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The Health of Seniors is both our largest national health problem and our largest national economic problem. Lack of systematic, regular exercise is the largest single contributor to disability, diminished quality-of-life, and unnecessary medical expenses for seniors.

I will make three points and briefly explore their policy implications. First, the underlying theory behind healthy aging is represented by the Compression of Morbidity paradigm. Second, new data document postponement of disability and infirmity in seniors by eight to twelve years through regular exercise and through changes in other risk factors. Third, major randomized controlled trials in seniors prove our ability to increase exercise, improve other behavioral risk factors, to improve health, and to reduce medical care costs.

The Compression of Morbidity paradigm envisions reduction of lifetime infirmity, shown on the chart as the shaded area, and of medical care costs by compression of the period of morbidity between an increasing average age at onset of disability and the average age of death. The healthy life is seen as a life vigorous and vital until shortly before its natural close. The strategy is that of postponing the onset of disability and high medical costs through prevention of diseases and reduction in medical care costs. However, for much of this century there was movement away from this ideal, with a steady increase in the proportion of a typical life spent ill or infirm. The acute infectious diseases of 1900 had given way to chronic diseases, resulting in longer periods of disability and morbidity.

As people took better care of themselves and lived longer, some suggested, they would live into those later years in which disability is greatest and would experience an increase in overall lifetime disability. Such critics feared that good behavioral health habits would lead to a large population of enfeebled, demented elders who would pose an immense strain upon medical care resources. In the chart, present average disability is represented by the top line and is concentrated between an average onset at age 55 and the average age at death, now just over 75 years. In future scenarios, extension of morbidity, on the second line, occurs if longevity is increased but the onset of disability is not postponed; this is the worst scenario. Compression of morbidity, on the third line, occurs if disability is postponed more than longevity is extended, as with the effects of exercise. The direct test of compression (or extension) of morbidity depends upon the effects of reduced health risks upon cumulative lifetime disability.

New longitudinal data document the ability of exercise to greatly postpone the onset of disability with age. For 14 years our research group at Stanford has studied the effects of long distance running and other vigorous exercise on patient outcomes in 537 members of a senior runners club, now averaging 70 years of age, compared with 423 age-matched community controls. Disability levels were assessed yearly, allowing the area under the disability curve to be computed. Runners, exercising vigorously for an average of 280 minutes per week, delayed the onset of disability by about 10 years compared with controls. Longevity differences between groups, on the other hand, are projected as only 2 to 3 years. Both male and female runners increased disability at a rate only one-third that of the controls, after adjusting statistically for age, initial disability, educational level, smoking behavior, body mass index, history of arthritis, and the presence of comorbid disease. As these subjects moved from age 58 toward age 70, the differences in disability rates between the exercising and the control

population actually increased, rather than decreased. Lifetime disability in exercisers is only one-third that of sedentary individuals. We have reported similar effects in the University of Pennsylvania alumni study and major studies by other groups confirm these findings. Daviglus and colleagues show substantial decreases in Medicare costs for those with few health risk factors in mid-life. Freedman and Martin showed significant age-specific functional improvement in seniors over a recent seven year period. Reed and colleagues related healthy aging to prospectively determined health risks, with results closely similar to ours.

Randomized controlled trials prove our current ability to achieve healthier and less costly senior lives through relatively inexpensive health improvement programs costing less than \$100 per year per person. The Bank of America retiree study, the very large California Public Employee Retirement System trial, disease-specific trials in arthritis and in Parkinson's disease, and trials of self-management materials all have documented our ability to both reduce health risks and to achieve a substantial return on investment.

Health policy implications follow:

- The Health Care Financing Administration must be enabled to provide effective health improvement programs for all Medicare beneficiaries. The cost will be modest.
- Incentives for behavioral risk reduction in seniors need to be provided.
- A review process must limit covered programs to those with proven effectiveness.
- Risk reduction must be an essential part of HCFA planning.
- Research through the AHCPH and the NIA must work toward improved behavioral interventions and rigorous program evaluation.
- Federal efforts must be coordinated for efficient implementations.

Healthier senior populations are achievable, and the personal and societal benefits will be very large indeed.