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Influence of Age and Health Behaviors on Stroke Risk: Lessons from Longitudinal Studies

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Abstract

Stroke is a major cause of death and serious neurological disability among elders in the United States today. The most effective means available for reducing the burden of stroke involves risk factor modification. Given the growing numbers of elderly adults at risk for stroke, it is increasingly important to identify those health behaviors that can produce significant change. Ongoing longitudinal studies have identified several behavioral factors that have been shown to improve overall health and reduce the risk of stroke. These include effective management of hypertension, cessation of cigarette smoking for those who smoke, and maintaining a healthy diet and active physical lifestyle. Since modification of risk factors remains a primary intervention for effective prevention of stroke, community-based studies that address and institute stroke prevention strategies have the best opportunity to reduce or postpone the devastating impact of stroke.

Keywords

stroke; prevention; risk factors; disability

INTRODUCTION

It is widely accepted that stroke is the most common life-threatening and disabling neurologic disease to affect elders in the United States today¹. The risk of stroke is substantial, often deadly and for the majority of survivors, disabling^{2;3}. With an ever increasing elderly population, stroke-related health problems and their impact on quality of life continue to be a major issue for health care providers and the communities they serve. From longitudinal studies we have accumulated much information on the incidence of stroke, an undistorted picture of its impact, an appreciation of the importance of risk factors and evidence that prevention strategies reduce stroke and its aftermath.

Several longitudinal studies have applied an epidemiological approach in an effort to understand the role of risk factors to stroke. Data from studies such as the Baltimore Longitudinal Study of Aging (BLSA), the Northern Manhattan Study (NOMAS), Atherosclerosis Risk in Communities (ARIC), the Cardiovascular Health Study (CHS), the Framingham Heart Study (FHS) and others constitute much of the state of the science in

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stroke epidemiology. In this paper, research predominately from the FHS will be cited because of its long standing contribution to stroke epidemiology. The FHS is a three generation longitudinal, community-based cohort study which was first initiated in 1948 and continues today. The focus at its inception was to document health and occurrence of cardiovascular disease including stroke and other diseases as they evolve over a lifespan in a community-based population sample. From FHS and other similar studies, we know that reduction in the incidence of stroke requires the identification of risk factors and the development of health strategies to reduce or eliminate them. Although it is vital to pursue technological advances in the treatment of stroke, it is equally important to provide interventions that can reduce or postpone the risk of stroke itself. The recent downward trends in stroke death^{4, 5} and disability rates are good indications that fatal and disabling strokes are not an inevitable consequence of aging. The superiority of planned systematic observations of populations as carried out in longitudinal studies to assess incidence, prevalence and factors associated with increased risk of stroke has been convincingly demonstrated.

DISCUSSION

Lifetime incidence and outcome following stroke

Clinical stroke, defined as rapidly developing signs of focal neurologic disturbance of presumed vascular origin and lasting more than 24 hours. The risk increases with age, the incidence doubling with each decade after the age of 45 years and over 70% of all strokes occur above the age of 65. Of the estimated 795, 000 new or recurring strokes that occur in the United States each year, approximately 145, 000 will result in death¹. For the 6.5 million individuals who survive a stroke and are alive today, nearly half will have moderate to severe neurological deficits, 30% will be unable to walk unassisted and over 25% will need assistance in their daily activities.⁶ The overall lifetime risk for stroke in men has been calculated to be 1 in 6 and 1 in 5 for women,³ men having higher rates in younger years and women in older ages (Figure 1). Because of a longer life expectancy for women, each year 55,000 more women have a stroke than men^{1;2}.

Stroke is also the leading cause of serious long-term disability. Studies using longitudinal data have determined the influence of older age and gender on disability after stroke.^{6;7} In Framingham, women were found to be significantly older (75.1 vs. 71.1 years) at the time of their initial stroke, more likely to be dependent in activities in daily living and mobility⁵ and were more than 4 times more likely than men to be institutionalized in a nursing home following stroke². The devastating residual disability associated with stroke, in addition to presence of other chronic illnesses at the time of the stroke, makes stroke one of the most feared consequences of aging.

Risk Factors: General Considerations

The term “risk factor” has evolved from epidemiological evidence relating suspected predisposing factors to subsequent development of disease. Risk factors are relevant if they are strong and dose-related, predictive in a variety of samples, pathogenically plausible and supported by other investigations.⁵ Data from longitudinal studies have shown that some of the most powerful lifestyle modifications to lower risk of stroke include reducing elevated blood pressure, cessation of smoking, daily physical activity and maintenance of a healthy diet and weight.^{8;9} It has been demonstrated that even a modest change in lifestyle risk factors are achievable and have a substantial effect on risk. Genetic background, information on risk factors and behaviors, and presence of subclinical conditions provide the most realistic appraisal of an individual’s future vascular risk (Figure 2). For the community at

large, improving health behaviors provides the best approach to reducing risk of stroke and its recurrence.¹⁰

Cigarette Smoking—Smoking is probably the greatest cause of preventable illness in the US today. Still approximately 20% of the adult population continues to smoke.¹ In several longitudinal multivariate studies it has been shown that cigarette smoking is a potent risk factor for stroke^{11–13} and that there is a dose-response relationship.¹⁴ For smokers, this risk continues throughout life, in both sexes and in various racial groups. In a meta-analysis of 32 studies, cigarette smoking was found to be a significant independent contributor to stroke with about a 50% increase in risk compared to non-smokers^{11;15} and smoking contributed to 12% to 14% of all stroke deaths. Cigarette smoking increases heart rate, blood pressure and the development of atherosclerosis and cessation has been associated with a significant risk reduction for stroke starting in the first year after quitting.¹¹ Because of the strong independent risk associated with smoking, cessation deserves a high priority in management of stroke risk. Advances in effective behavioral and pharmacologic interventions make quitting an achievable goal for the individual and an appropriate challenge for the public health of a community.

Physical activity—It is well documented that physical activity exerts a beneficial protective effect on reduction of stroke risk and recurrence throughout life including in older adults^{16–19}. This association was first described in 1967 in the longitudinal study of former male college students²⁰. More recently in the Nurses Health Study and the Women's Health Initiative, mild exercise such as walking was associated with reduced risk^{16;18}, and in postmenopausal women, slow walking speed was a strong independent predictor of increased risk of stroke.²¹ In a multiethnic longitudinal study of older, multiethnic, urban-dwelling stroke free individuals, greater exercise intensity was found to be associated with lowering stroke risk for men¹⁹. A meta-analysis report of physical activity and stroke risk concluded that moderately and highly active adults had a lower risk of stroke than low-activity adults. Moderately active adults had a 20% stroke risk reduction and in highly active adults, a 27% risk reduction.²² Possible mechanisms activated in physical activity to reduce risk include reduction in plasma fibrinogen, decrease aggregability of platelets, lowering blood pressure and reducing weight²³. Despite the documented benefits of an active life as demonstrated in a number of longitudinal studies, sedentary lifestyles continue to be an increasing trend. For stroke, the benefits of even light to moderate activities results in an important health benefits in the pathway to stroke reduction.

Diet—Several aspects of diet have been associated with stroke risk. The two aspects of diet that deserve attention in stroke prevention are healthy eating choices and maintaining normal weight. In the Nurses Health Study and the Health Professionals' Follow-Up Study, increased consumption of fruits and vegetables was associated with a stroke risk reduction, with a linear relationship of greater consumption to lower risk.²⁴ For each 1 serving a day increment of fruit or vegetables, the risk of stroke was reduced by 6%. In a meta-analysis of 9 cohort studies, He and colleagues found strong evidence to recommend consumption of at least 5 servings of fruits and vegetables per day.²⁵

A dramatically increasing health problem in the US today is the prevalence of obesity and overweight.²⁶ In a community-based longitudinal study, Suk found that ischemic stroke was strongly related to obesity (OR 3.0, 95% CI 2.1–4.2)²⁷ as well as hypertension, diabetes and cardiovascular disease. Among male health professionals followed for up to 12.5 years, BMI >30 was associated with an adjusted relative risk (RR) of stroke of 2.0 (95% CI 1.5 to 2.7).²⁸ Current guidelines recommend weight reduction for stroke prevention along with daily physical activity and improvement in obesity-related risk factors.¹⁰

Hypertension—A major finding from cohorts followed longitudinally over time is that modifiable behaviors such as smoking, physical inactivity, and inadequate diet have an important cumulative association to hypertension and thus potentiating the risk of stroke through the mechanism of involved with increasing blood pressure parameters. Hypertension, the most prevalent and modifiable risk factor for stroke, increases with age and has a lifetime probability of 90% in those who survive to 80 years.²⁹ Longitudinal studies have demonstrated that there is a strong consistent association between blood pressure and stroke in both men and women, for fatal and non fatal stroke and at all ages. Following individuals over decades has shown that starting at mid-life, blood pressure increases the relative risk of stroke by 1.7 fold in men and 1.9 fold in women per SD increment.³⁰ Treatment at any age is effective. Even in those 80 years and older, antihypertensive therapy in those with hypertension reduced stroke risk by 30% and mortality by 21%³¹. Despite strides in the identification, treatment and monitoring of hypertension, only 70% of Americans are aware they have the condition and less than a third are controlled.³² For hypertensive individuals, lifestyle changes in health behaviors and/or medications are the best approach to effective management to reduce stroke risk.

Psychosocial behaviors and risk—It has been suggested that our psychosocial well-being interacts with biological factors to influence risk of disease. Longitudinal studies provide an appropriate venue to follow the association of psychosocial well-being with health behaviors over sufficient amount of time to observe the relationship, interactions and the effect on health and disease. Evidence derived from longitudinal studies has demonstrated that marital strain, job stress and depression are associated with coronary heart disease, mortality and stroke^{33; 34;35}. Depression has been associated with unhealthy health behaviors such as inactivity, change in diet and increased smoking.^{36;37} and starting at middle age, its presence has been associated with increase risk of stroke in both men and women.³⁶

A new model for novel risk factor interaction is currently evolving around the association of social connections and health behaviors. In two recent studies both obesity and smoking were shown to spread through social ties. For example, if the person you admire is overweight or a smoker, over the years you also tend to adopt that behavior. One's social network and health behaviors, both positive and negative, are connected over time and with exposure^{38;39}. Addressing the influence of psychosocial stress, depression and social interaction through community-based longitudinal studies is an evolving and appropriate inquiry.

RECOMMENDATIONS FOR FUTURE RESEARCH

Identification of modifiable health behaviors remains a critical element in the prevention of stroke. Given the growing numbers of elderly adults at risk for stroke, it is increasing important to identify those lifestyle choices and social factors that can reduce risk. Lack of management of hypertension, smoking, physical inactivity and obesity put elders at high risk for disabling strokes. It is clear that more resources should be directed towards research on determinants of lifestyle behaviors and effective interventions to change them. Isolation and lack of community support for engaging in healthy behaviors increase levels of risk. By targeting modifiable risk factors in the healthy elderly, it is possible to avoid or postpone stroke; and for those who have had a stroke, reduce its impact.

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Figure 1.
Gender-specific mortality-adjusted cumulative incidence of lifetime risk of stroke.

Figure 2.
Stroke Risk Model