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Prevention of heart disease, cancer and stroke: the scientific basis

Heart disease, cancer and stroke cause more than two out of three deaths in the United States annually. This toll is largely a result of risk factors such as smoking, unhealthy diet, high blood pressure, physical inactivity, and exposure to toxic substances in the environment. There is compelling evidence from various countries that the prevalence of these factors can be significantly lowered and that the mortality attributable to the diseases can thereby be greatly diminished.

Heart disease, cancer and cerebrovascular disease cause almost 70% of deaths in the United States. Approximately half of these deaths occur before the age of 75, which is the average life expectancy in the country, and are therefore considered to be premature. The cost of the diseases has been estimated at US$ 120 billion annually and the pain and suffering they cause are immeasurable. The situation is particularly tragic because most of the premature deaths are preventable and because a large number of the deaths that occur after the age of 75 could be either prevented or substantially delayed.

Leading causes of death

Heart disease is the leading cause of death in the United States, being responsible for almost 40% of all mortality (Table 1). Second and third are cancer and cerebrovascular disease, which account for 22% and 8% of deaths respectively. Mortality rates for heart disease and cerebrovascular disease have declined significantly over the past two decades. Those for cancer have increased slightly during the same period, largely due to an increase in the incidence of lung cancer.

Studies conducted during the past 30 years have identified a number of factors that increase the risk of developing heart disease, cancer and cerebrovascular disease. Most of the risk factors fall into two broad categories: unfavourable life-style and environmental toxic exposure.

Risk factors for heart disease

More than 80% of deaths from heart disease are due to ischaemic heart disease, three major risk factors for which have been

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Table 1. Leading causes of death, United States, 1982

Causes of death	Numbers of deaths	% of all deaths
Heart disease	755 592	38.3
Cancer	433 795	22.0
Cerebrovascular disease	157 710	8.0
Accidents	94 082	4.8
Chronic obstructive pulmonary disease	59 869	3.0
Pneumonia and influenza	48 886	2.5
Diabetes	34 583	1.8
Suicide	28 242	1.4
Chronic liver disease and cirrhosis	27 690	1.4
Arteriosclerosis	26 823	1.4
All other causes	307 525	15.6

identified: elevated serum cholesterol, high blood pressure, and cigarette smoking. The higher the level of each, the greater is the risk. If the serum cholesterol level is 240 mg/dl the risk of developing heart disease is double that for a serum cholesterol level below 200 mg/dl; a level of 300 mg/dl increases the risk fivefold. A blood pressure of 160/95 mmHg increases the risk of developing heart disease twofold compared with a level below 140/90 mmHg; a level of 200/120 mmHg increases the risk fivefold. A one-pack-per-day cigarette-smoker has double the risk of developing heart disease compared with a nonsmoker, and a two-pack-per-day smoker has three times the risk of the nonsmoker.

Studies in various countries have clearly shown that the prevalence of heart disease is directly proportional to the average serum cholesterol level in adults and to the average adult blood pressure. A study of people who migrated from Japan to Hawaii and then to California showed that, as they moved eastwards, their dietary fat intake, serum cholesterol levels, and mortality from coronary heart disease all increased. Another study revealed significant direct correlations between the percentage of calories derived

from fat, mean serum cholesterol levels, and the presence of advanced atherosclerotic lesions in 15 widely differing populations. Within the populations, there was also a direct correlation between individual serum cholesterol levels and the extent of coronary artery disease.

Studies in various countries have shown that the heart disease rates in each were directly related to both the prevalence and intensity of smoking (1). The greater the number of people who smoked, the higher was the risk of developing heart disease, and the risk increased with the number of cigarettes smoked.

Each of the major risk factors independently increases the risk of developing ischaemic heart disease. On average, the presence of any one of the three major risk factors for heart disease increases the risk about twofold. When all three are present to a moderate degree, e.g., one-pack-per-day cigarette smoking, serum cholesterol of 220 mg/dl, and blood pressure of 160/95 mmHg, the risk increases tenfold. If the levels of these three risk factors are higher, the risk increases even more.

The three major risk factors for heart disease are largely a reflection of life-style. For example, elevated serum cholesterol results

> **Within a year of stopping smoking, a person's risk of developing heart disease falls by almost half.**

primarily from a diet high in fat, particularly saturated fat. In the average American diet, 40% of the calories are derived from fat, approximately 16% coming from saturated

fat. These values considerably exceed those in countries with lower rates of heart disease. Numerous population-based studies and metabolic ward studies indicate clear correlations between serum cholesterol

> **Most heart disease is caused by elevated serum cholesterol, smoking, high blood pressure and/or physical inactivity.**

levels and the amount of fat and cholesterol intake as well as the type of fat ingested.

Blood pressure is strongly influenced by life-style. The most important factor is salt intake; the more salt a person habitually eats, the greater is the risk of developing high blood pressure. The heavier a person is, the greater is the likelihood of developing high blood pressure. A third important factor is alcohol intake; the greater the alcohol intake, the higher is the average blood pressure. Physically inactive people tend to have higher blood pressure than the physically active. Finally, there is growing evidence that diets high in fat can lead to increases in blood pressure.

Minor risk factors

Several minor risk factors for heart disease have also been identified. The most important is physical inactivity. As with the other risk factors, the risk is graded in nature, i.e., the more inactive a person, the greater the risk. On average, physical inactivity increases the risk of developing heart disease by a factor of 1.5–2. A low level of high-density lipoprotein cholesterol has been linked to an increased risk of developing heart disease, particularly in persons aged over 50; high-density

lipoprotein cholesterol levels are higher in persons who are physically active, do not smoke, and are lean than in those not having these attributes.

Diabetes raises the risk of developing heart disease approximately twofold. The use of oral contraceptives raises the risk approximately fourfold, and this increases to almost fortyfold if smoking also occurs. Type A behaviour (characterized by competitive drive, hostility, and a sense of urgency or impatience) has been linked in several studies to an increased risk of developing heart disease, although other studies have not confirmed this association.

Studies on the role of obesity as an independent risk factor for heart disease have given conflicting results. Much of the risk due to obesity appears to result from the significant adverse changes it causes in the prevalence of high blood pressure, elevated serum cholesterol, low high-density lipoprotein cholesterol, and diabetes, as well as its strong association with physical inactivity. However, recent data suggest that there is probably an additional increase in risk due to obesity above that attributable to the associated accentuation of these other risk factors.

It is clear from Table 2 that most heart disease is caused by elevated serum cholesterol, smoking, high blood pressure and/or physical inactivity. It is highly unusual for a person unaffected by any of these risk factors to develop ischaemic heart

Table 2. Percentages of heart disease attributable to risk factors, United States, 1982

Risk factor	% of heart disease
Elevated serum cholesterol	30–40
Smoking	20–25
High blood pressure	20–25
Physical inactivity	10–20

Table 3. Cancer deaths by site, United States, 1982

Site	% of cancer deaths
Bronchus and lung	25.8
Colon and rectum	13.3
Breast	8.7
Prostate	5.4
Pancreas	5.2
All other sites	41.6

disease. Table 2 shows that elevated serum cholesterol is the single most important risk factor for ischaemic heart disease.

Risk factors for cancer

The percentages of cancer deaths by primary site in 1982, based on data from the National Center for Health Statistics, are presented in Table 3. The mortality rate for most cancer sites has been relatively stable in the past 20 years, the major exception being lung cancer, which has risen dramatically. Cancers of the lung, colon and breast account for almost 50% of deaths from cancer.

A diet high in fat, such as is common in the USA, increases the risk of developing three of the most common cancers: colo-rectal, breast and prostatic. There is also some evidence linking several less common cancers to excessive dietary fat. The fact that a low fat intake is associated with low rates of cancer is especially important since, as noted earlier, a low-fat diet is also associated with a low rate of heart disease.

Low intake of vitamin A is associated with an increased risk of developing lung cancer. Low fibre intake is associated with an increased risk of developing colo-rectal cancer. The average American diet is low in both of these factors. High intakes of smoked or pickled foods increase the risk of developing stomach cancer; the

consumption of these foods has decreased in recent years, as has the incidence of this type of cancer. Finally, there is some evidence linking obesity to an increased risk of developing certain cancers; at least part of this increased risk is probably due to excessive dietary fat consumption rather than to obesity itself.

Cigarette smoking is responsible for most lung cancer and significantly increases the risk of developing cancers of the mouth, larynx, oesophagus, bladder, pancreas and kidney. It may also increase the risk of developing cervical cancer.

Excessive alcohol consumption is a risk factor for cancers of the buccal cavity, pharynx, larynx, oesophagus and liver, among others. For several of these cancers, alcohol and cigarette smoking act synergistically.

The extent to which exposure to toxic substances in the environment and the workplace contributes to cancer rates has not been quantified precisely. A few substances such as asbestos have been clearly shown to cause cancer in humans, but many other substances have been insufficiently

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studied to determine their carcinogenicity. Exposure to many newer chemicals has occurred only in recent years and it is, therefore, too soon for them to have produced detectable changes in the incidence of cancer.

Table 4. Percentage of cancer attributable to risk factors, United States, 1982

Risk factor	% of cancer
Unhealthy diet	25–35
Smoking	25–30
Occupational toxic exposures	10–20
Environmental toxic exposures	5–10
Alcohol	3–5

At least 80% of cancers are thought to be attributable to risk factors (Table 4). Significantly, over 50% of cancers are caused by dietary, smoking and drinking habits.

Risk factors for cerebrovascular disease

Almost all deaths from cerebrovascular disease are caused by strokes, approximately 90% of which are attributable to uncontrolled high blood pressure. The higher a person's blood pressure, the higher is the risk of stroke. The risk increases substantially as the systolic pressure rises above 140 mmHg and/or the diastolic pressure rises above 90 mmHg. When both systolic and diastolic blood pressures are substantially elevated (e.g., above 190 mmHg and 110 mmHg respectively), the risk rises as much as ten times that of a person with normal blood pressure.

Several minor risk factors for cerebrovascular disease have been noted. Diabetes raises the risk approximately twofold. Cigarette smoking may raise it by a factor of 1.5, although no clear dose-response relationship between the amount smoked and the risk of cerebrovascular disease has been demonstrated. The use of oral contraceptives increases the risk two to three times and when combined with smoking a sevenfold increase in risk results. Finally, alcohol consumption increases the risk of developing cerebrovascular disease; the risk rises with the amount consumed,

and much of the increase is attributable to the effect of alcohol on blood pressure.

Overlap in risk factors for leading causes of death

The preceding outline of the epidemiology of heart disease, cancer and cerebrovascular disease shows that several risk factors are common to these causes of death. All three diseases are caused by several major and minor risk factors, each of which can result in several diseases. These interrelationships are summarized in Table 5.

Prevalence of risk factors

The problem of preventing these three diseases is compounded by the pervasiveness of the risk factors (Table 6). It is important to note that, as a rule, the risk factors first appear in childhood or early adulthood. Their prevalence suggests the magnitude of the public health problem they pose. For example, at least 80% of the population eat a diet sufficiently high in fat to increase their risk of developing heart disease and cancer. A third of adults, including more

Table 5. Risk factors for heart disease, cancer and cerebrovascular disease in the United States

Risk factor	Heart disease	Cancer	Cerebro-vascular disease
Unhealthy diet	xx	xx	xx
Smoking	xx	xx	
High blood pressure	xx		xx
Physical inactivity	x		x
Diabetes	x		
Excessive alcohol intake		x	x
Occupational toxic exposures		xx	
Environmental toxic exposures		x	

xx = major risk factor
x = minor risk factor

than 60% of those aged over 65, have high blood pressure. Most people are physically inactive. Virtually everyone is exposed to environmental toxic substances, although the exposure levels are generally low.

These risk factors affect vast numbers of people. Most residents of the United States should be considered at high risk for developing heart disease, cancer and cerebrovascular disease. Less than 20% of the population are at low risk of developing these diseases.

Efficacy of intervention programmes

The epidemiology of the leading causes of death has been recognized for a long time. However, evidence that the reduction or elimination of the risk factors diminishes mortality rates has emerged only in recent years.

High blood pressure

Three large clinical trials lasting 5 years on the effects of treatment of high blood pressure showed reductions in mortality from heart disease and cerebrovascular disease of up to 75% (2–4). The reductions began within a year of the inception of the trials. The differences in mortality between the intervention and control groups widened

Table 6. Prevalence of risk factors in the United States

Risk factor	% of adults
Unhealthy diet	80
Physical inactivity	70
High blood pressure	33
Smoking	30
Diabetes	5
Excessive alcohol intake	10
Environmental toxic exposures	100
Occupational toxic exposures	15

with the passage of time. Mortality from heart disease and cerebrovascular disease was more than 20% lower in the vigorously-treated groups than in controls by the end of the trials.

The most successful community-based intervention trial on the control of high

> **The major risk factors for heart disease are largely a reflection of life-style.**

blood pressure was the Connecticut High Blood Pressure Control Programme, a federally funded endeavour aimed at showing the effects of coordinated screening, education and referral of persons with high blood pressure. Full-scale intervention began in 1978. By 1981, age-adjusted mortality rates for heart disease had dropped by 11.6% in Connecticut, compared with 5.2% over the whole country. The declines in age-adjusted mortality rates for cerebrovascular disease were even more impressive: 28.3% in Connecticut compared with 15.5% in the United States as a whole.

Smoking

Within a year of stopping smoking, a person's risk of developing heart disease falls by almost half (5). Subsequently, it continues to decrease slightly, and after 10 years is equal to that of a nonsmoker. The risk of developing cancer decreases much more slowly. After 10 years the risk of developing the seven types of cancer caused by cigarettes decreased by approximately 50%, and 20 years of smoking cessation are required for an ex-smoker's risk of

developing cancer to approach that of a lifetime nonsmoker.

Cholesterol

A large clinical trial that studied the effectiveness of cholesterol-lowering alone on mortality rates for heart disease has recently been completed (6). In the Lipid Research Clinics Coronary Primary Prevention Trial, men on cholesterol-lowering medication and diet experienced a 24% lower mortality rate from heart disease after 7 years, compared with men on cholesterol-lowering diets alone. There was a 64% reduction in the heart disease mortality rate among men whose serum cholesterol fell by more than 25%. More than a dozen smaller clinical trials have also looked at the effect of lowering serum cholesterol on the mortality rate for heart disease. Most have shown reductions in mortality comparable to those indicated above.

Combined risk factor reduction programmes

Two large clinical trials on the effect of multiple risk factor reduction programmes on mortality from heart disease have been conducted. A Norwegian study focused on lowering serum cholesterol through diet and on smoking cessation. By the end of 5 years, the mortality rate for heart disease was almost 50% lower in the intervention group than in the control group (7). In the USA, a multiple risk factor intervention trial focused on the effect of control of high blood pressure, smoking, and elevated serum cholesterol on heart disease mortality (8). It has been criticized for design flaws. Both the intervention group and the usual-care group showed reductions in risk factors and heart

disease mortality rates. Overall, the intervention group showed only a 7.1% lower heart disease mortality rate than the usual-care group. Adverse effects from certain antihypertensive medications may have been the reason why there was not a larger reduction in heart disease mortality rates in the total intervention group, since men with high blood pressure in this group actually had higher heart disease mortality rates than those in the control group. Subgroup analysis revealed that heart disease mortality rates in men without high blood pressure were 34.7% lower in the intervention group than in the control group, owing to greater reductions in their serum cholesterol and smoking habits.

For the past 8 years, five countries have conducted worksite-based cardiovascular disease prevention programmes (9). Each programme has attempted to reduce elevated cholesterol and excess dietary fat intake, to control high blood pressure, and to promote nonsmoking and vigorous exercise. After 6 years the three most successful programmes achieved reductions in heart disease mortality of 30%, 21% and 20%.

The most successful community-based intervention trial took place in North Karelia, Finland from 1972 to 1977 (10, 11). It involved a comprehensive programme to prevent heart disease through a reduction in the prevalence of smoking, elevated serum cholesterol, and high blood pressure. Overall reductions in risk of 17% among men and 12% among women were reported. Age-adjusted mortality rates for heart disease declined annually in North Karelian males and females by 3.7% and 2.2% respectively, compared with 1.7% and 1.2% in Finland as a whole.

Finally, in the United States, smoking rates have decreased by about 10% since 1964.

Because people have lowered their dietary fat intake during the same period, average serum cholesterol has decreased by approximately 10 mg/dl. Control rates for high blood pressure have improved considerably, especially during the past 10 years. A large number of people have begun exercising regularly. Concomitant with these changes in risk factors, age-adjusted mortality rates for heart disease have declined by approximately 30%, and those for cerebrovascular disease have fallen by about 50%.

There has been some debate about the role played by reductions in risk factors in the declining mortality rate associated with heart disease. It is important to note, however, that the decline in the mortality rate for heart disease predicted by the Framingham multiple logistic risk function, on the basis of the nationwide changes in smoking rates, average serum cholesterol, and average blood pressure, is almost identical to that which has occurred. □

Acknowledgements

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