prevention. The questions about habits involved how often they eat breakfast and snack, alcohol consumption, usual amount of sleep, smoking, and physical activity in leisure time.

In later contacts with the respondents we asked about the presence of certain kinds of stressors. Questions concerning the occurrence of change in residence, bereavement, neighborhood deterioration, divorce, etc., were asked.

There were also questions about people's feelings—general psychological indicators that give you some ideas about depression and morale. Of course, standard demographic information was also collected. Other questions addressed people's social involvement—their marital status, how they felt about their marriage, and/or their children, whether they were involved with other friends and relatives, and how often they saw them. In addition they reported on more formal social activities such as participation in organizations and religious groups. Now I just want to point out something. These are all questions which people currently include in surveys, because it's now recognized that social connections and social support impact on health. But in 1965, this was not generally recognized and I think that it's a real tribute to the thinking of Lester Breslow and his early

FIGURE 1— *Design of Human Population Laboratory Study*



colleagues at HPL that this kind of information was included in 1965. Today as I examine the HPL data I consider myself very fortunate that 16 years later I have these types of data.

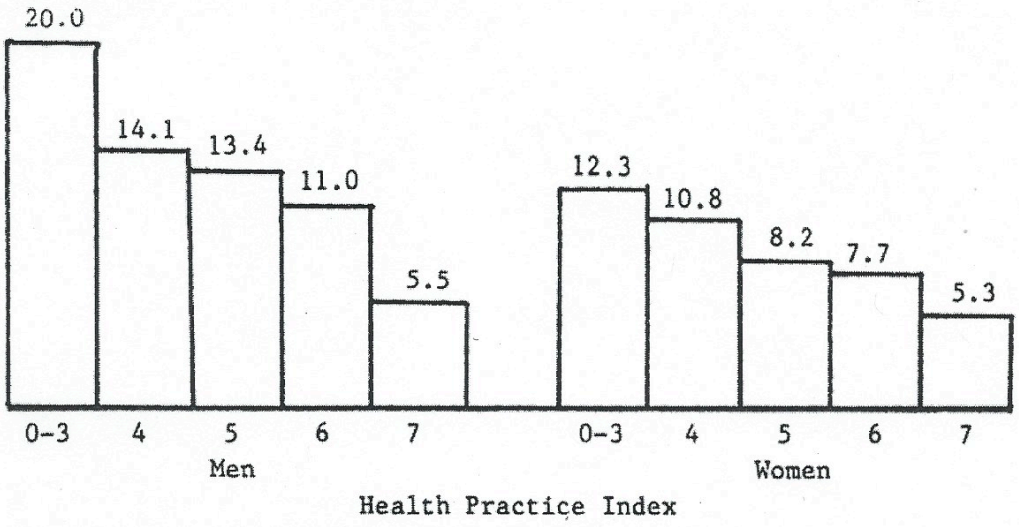
Finally, the last question asked is probably the most important of all - "Would you please give the name of a relative or friend outside of the household with whom you keep in touch, in case we want to contact you in the future." In 1965 the HPL was already planning to follow these people at a later date and knew how difficult it would be to follow up without such a contact person. In fact it was difficult because as we later found out, 60% of this population moved in the period 1965-1974.

In 1974 in order to locate the survivors from the 1965 survey we first attempted to identify all those who had died in that 9½ year period. Even this was difficult. HPL staff developed a computer linkage system which allowed us to scan the California death registry for our 1965 respondents. This is a procedure which will become more and more common as we develop a national death index, but it is a very complicated business; people change their names, they appear as Robert in one place and Bob in another; or they change their names by marriage, or whatever, so it's difficult but possible to carry out. In 9-1/2 years we identified 717 deaths that had occurred in this population. We then put all our resources into tracing the other people, i.e., the people believed to be living. These absolutely heroic efforts involve calling employers, neighbors, current residents of previous residences, searching records out of state, etc. With these efforts, it was possible to account for 96% of this population 9 years later. There were only 252 out of 6,928 who were not found. For purposes of analysis these people were considered lost to followup.

In 1974, we were able to find almost all of the 1965 respondents who were still alive and to measure health habits, psychological functioning, health status, and social functioning for the second time. Half of these 1974 respondents will be interviewed again in 1982. Thus, this year we will have 17-year mortality figures.

Now, I will highlight a few of the findings from a variety of different domains that have come out of the HPL studies in order to indicate the broad spectrum of risk factors associated with the future health of this population. Probably the most often quoted result from this study is the relationship between number of health practices and mortality. The health practices index is composed of information reflecting smoking, height relative to weight, alcohol use, leisure time physical activities, sleeping patterns, and eating snacks and breakfast. Figure 2 shows both for

FIGURE 2 – *9-Year Mortality/100 for Alameda County Residents Aged 16-94*



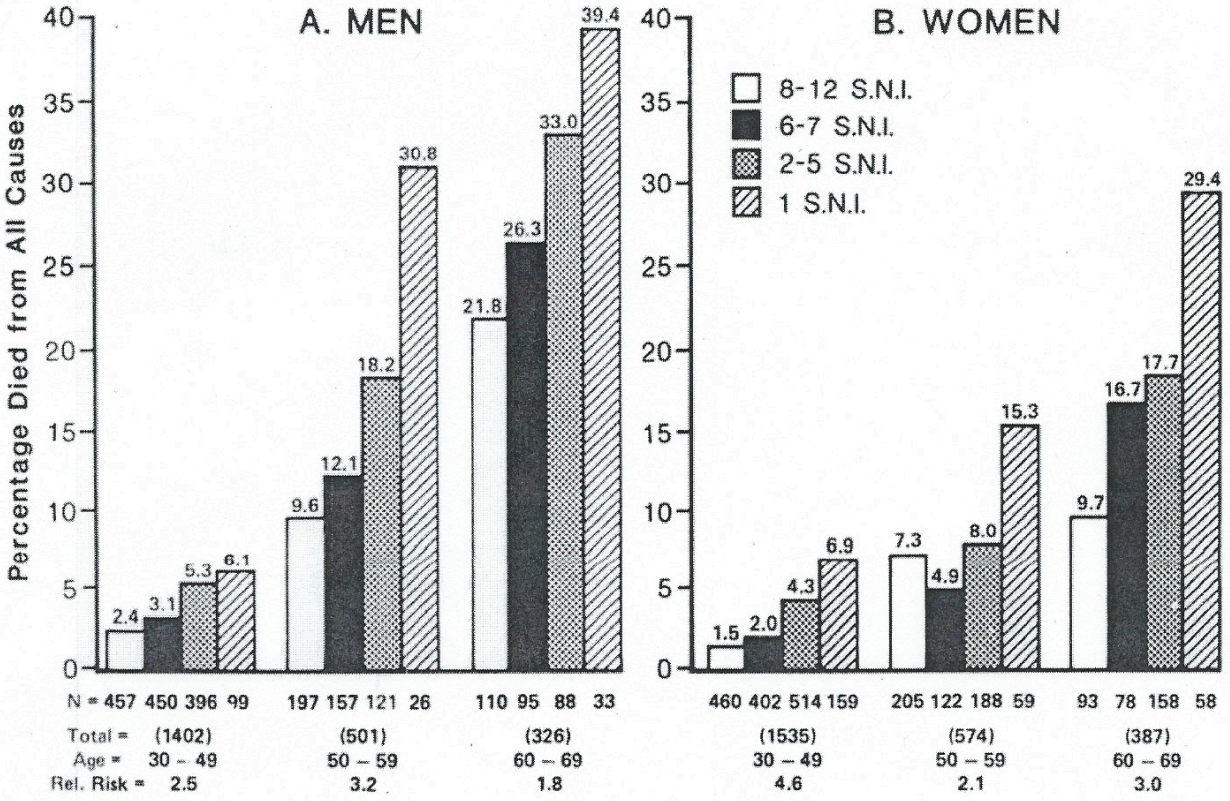
Source: Breslow L, Enstrom JE, 1980

men and women that there is the same pattern of mortality associations with the practice of more health habits with lower mortality rates.

People who practiced seven good health practices have the lowest mortality, while people who practiced zero to three good health practices show the highest. That is true in each age group and for both men and women. The overall relative risk associated with practicing zero-three versus seven health practices is approximately 3.6 for men and 2.3 for women. What that says is that if you do all these things, if you smoke, if you are over or under average weight, if you drink more than moderately, have little leisure time physical activities, and if you sleep more or less than 7-8 hours, your risk of dying during the next 9 years is around 2.3 times that of somebody who does not do any of those things. So I think this is the strong evidence that has buttressed a lot of prevention activities, i.e., the notion that there is a relationship between discretionary behavior and health—the things people do—studied in a large community, and future mortality. It turns out that this relationship also exists between future morbidity. People's health status in 1974 was related to how many of these discretionary health practices they had practiced.

A second major domain of analysis that has been carried out at the HPL involves looking at the relationship between measures of social functioning and future health. Berkman and Syme created what they called a social network index. This index is a measure of the extent to which you are involved with friends and relatives, are married vs. single, and belong to formal or informal groups. As you can see in Figure 3 people who were more involved in their social environment show a lower mortality rate between 1965 and 1974. Furthermore, this association between social participation and mortality remains when 1965 health status or health practices are taken into account.

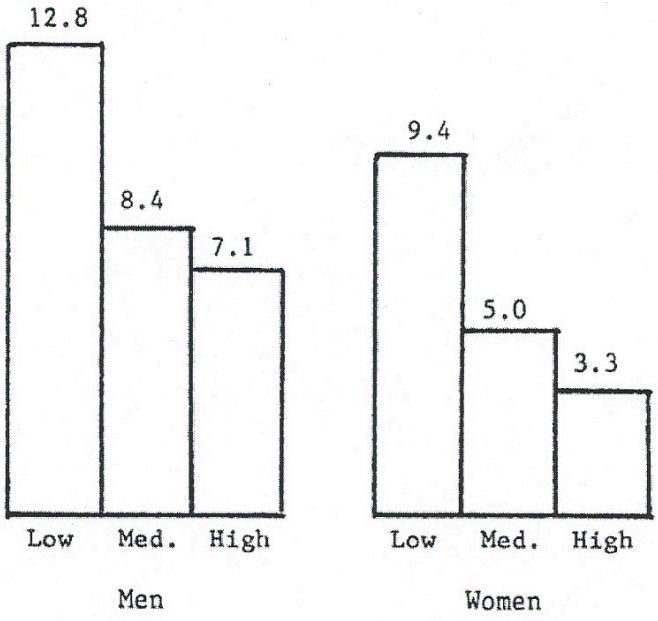
FIGURE 3 – *Mortality Rates from all Causes by Social Network Index Age, Sex-Specific Rates, 1965-74*



Psychological variables such as life satisfaction are also importantly associated with mortality. An index was created from responses to a variety of items in the HPL questionnaire which asked how satisfied respondents were with their life in general, with specific areas of life—work, marriage, family, etc. As you can see in Figure 4 those who reported high life satisfaction had low moratality rates, and those who reported low life satisfaction had high rates.

So what have we found? We have found that the things that poeple do, their social interaction with other people, and how they feel about their life are all related to mortality and, in some cases, morbidity.

FIGURE 4 – *9-Year Mortality Rates/100 for Alameda County Residents Aged 30-69*



Source: Berkman L, Syme SL, 1978

We have also examined the relationship between the occurrence of various life stresses and respondents' health. Here, instead of looking at mortality, we examined the 1974 health status of 1965 respondents. On the basis of their age, sex, and physical health status in 1965, we predicted their physical health status in 1974. We then examined the deviations between this predicted health status and actual health status for those who reported the occurrence of various negative life events. As you can see in Figure 5, the number of negative life events which they reported happening in the 3-year period prior to 1974 was related to 1974 health status. Those who reported six or more negative events have substantially poorer physical health status than was predicted. Figure 5 also shows deviations from predicted health status for specific negative events: separation or divorce, financial problems, neighborhood deterioration, and death of a spouse.

Thus we see from these analyses that a variety of aspects of people's lives are related to their survival. Identification of these risk factors can help substantially, we believe, in the planning of interventions and also in the analyses of why some interventions fail and others succeed.

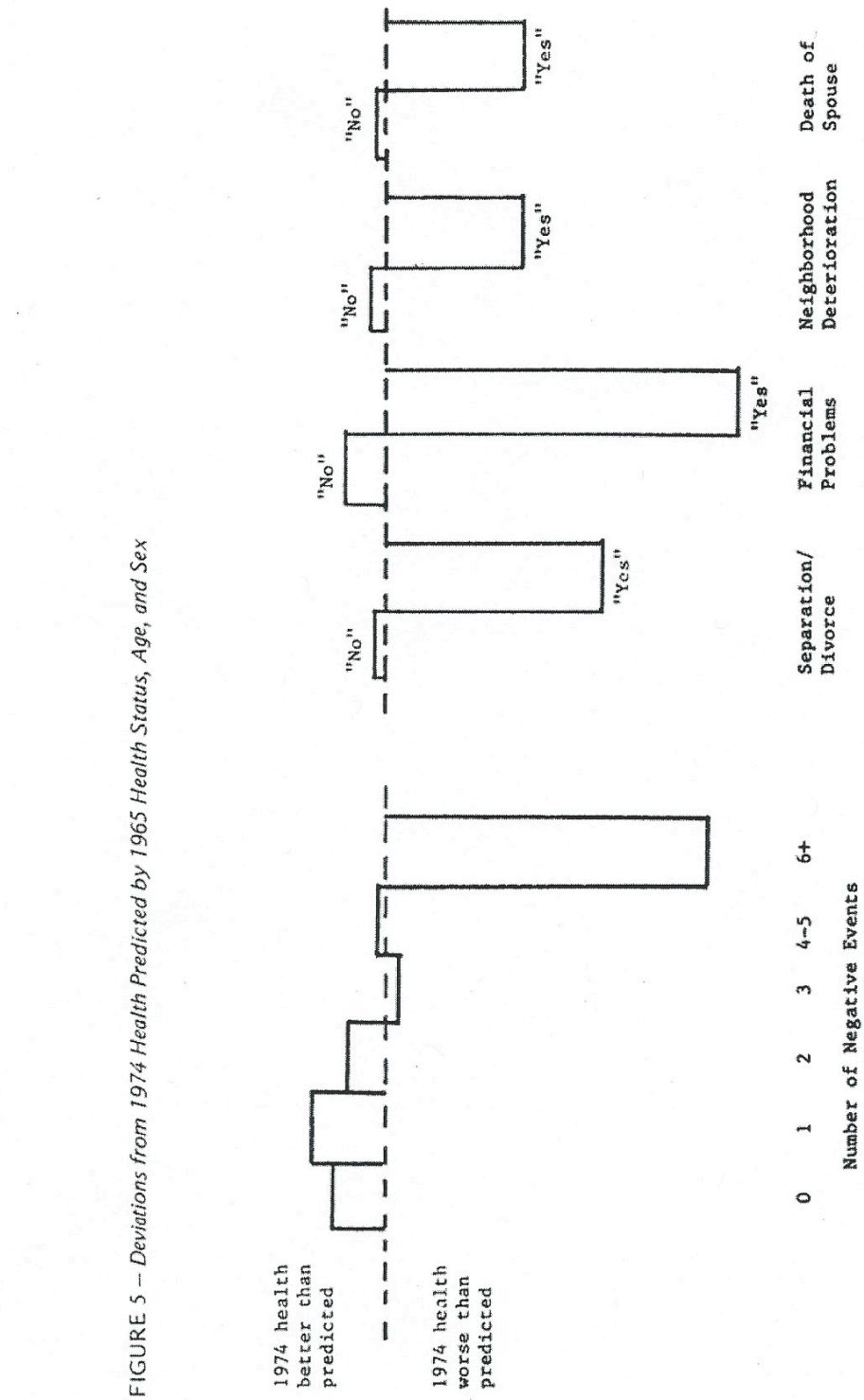


FIGURE 5 — *Deviations from 1974 Health Predicted by 1965 Health Status, Age, and Sex*

For example, successful intervention programs often involve action at all of these levels. If you look at some of the large-scale clinical trials, evaluating, for example, the effectiveness of a new anti-hypertension drug you can generally see that the intervention involves more than just a new drug. Participants in such studies find themselves involved in a new social support system. They become part of a new reference group that involves all the other people who are also being treated. They're sometimes even driven to the clinic to be checked. They get lots of encouragement, social support, and they probably feel better about themselves as a result. I think this has got to become a part of any successful intervention; what's happening in successful intervention probably involves interaction between all of these different factors. In fact, I think it's highly likely that these efforts act synergistically. Successful antismoking attempts are another good example. They often involve creating peer support groups and involve more than just risks. They involve restructuring the nature of people's social and psychological support systems and how they feel about themselves.

The work in the future at HPL will involve following up on many of the findings and ideas which I've been mentioning, and also continuing data collection. Starting in January, we will be out in the field interviewing a 50% sample of the people who responded in 1974 and who are still alive. One of the major purposes of this third wave of data collection is to be able to look in more detail at things that have to do with trajectories of health—both upward and downward. What makes some people more resistant or hardier?

Increased host resistance which allows some to remain healthy over time more likely than not involves features of the individual's social, psychological, and behavioral functioning. We will be searching for the thread which links them all.

We will also be examining 1965-1974 changes in levels of physical activity, smoking, and health practices between in general. We will be able to get estimates about the impact of those changes on future health. In order to understand these changes we are also we will look to factors in their social and psychological environment in 1965 which made it more likely that they will change. Thus we are starting to look in a more complex way at the relationships between a variety of factors and health in these data. I am convinced that the information from this will be relevant to many kinds of prevention and intervention efforts.

In addition to these general health outcomes, we will also be looking at factors related to specific conditions and causes of death, and issues associated with aging, disability, and improved health functioning in the aged. Our overall purpose in this phase of HPL analysis is to obtain more information on the factors that are associated with less or more risk in individuals, in order to have better documentation on areas where prevention is most called for. Through this analysis we hope to help focus prevention and intervention efforts where the impact is likely to be greatest.