

Alcohol and Obesity: A New Look at High Blood Pressure and Stroke

An Epidemiological Study in Preventive Neurology

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Summary. An investigation of the staff of a car assembly plant (3,351 persons) revealed a similarity between the change in relative body weight and diastolic blood pressure with age. There is a good temporal correlation between the course of alcohol consumption during life and the change of the relative body weight. German women had significantly less blood pressure for the same relative body weight than German men, and foreign employees had lower blood pressure than Germans. In both cases the main cause is the difference in alcohol consumption. Besides obesity and hereditary factors, alcohol is the main cause of “essential” hypertension today. Epidemiological and experimental data indicate that there are two ways from alcohol to high blood pressure, a more direct one and an indirect one via obesity. Alcohol causes obesity via a change in metabolism (hyperinsulinism) rather than by higher caloric intake. In both ways alcohol is an important cause of stroke. To reduce body weight and blood pressure, a reduction of alcohol consumption should be recommended in addition to reduced caloric intake and increased physical activity as means of preventive neurology.

Key words: Stroke – Alcohol – Obesity – Hypertension – Diabetes – Preventive neurology

Introduction

In the USA, Japan and Israel, it is generally accepted that high blood pressure is the most important risk factor for stroke, more precisely for both intracerebral hemorrhage and ischemic brain infarction [10–12, 21]. Because of differences in life style, the impact of high blood pressure on stroke may differ in different countries. However, the conclusions drawn from the epidemiological data in the USA probably hold for middle Europe. The available quantitative data from Germany [7] show that the younger the patients, the larger the relative impact of high blood pressure, since in the old age group the age itself becomes a major risk factor for stroke. In the age group 20–49 years the difference between the stroke patients and the patients with a common cold (who served as controls) was 43 mm Hg systolic and 28 mm Hg diastolic blood pressure on average. However, even in the age group 80–99 years the stroke patients had significantly higher blood pressure than the patients with a cold, on average 31 mm Hg higher systolic and 15 mm Hg higher diastolic blood pressure than the

cold patients. Treatment of high blood pressure reduces the risk of stroke, even in high age group and also in cases of mild hypertension.

In more than 90% of cases, hypertension nowadays is idiopathic or “essential”. There are genetic factors involved in “essential” hypertension, but their influence has been overestimated in the past; the environmental factors are more important [27]. It is a popular belief that occupational stressors are major factors in “essential” hypertension. Careful examination, however, does not support this hypothesis: there was no correlation between loud industrial noise, piece work, shift work, other industrial stressors and blood pressure in a German industrial plant [16]. Among Japanese in Hawaii there was no hint towards stress (by migration or occulturation) as a cause of high blood pressure [28]. Another suspected environmental factor is sodium intake. However, when the sodium intake was measured in high and low blood pressure groups within a population, no significant difference was found [2, 25, 31]. The relationship of potassium and magnesium to sodium intake may be more important.

Recently it became clear that chronic alcohol consumption is another etiological factor in many cases which have so far been classified as “essential” hypertension (for review see [15]). A linear relation between alcohol intake and blood pressure has been found in many epidemiological studies in men including one prospective study [6].

There is a high correlation between alcohol consumption and stroke. An epidemiological study on more than 11,000 men in Yugoslavia has shown that high blood pressure is the pathogenetic link between alcohol consumption and stroke [19]. A number of pathogenetic mechanisms have been suggested to explain the hypertension resulting from alcohol (for review see [15]) including increased sympathetic activity, hyperinsulinism (causing sodium retention) and decreased intracellular magnesium and potassium.

The alcohol consumption per capita in the Federal Republic of Germany has increased more than 300% since 1950. While Germany used to be in the middle field, it is now in the highest group together with France and Italy. The daily alcohol consumption in the FRG is now 30 g/person, about three times more than in Sweden or Japan. It is probably mainly in consequence of this change that both diastolic and systolic blood pressure of young and middle aged men in Germany are now on average 10 mm higher than in 1925 [17, 30].

There is wide agreement that one important causal factor of “essential” hypertension is obesity (for review see [36]). The pathogenesis from obesity to hypertension is thought to

be partially via hyperinsulinism which is frequently encountered in obesity. High plasma insulin causes sodium retention in the kidney [5].

The purpose of this paper is to investigate that besides a more direct route from alcohol to high blood pressure there may also be an indirect pathogenesis via obesity. In other words, alcohol consumption is a major cause of obesity, especially in men. This relation is not trivial, and is not just due to the caloric content of alcohol.

Methods

All the workers of a German motor industry plant (3,351 persons) were investigated. 2,956 were men and 395 women. Blood pressure was measured in the sitting position after 5 min rest during the regular break in working time by means of the modified Riva-Rocci method. Body height (without shoes) and body weight (without heavy working clothes) were measured, and industrial stressors (noise, shift work, piece work, heavy work, responsibility) were documented (for details see [16, 17]). Eating, drinking, smoking, physical activity and leisure time habits were recorded by means of

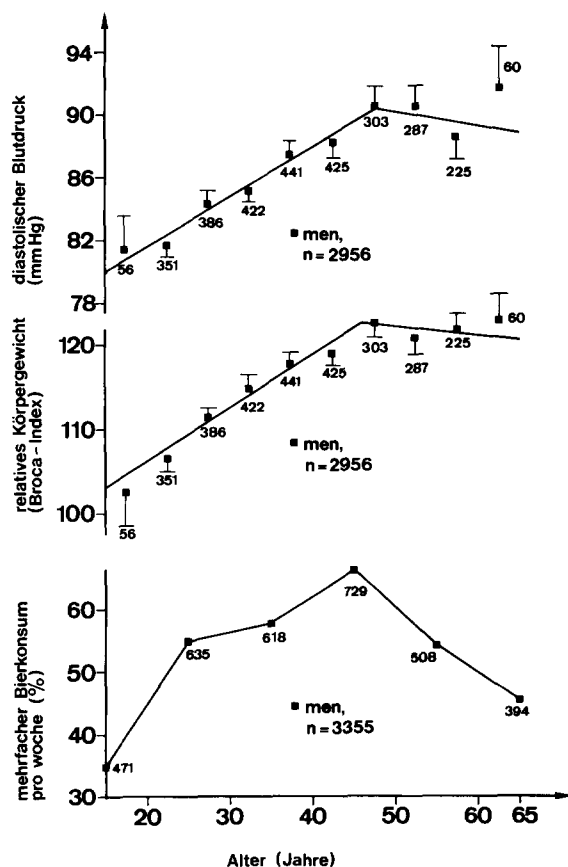


Fig. 1. Top curve diastolic blood pressure of the 2,956 men of the car assembly plant plotted over age: the diastolic blood pressure increases from age 20 to 50 linearly and decreases slightly thereafter. Middle curve the relative body weight (Broca index) of the 2,956 men increases, as the diastolic blood pressure, until age 50 and decreases slightly thereafter. Lower curve consumption of beer "several times weekly" in the German male population over age: beer consumption increases until age 50 and decreases thereafter. Data from a 1982 poll from a representative group of 3,355 Western German men, from Burda Marktforschung [4]

a questionnaire in the persons with a casual blood pressure higher than 160/95 mmHg.

Furthermore a 7-day eating and drinking record was kept for 100 male employees (50 German and 50 foreign) of the car assembly plant. They were adjusted for age and relative body weight and both subgroups consisted of 50% normotonic and 50% hypertonic persons. In addition to the food, drinking and smoking habits, the leisure time habits and physical activity (including bicycling and gardening) were recorded. Sodium excretion was measured in the morning urine.

Results

The relative body weight (Broca index) rose from 1.02 (age group 16–19 years) to 1.23 (age group 45–49) in the men. Thereafter there was a slight decrease. The diastolic blood pressure over age parallels the relative body weight remarkably (Fig. 1). There was a similar course in beer consumption in the adult male German population at the same time (Fig. 1). The cause of the systolic blood pressure over the age is different. Until age 40, the systolic blood pressure of the men in the car assembly plant remained constant at about 132 mmHg on average, then there was a monotonic rise starting at age 45 (Fig. 2).

In the women there was a faster increase in relative body weight (Broca index) between age 40 and 50 with a slight decrease thereafter (Fig. 3).

Independent of age, there was a monotonic increase in both systolic and diastolic blood pressure with relative body weight (Fig. 4). However, obesity is not the only cause of "essential" hypertension. For the same Broca index the men had a significantly higher systolic and diastolic blood pressure than the women (Fig. 4). On average a man had 7 mmHg higher diastolic and 14 mmHg higher systolic blood pressure than a woman of the same Broca index. The Broca index for

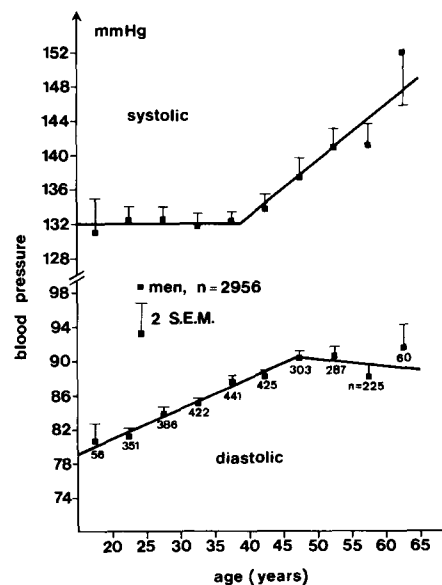


Fig. 2. Blood pressure depending on age. Data from the 2,956 men of the Württemberg car assembly plant. Diastolic blood pressure increases up to age 50 and decreases slightly thereafter. Systolic blood pressure, however, is almost constant from age 20 to 40; thereafter, there is a steeper increase due to diminished elasticity of the large arteries

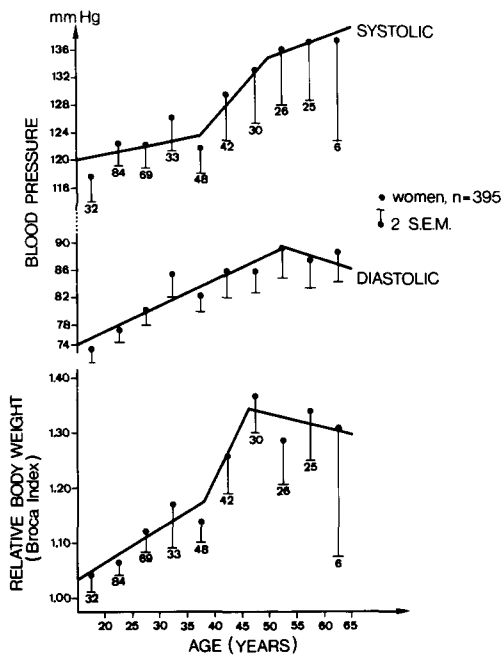


Fig. 3. Blood pressure and relative body weight (Broca index) in 395 women of the Württemberg car assembly plant. There is an extra increase of the relative body weight between age 40 and 50, obviously due to climacteric hormonal changes

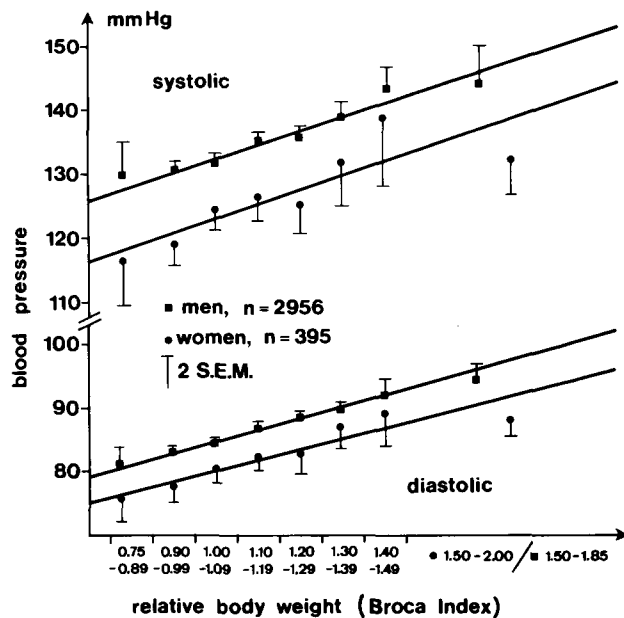


Fig. 4. Average blood pressure increases linearly with relative body weight (Broca index) in both men and women. However, for the same Broca index, the men have about 14 mmHg higher systolic and 7 mmHg higher diastolic blood pressure on average. Data from 2,956 men and 395 women of the Württemberg car assembly plant

women is calculated from a formula slightly different from that for men. When the formula for men is applied for both women and men, the parallel shift (Fig. 4) remains similar, the difference between men and women of the same Broca index being 3.4 mmHg for the diastolic and 8 mmHg for the systolic blood pressure ($P < 0.01$).

A similar difference was found for the German and foreign workers of the car assembly plant (Fig. 5). For the same rela-

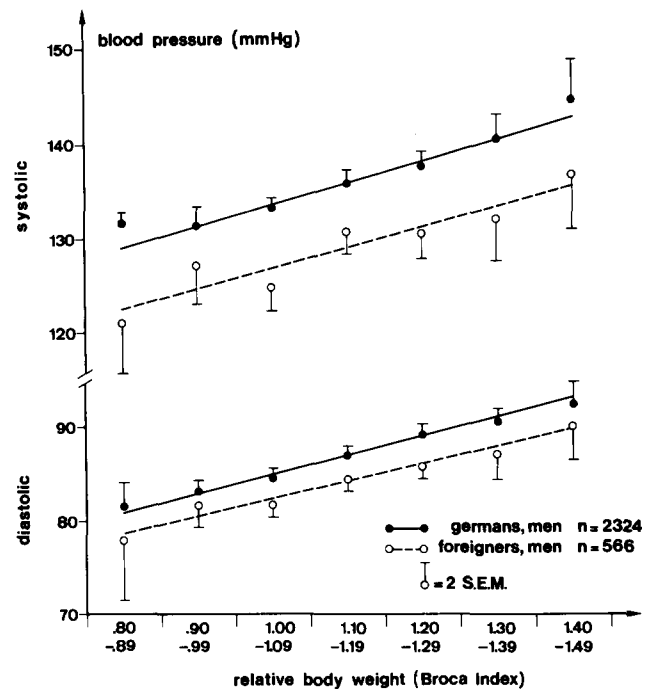


Fig. 5. Blood pressure of the German and foreign male employees of the car assembly plant increases similarly with the relative body weight. However, for the same Broca index the Germans have about 7 mmHg higher systolic and 3 mmHg higher diastolic blood pressure than the foreign employees (mainly from Turkey). From Kornhuber and Lisson [18]

tive body weight the male Germans in the total group of employees had on average about 3 mmHg diastolic and 7 mmHg higher systolic blood pressure ($P < 0.01$). The foreign workers were predominantly Turks.

The 7-day eating and drinking record in the 50 German and 50 foreign employees showed that the main difference was in the drinking habits, the foreigners drank only half as much alcohol as the Germans, mainly for religious reasons (the Turks being muslims). The admitted daily alcohol consumption of the 50 Germans was 32 g on average, of the foreigners 14 g ($P < 0.001$). There was a similar difference between the normotonic and hypertonic Germans. Those of the 50 Germans who drank less than 40 g alcohol/day had on average a systolic blood pressure of 135 mmHg, however those who admitted to drinking more than 40 g alcohol/day had 147 mmHg ($P < 0.01$). Of the total variance of the systolic blood pressure of the 50 Germans, 20% could be accounted for by differences in admitted alcohol consumption. There was an increase of 2 mmHg in systolic blood pressure per 10 g daily alcohol consumption. For comparison, 10% more relative body weight (Broca index) correlated with 2 mm more systolic blood pressure in the total group of more than 3,000 workers.

The only other significant difference in the nutritional habits between the foreign and the German workers was in potassium consumption: the foreigners ate more potassium in beans, fruit etc. than the Germans. However, there was no correlation between potassium consumption and blood pressure.

There was no significant correlation between the total caloric intake and relative body weight in the group of 100 workers; the tendency, however, was toward a slight negative correlation (-0.03). By contrast, there was a tendency

towards a positive correlation between the alcohol consumption (g/day) and the Broca index, especially among the German workers (+0.29, nearly significant).

There was no difference in sodium excretion (measured in the morning urine) between the foreign and German workers nor between the high or low blood pressure persons in the group of 100. There were no differences in the consumption of onions and garlic and many other items.

Out of more than 800 workers with a casual blood pressure of more than 160/95 mmHg, 299 agreed to fill in the life style questionnaire. From these, the men admitted to drinking 50 g alcohol/day on average. As judged from the total beer consumption of the plant, this is an understatement. Since beer was the only alcohol available during working time in the plant, most beer was consumed during work. When looking at the statements about wine and spirits consumption (which took place mainly at home contrary to the beer drinking) it is clear that alcohol consumption in the males increased with age up to the age group around 50. While until age 40 the wine and spirits consumption per day was in the order of 10 g alcohol per day, it rose to 17 g in the age group 40–49 and to 19 in the group 50–59 years, thereafter dropping to 15 g in the 60–65 years group. It is also known from the German alcohol poll [4] that the peak for wine consumption is slightly later than the peak of beer consumption (which is about age 50 in German men today).

Discussion

As pointed out elsewhere [18], the difference in blood pressure between the German and foreign employees of the car assembly plant cannot be explained by genetic factors. The main cause is the same as for the difference between male and female Germans: the men and the Germans drink more alcohol than the women and the foreigners. According to representative demoscopic data from contemporary Federal Republic of Germany [4] men drink at least three times more beer than women (Fig. 6). In Germany, most alcohol is consumed as beer.

The causal relation of alcohol and high blood pressure is evident not only from correlation with the admitted consumption, but also from objective enzyme data, from the covariation of stroke and cirrhosis mortality [22], from prospective investigations [6] and from intervention: hypertension disappears when the patients abstain, and blood pressure raises again with the end of abstinence [26]. There is no safe dose of alcohol. Even 10 g alcohol per day is on average correlated with higher blood pressure (for review see [15]).

The increase of alcohol consumption with increasing age (Figs. 1 and 6) is, of course, due to the fact that alcohol is a drug causing addiction. The reduction of beer consumption after age 50 and wine consumption after age 60 in the males may be due to beginning intolerance (gastritis, pancreatitis, hepatic steatosis, epilepsy etc.).

At present the beer consumption in women in Germany culminates earlier than in men, namely in the age group 30–39 years (Fig. 6). The poll method looks at different generations with different sociocultural influences at the critical age around puberty. The younger generation of females today was under the “emancipatory” influence of 1968 and therefore drinks more alcohol [14].

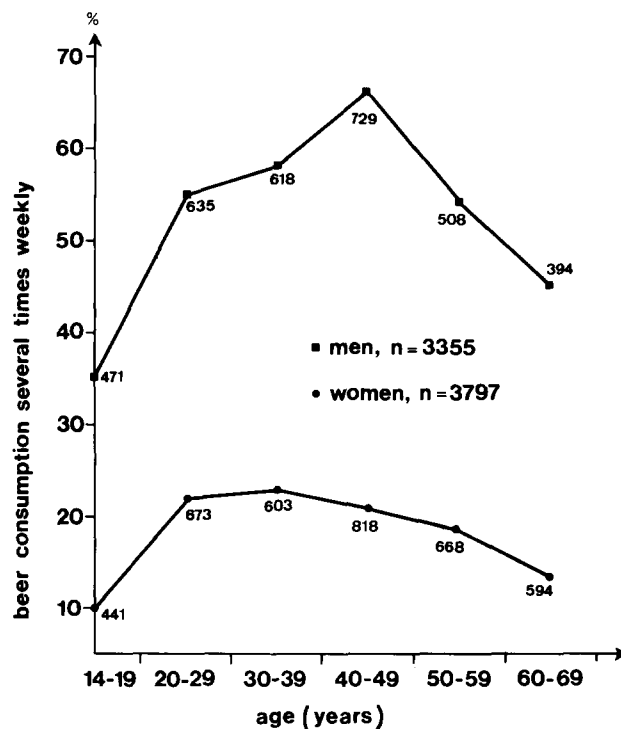


Fig. 6. Beer consumption “several times weekly” in percentage of the population. Data from a 1982 poll from 3,355 men and 3,737 women who were representative for the average population in Federal Republic of Germany (From Burda Marktforschung [4]). The beer consumption of the males is about three times higher than that of the females. The consumption increases with age and reaches a maximum in men in the age group 40–50, in women in the age group 30–39. This earlier peak in females is due to the “Zeitgeist”: increasing alcohol consumption in the female youth following the 1986 “emancipation” or “cultural revolution”

The increase of systolic blood pressure after age 45 in the men (at a time when the diastolic blood pressure on average remains constant or even decreases slightly) is due to diminished elasticity of the large arteries (“Windkessel” hypertension). The halt in the increase of diastolic blood pressure at age 50 may be partly due to the same Windkessel effect. However, the distribution of relative body weight over age (Fig. 1) cannot be explained by this change in elasticity. The similarity between the life course of both diastolic blood pressure and relative body weight on the one hand and beer consumption on the other hand, however, is striking. The temporal correlation with the bend in diastolic blood pressure fits better with alcohol consumption than with systolic pressure. In times of less alcohol consumption the diastolic bend at age 50 was not apparent [30].

Furthermore, there is an epidemiological correlation between alcohol consumption and obesity [1, 11, 32, 34, 35]. In an investigation of middle aged Dutch men [20] it was found that the most obese quartile of persons drank significantly more alcohol than the most lean quartile. This was not due to the caloric content of the alcohol or more appetite in consequence of drinking since the most obese quartile consumed 300–400 kcal less food energy than the most lean quartile. Moreover, the most obese quartile consumed less of all major foods, but they drank significantly more alcohol. The same tendency appears from our data (although insignificant because of the smaller number of probands). This suggests that

it is because of some other alcohol effect, that alcohol is one of the causes of overweight. Two hypotheses come to mind: first, people with a higher alcohol consumption may be less physically active. Secondly, alcohol may have some metabolic effect leading to obesity. The first hypothesis may be excluded on the basis of our life style investigation in 50 German and 56 foreign workers of the car assembly plant, as there was no significant difference in the physical activity (including bicycle riding to work, gardening etc.) between the two ethnic groups nor between Germans who drank more or less alcohol. On the other hand it is clear that alcohol does cause metabolic changes which could lead to obesity namely hypertriglyceridemia, hyperinsulinaemia [23a] and enhanced incorporation of fatty acids into the liver and adipose tissues [23]. The fact that the obese, on average, eat less than the lean persons does not contradict the law of conservation of energy. The balance of energy depends on both input and output. The output of energy, however, is diminished in the obese due to a reduction of nutritive (nonshivering) thermogenesis [9]. The nonshivering thermogenesis depends on the sympathetic system, thyroid function, insulin, Na^+/K^+ -ATPase and other factors, some of which may be altered by alcohol [2a].

The climacteric increase of the body weight in the female employees is obviously due to hormonal factors [8]. A climacteric increase similar to Fig. 2 and a corresponding increase of blood pressure have been found at times when women did not used to drink alcohol as nowadays [30]. The rise of relative body weight in women before age 45 is, according to our clinical impressions, mainly due to child birth. Many women eat more during pregnancy and breast-feeding and do not decrease their body weight thereafter to previous standards.

We do not think that alcohol is the only cause of obesity in the human male. There are genetic differences in nonshivering thermogenesis [9] and environmental factors influencing food consumption and physical activity. However, there is little doubt that alcohol is a major factor in the pathogenesis of obesity of male adults in our alcoholic society. While using alcohol for celebrations, we must dispense with daily alcohol. For people who like beer daily alcohol-free beer is a good choice.

In conclusion, there are two ways in which alcohol influences blood pressure, a more direct one and an indirect one via obesity. Both contribute to the high prevalence of hypertension today. Due to its tendency to initiate hyperinsulinism and obesity, alcohol is also a major cause of atherosclerosis [33a] and type 2 diabetes. In order to reduce body weight, blood pressure, diabetes, and stroke, a reduction of alcohol consumption should be recommended in addition to reduced caloric intake and increased physical activity as means of preventive neurology [13].

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