Table VII.3
Relationship between fibre intake and blood pressure

	Number of subjects	Blood pressure (mmHg)	
		Systolic	Diastolic
High fibre	45	116 ± 1.5*	75.2 ± 1.0**
Low fibre	49	123 ± 1.3*	78.5 ± 0.8**

* P<.001 ** P<.02

Source: Angela Wright, P G Burstyn and M J Gibney, 'Dietary fibre and blood pressure', *Br Med J*, 1979, **ii**: 1541–3, p. 1542. (With permission of the BMJ Publishing Group.)

were slightly but significantly higher in the low fibre group (Table VII.3).[11] Their findings were subsequently confirmed in a study conducted by Lawrence Appel and his co-workers. At the end of a three week run in and eight weeks of controlled diets, volunteer subjects whose blood pressures were initially comparable diverged. The control subjects who were continued on a typical North American diet ended with mean blood pressures higher than those of the subjects whose diet was enriched in fibre.[12] Together the two studies indicate that a diet lacking in fibre is conducive to blood pressure elevation, both systolic and diastolic.

Salt

Salt is the only condiment which is a physiological necessity. Concern about harmful effects of high consumption arose only in the twentieth century. Salt as a supplement had been deemed invaluable as a preservative and esteemed from the early days of recorded history.[13] It was included in sacrifices in early biblical times when inviolable obligations were designated salt covenants.[14] Homer considered the salt with which the meat of celebratory feasts was sprinkled to be divine.[15] Its commercial importance in Roman times is attested by the designation of money given to soldiers for salt (*sal*) as *salarium* from which the word salary is derived. Until recently a person in authority visiting a community would often be offered bread and salt as a ceremonial expression of welcome and a form of homage.

In medieval and Tudor times salt was produced exclusively by evaporation of sea water in maritime basins.[16] In England the climate prevented this from occurring naturally to a reliable extent as in Mediterranean countries, and evaporation depended

[11] Angela Wright, P G Burstyn and M J Gibney, 'Dietary fibre and blood pressure', *Br Med J*, 1979, **ii**: 1541–3, p. 1542.
[12] Lawrence J Appel *et al.*, 'A clinical trial of the effects of dietary patterns on blood pressure', *N Engl J Med*, 1997, **336**: 1117–24, p. 1122.
[13] S A M Adshead, *Salt and civilization*, New York, St Martin's Press, 1992, pp. 25, 27.
[14] Leviticus, 2:13; Numbers 18:19.
[15] Homer, *Iliad*, 9.214.
[16] Adshead, op. cit., note 13 above, p. 86.

on heating sea water with charcoal. The salt pans were made of lead, which limited the temperatures that could be attained. Charcoal was relatively inefficient as a fuel and its use contributed to the denudation of forests, resulting in a growing scarcity by the start of the eighteenth century. However, coal was then substituted for charcoal, the change being facilitated by improvement in mining methods and in transport facilities, both by sea and through inland waterways. At about the same time there was a considerable improvement in evaporative techniques with construction of larger iron salt pans that could withstand higher temperatures. More important, however, was the discovery of rock salt in Cheshire in 1670 with exploitation of the deposits in that county and subsequently, and to a somewhat lesser extent, in nearby Worcestershire. The salt was either mined directly or extracted by pouring water into the mines in order to produce a brine which was then pumped up to the surface, a process facilitated by the newly invented steam powered pumps.[17] Transport of the final product became easier with improvements in waterway management, notably the changes which made the River Weaver navigable so that Cheshire's salt could be shipped to Liverpool and thence by sea to other parts of the country and points beyond.[18]

Records of eighteenth-century salt production are based largely on figures documented by excise officers. These, however, were subject to considerable error. Scales were not always accurate, excise officers were inefficient, the desire of merchants to evade taxes great and weight checks inaccurate, especially when dealing with salt imports. When ships were loaded or unloaded it was often difficult to distinguish between coastal and foreign traffic.[19] Despite the resulting underestimation of salt production in official statistics, the numbers indicate a dramatic increase in output during the eighteenth century. Total English salt production in 1700 was estimated at 500,000 cwt. It rose eightfold during the eighteenth century. By 1796, 2 million cwt of Cheshire salt alone was being shipped through the River Weaver outlet.[20] Its importance to the national economy can be gauged by the fact that in 1696 a £2,500,000 government loan from the Bank of England was secured by the anticipated salt duties.[21]

The dramatic rise in salt production during the eighteenth century is indicative of a considerable rise in individual consumption. In addition to being used as a condiment, it was utilized extensively as the only means of preserving meat, fish and dairy products such as butter and cheese. A rise in salt intake was consequently an inevitable accompaniment to the increasing consumption of these foods. The eightfold eighteenth-century growth in production calculated by Adshead far exceeded the rate of population growth and therefore indicated a doubling of average daily intake per head, from about 14 grams of salt in 1700 to 28 grams by 1800.[22] The overall impression is of a very considerable rise in salt consumption during the eighteenth

[17] Ibid., pp. 378, 385, 398.
[18] Ibid., pp. 105–6.
[19] Edward Hughes, *Studies in administration and finance 1558–1825*, Philadelphia, Porcupine Press, 1934, pp. 308, 364–5.
[20] Ibid., p. 114.
[21] Ibid., p. 171.
[22] Adshead, op. cit., note 13 above, p. 21.

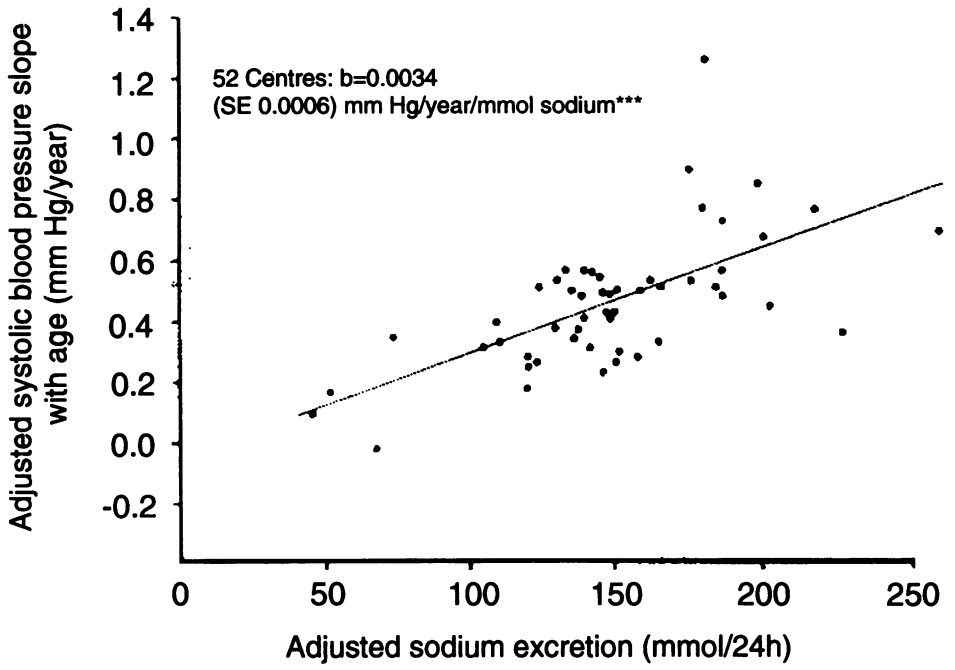


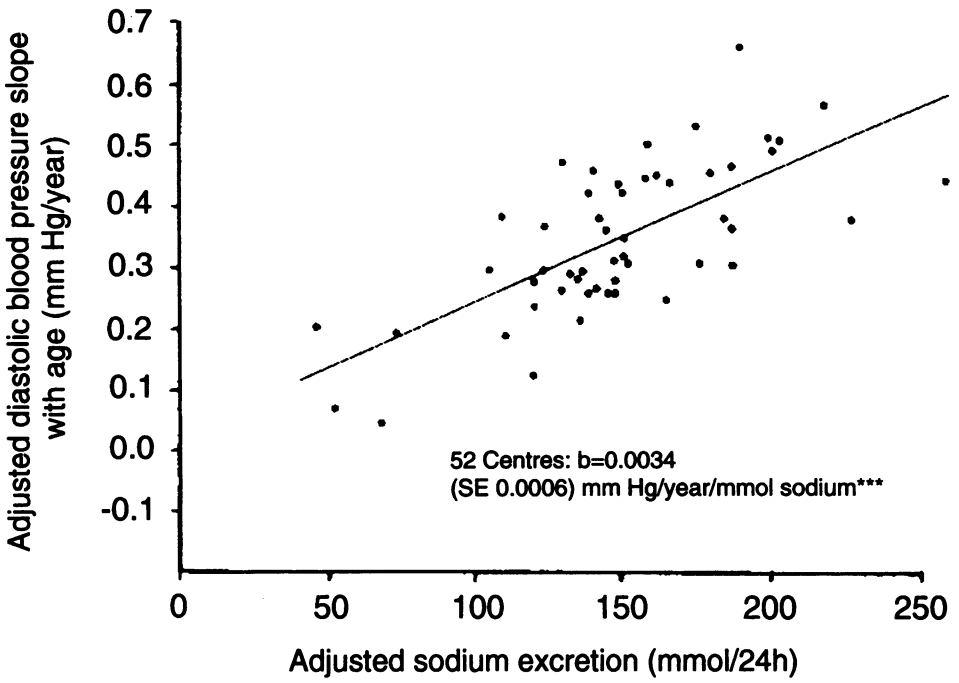
Figure VII.1a

century, with some subsequent levelling off, at amounts that would now be considered excessive.

The relationship of hypertension to salt consumption is complex. Studies of pre-industrial populations with low salt consumption have shown that sodium intake averaging below 30 mEq per person per day is compatible with good health and in such communities blood pressure does not rise with age. In striking contrast were the results of a study of the Lau, a people living on very small Solomon Islands in the Western Pacific. They were fishermen who differed from neighbouring islanders by using salty coastal water to prepare meals, and their daily intake of sodium of 150 to 230 mmol/day was in consequence much the greater. The Lau as a group had systolic and diastolic pressures that were higher than those of the adjacent islanders, consistent with an association of generous salt intake with elevation of blood pressure.[23] A comparative interstate study of westernized countries that included all continents except Australasia showed that both systolic and diastolic blood pressures, were positively correlated with salt excretion, the latter being a good indirect measure of intake (Figures VII.1a and 1b).[24] Lillian Gleibermann's conclusions were similar.

[23] Lot B Page, Albert Damon and Robert Moellering Jr, 'Antecedents of cardiovascular disease in six Solomon Islands societies', *Circulation*, 1974, **49**: 1132–46, p. 1136.

[24] Interstate Cooperative Research Group, 'Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24-hour urinary sodium and potassium excretion', *Br Med J*, 1988, **297**: 319–28, p. 323.



Figures VII.1a and 1b: Relation of age changes in blood pressure to daily sodium excretion as a reflection of salt intake. Adjusted for body mass index, age, sex and alcohol intake. Source: Interstate Cooperative Research Group, 'Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24-hour urinary sodium and potassium excretion', *Br Med J*, 1988, **297**: 319–28, p. 323. (With permission from the BMJ Publishing Group.)

In a review of twenty-seven worldwide populations she found that, with few exceptions, salt excretion and hence intake correlated positively with blood pressure levels.[25]

In a comprehensive review, Martin Muntzel and Tilman Drüeke reported considerable individual variability in blood pressure responses following dietary salt restriction. Depending on variation in compensation mechanisms, the mean arterial pressure could increase, decrease or remain more or less unchanged but with decrease being the most frequent.[26] Overall, the evidence indicates that in communities with a high average salt consumption there will be considerable variations in blood pressure levels, but some part of the population will be salt sensitive and become hypertensive, the tendency increasing with age, as is usual in developed societies. Muntzel and Drüeke noted that the sensitivity is greater in elderly subjects and in the obese.[27]

[25] Lillian Gleibermann, 'Blood pressure and dietary salt in human populations', *Ecol Food Nutr*, 1973, **2**: 143–56, p. 144.

[26] Martin Muntzel and Tilman Drüeke, 'A comprehensive review of the salt and blood pressure relationship', *Am J Hypertens*, 1992, **5**: Suppl 4, 1S–42S, p. 7.

[27] Ibid., 26S.

It can be concluded from twentieth-century studies that a high incidence of hypertension characterizes an aging and increasingly obese community, especially if combined with liberal consumption of saturated animal fats, low polyunsaturated fat intake, increasing use of salt and reduced fibre consumption. All of these features characterized the way of life of the growing middle and upper classes of eighteenth-century England and raise the possibility, even if not measurable, of a rise in their incidence of hypertension at that time. Its significance relates to the status of hypertension, both systolic and diastolic, as a long and well-established risk factor for development of coronary heart disease in men and women and in all of the clinical ways in which it presents.[28] We cannot know what blood pressure levels were in the eighteenth century. We do know that much was then being done unwittingly to ensure that they would be raised.

[28] William Kannel, 'Role of blood pressure in cardiovascular disease: the Framingham study', *Angiology*, 1975, **26**: 1–14, p. 5.