

registrars who provided additional information concerning illness and treatment of their patients and certified cause of death respectively.

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## Blood Pressure in a Scottish Town

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### Summary

**As part of a general health screening survey in the Burgh of Renfrew blood pressure was measured in 3,001 subjects (78.8% of those eligible) aged 45 to 64. In 468 (15.6%) diastolic blood pressure was 100 mm Hg or more. A year later the mean blood pressure for those of the population re-examined showed no change, there being an equal number of subjects with increased and decreased pressures. The prognostic significance of those showing the larger fluctuations remains to be determined through medical-record linkage.**

Examination of the general practitioners' medical records of 422 of the 468 subjects with diastolic blood pressure of 100 mm Hg or more showed that 255 had no previous documented hypertension. Of the remainder 73 were receiving antihypertensive therapy. Examination of the records of subjects whose blood pressure was under 100 mm Hg showed that 55 were receiving antihypertensive treatment and that another 113 had previously been recorded as having a diastolic blood pressure of 100 mm Hg or more by their general practitioner. Altogether at least 636 (21.2%) of those who were examined had been considered at some time to have evidence of hypertension.

The prevalence of undetected hypertension in the general population has important implications for the resources of the National Health Service if current trials show benefit to the health of the community from treating "mild" as well as "moderate" hypertension.

### Introduction

Because hypertension is common (Wilber *et al.*, 1972; Finnerty *et al.*, 1973; Reid *et al.*, 1974), a hazard to health (Metropolitan Life Insurance Company, 1961; Kannel *et al.*, 1972), often symptomless (Al Bradan *et al.*, 1970; Waters, 1971; Weiss, 1972), and usually treatable (Hamilton *et al.*, 1963; Veterans

Administration, 1967, 1970) information on its prevalence in the community is important. There have been numerous surveys and it is apparent that there are differences of blood pressure between countries and between different parts of the same country (Stamler *et al.*, 1967; Hawthorne *et al.*, 1969; Evans and Rose, 1971). There is less information on the number of patients not detected by such surveys because they were being adequately treated for hypertension at the time of the survey (Langfield, 1973).

The study reported here is part of a mass health examination programme for residents aged 45 to 64 years of the town of Renfrew (World Health Organization, 1971; Hawthorne, 1969). One of the objects of the programme other than the detection of tuberculosis was to conduct a random controlled trial of the effect on mortality of stopping smoking in people at high risk from coronary artery disease, lung cancer, and chronic bronchitis (*Report of the Working Group on Epidemiological Studies of Ischaemic Heart Disease*, 1968, 1969) so an estimation of blood pressure was an integral part of the schedule of examinations.

### Material and Methods

Renfrew is an urban burgh with a population of about 19,000. A census of all people between the ages of 45 and 64 on January 1972 and resident in the 6,534 households on the burgh assessor's rating list was completed between November 1971 and March 1972. Information on all but 59 (0.9%) households showed that there were 1,788 males and 2,022 females (a total of 3,810 subjects) in this age group.

All were offered a timed appointment to attend a temporary examination centre established in the town hall in Renfrew during 15 days in March and April 1972. Before attending each patient was asked to complete a standard questionnaire\* on symptoms of cardiovascular and respiratory disease.

A schematic plan of the accommodation in the town hall is shown in fig. 1. Ten subjects arrived every 10 minutes during each session. Individual questionnaires were checked and standard investigations lasting about 20 minutes were undertaken. Height and weight were measured, and forced expiratory volume in one second was measured using a Garthorpe Vitalograph with the subject standing, the best of two expirations being recorded. A six-lead electrocardiogram (leads I, II, III, aVR, aVL, and aVF) was made with the subject sitting. Blood pressure was measured seated using the London School of Hygiene and Tropical Medicine sphygmomanometer (Rose *et al.*, 1964) with a cuff of 12 × 22 cm. Diastolic blood pressure was taken at the

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\*The questionnaire is available from the authors

disappearance of the fifth Korotkoff sound. Observers had been trained to measure blood pressure using special tape recordings (Rose, 1965). A 10-ml non-fasting blood sample was taken for plasma cholesterol, electrolytes, urea, and blood sugar. The sample for plasma potassium concentration was centrifuged within two hours of venepuncture. Finally a tuberculin tine test (Lederle) was performed, a miniature chest x-ray picture taken, and sputa collected for direct examination and culture as part of a study of tuberculosis.

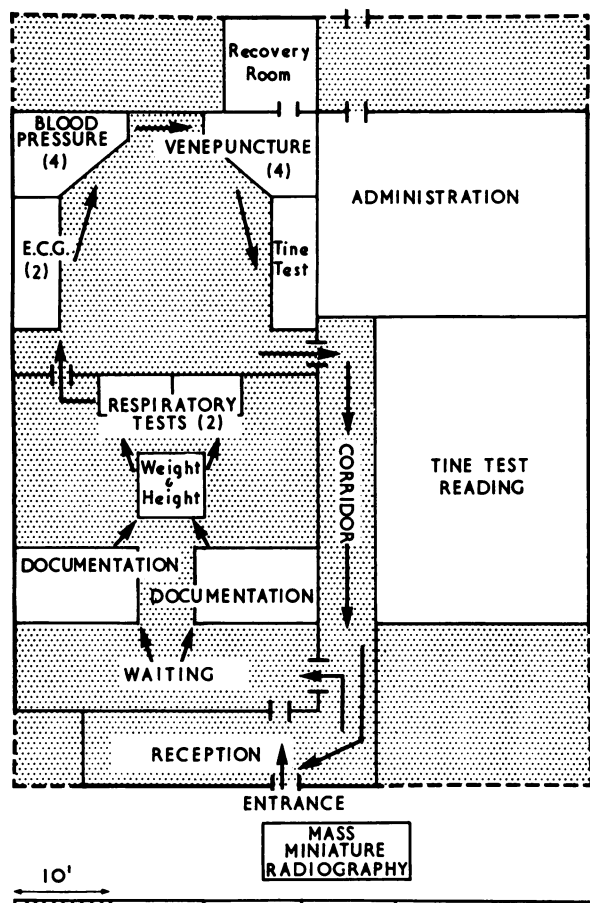


FIG. 1—Plan of temporary examination centre in Renfrew Town Hall. Numbers of staff operating each unit are given in parentheses.

The cost of the health examination was £4.31 per person.

All subjects with abnormalities needing immediate attention were referred directly to their general practitioner. This group included patients with a diastolic blood pressure of 115 mm Hg or more which had been confirmed by two observers. Subjects with diastolic blood pressures between 100 and 114 mm Hg were recalled for a second screening examination 12 weeks later. All subjects with other abnormalities had these rechecked and where necessary were referred to the general practitioner or through the general practitioner to hospital. Risk scores for each subject were calculated on a scale derived from the Framingham study (Truett *et al.*, 1967), and a high-risk group of smokers constituting

about 10% of the population most likely to develop coronary heart disease, lung cancer, and chronic bronchitis were randomly allocated to a controlled trial of the effects of stopping smoking on mortality. These results will be reported separately.

The same population was offered re-examination a year after their original examination. In order to study mortality and morbidity in the whole population medical-record linkage was arranged with the Registrar General in Scotland, the Scottish Home and Health Department Research and Intelligence Unit, the Western Regional Hospital Board Cancer Registration Bureau, and the local tuberculosis department. Written permission was obtained from all but one person to consult his or her health records for this purpose.

In co-operation with the nine Renfrew general practitioners a special blood pressure clinic was established in the local health centre to undertake the detailed investigation of confirmed cases of hypertension and to initiate and supervise treatment.

Persons whose diastolic blood pressure was 115 mm Hg or more at primary screening in 1972 and those whose diastolic blood pressure was between 100 and 114 mm Hg at both screening examinations were invited to attend the blood pressure clinic. Sessions were held during the morning, afternoon, and evening by one of us (D.G.B.) together with a medical registrar from the Royal Alexandra Infirmary, Paisley, and another from the Western Infirmary, Glasgow. A part-time nurse/secretary was employed for administration and blood pressure taking.

## Results

Altogether 3,001 (78.8%) of those identified by the census as eligible attended for primary screening in 1972 (table I). There were no important differences in attendance rates for men and women, for afternoon or evening sessions, or for different days of the week. Sixteen people who had died between the time of the census in 1971 and primary screening were excluded, as were 152 who were in hospital, ill at home, or had moved from the district. In 1973 2,289 (80.5%) of those previously examined attended. In calculating this response rate 26 people who had died, 46 who were too ill to attend, and 85 who had moved away from the district were excluded. The net response rate after one year was thus 60.1% of the original 3,810 who were eligible.

The distribution of diastolic blood pressure for the 3,001 respondents examined at primary screening in 1972 is shown in fig. 2. There was no evidence of a bimodal distribution into persons with and without hypertension so arbitrary cut-points were used in defining patients with high blood pressure (Pickering, 1968). Three of these arbitrary divisions are shown in table II. Taking a diastolic pressure of 90 mm Hg or more—a level known to represent a risk (Hamilton *et al.*, 1964; Finnerty *et al.*, 1973)—40% of the population would be considered "hypertensive." Raising the cut-off to 100 mm Hg greatly reduced the yield.

Re-examination of those with a diastolic pressure of 100 mm Hg or more further reduced the yield of hypertensive subjects. Thus only 165 (5.5%) subjects were finally referred to the clinic at the health centre with sustained hypertension.

Among 468 subjects whose diastolic pressure was 100 mm Hg or more after original observation in 1972 general practitioner N.H.S. records were traced for 422 subjects. The records showed that 255 (54.5%) had not previously been noted as

TABLE I—Response Rates from those Eligible for Examination in 1972 and 1973 Surveys

	1972		1973		
	No. Eligible	No. (%) Responding	No. Eligible	No. (%) Responding	% of those Eligible in 1972
Men	1,788	1,409 (78.8)	1,335	1,074 (80.4)	60.1
Women	2,022	1,592 (78.7)	1,509	1,215 (80.5)	60.1
Total	3,810	3,001 (78.8)	2,844	2,289 (80.5)	60.1

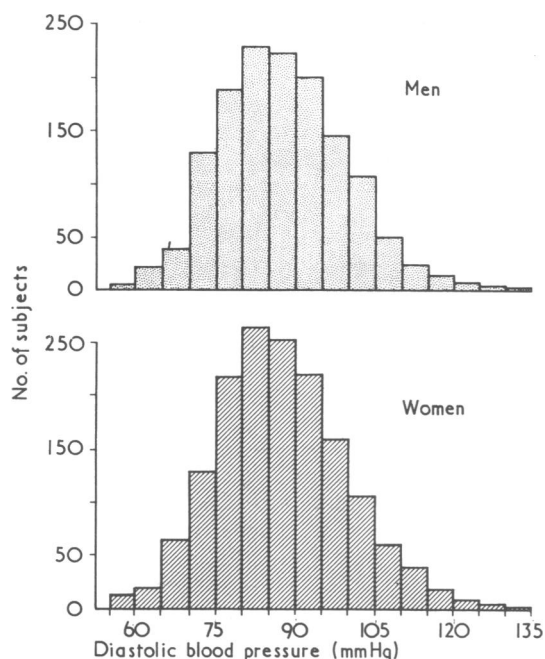


FIG. 2—Distribution of diastolic blood pressure at primary screening.

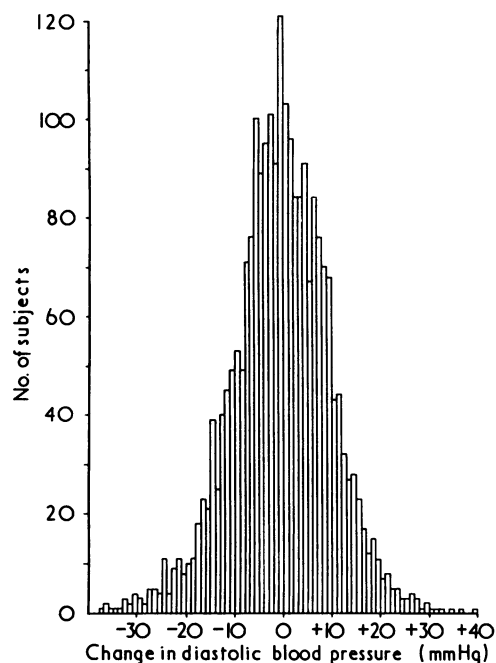


FIG. 3—Distribution of change in diastolic blood pressure in individual subjects between 1972 and 1973.

hypertensive and that 73 of the remaining 167 were receiving treatment at the time of primary screening. Examination of the records was also possible for 2,139 of 2,533 subjects whose diastolic pressure was less than 100 mm Hg in 1972. Fifty-five (2.2%) subjects were receiving antihypertensive therapy

at that time, and a further 113 (4.5%) subjects who were not receiving therapy had been previously identified by their general practitioner as having had a raised blood pressure.

Altogether 335 (52.7%) out of 636 subjects (21.2% of the population surveyed) had previously been recorded as having a raised diastolic blood pressure by their general practitioner, and 128 (20.1%) were receiving antihypertensive therapy at the time of the first examination. In addition 18 subjects with diastolic blood pressure below 100 mm Hg at the time of the survey were taking drugs with an antihypertensive action (beta-blockers and diuretics) for other reasons. Some might have had a raised blood pressure had they not been receiving this therapy.

#### DIFFERENCE OF BLOOD PRESSURE IN 1972 AND 1973

Blood pressure was taken again on two occasions in March and June 1973, a year after the first two examinations. The change in individuals' diastolic pressures on two occasions separated by one year is shown in fig. 3. In a further 93 subjects blood pressure had apparently risen from less than 100 mm Hg in 1972 to levels higher than this in 1973. These patients were also put under surveillance in the blood pressure clinic.

Despite the tendency for blood pressure to vary in individuals the mean blood pressure ( $\pm$  S.D.) for the whole population remained remarkably constant on the two occasions for both men and women (table III).

#### Discussion

Renfrew shares with other urban areas in the west of Scotland one of the highest rates of cardiovascular mortality in the United Kingdom. The town lies eight miles west of Glasgow and has a soft water supply. Nine general practitioners serve the burgh from a central health centre, giving a doctor:patient ratio close to the average for Scotland.

The Hebridean Island of Tiree lies one hundred miles north west of Glasgow. The population of about 850 is served by one general practitioner—a doctor:patient ratio similar to that in other Scottish islands. The mean blood pressure values by age and sex were higher in Tiree than in Renfrew, confirming the differences between the island and the mainland already observed (Hawthorne *et al.*, 1969). People examined at work in the west of Scotland and elsewhere (Reid *et al.*, 1974) had lower values, showing the differences in blood pressure which exist between samples of the general population and samples of occupational or professional groups.

A response rate of 79% for a screening survey of this type compares with those of other studies which vary between 68% and 90% (Rose and Blackburn, 1968). Losses from a survey repeated at intervals tend to be cumulative, as shown by the fact that only 60% of those originally eligible in 1972 were seen a second time in 1973. To some extent this is inevitable since death and departure from the area are bound to occur.

The group fluctuations of blood pressure around the group mean observed in subjects re-examined after one year (fig. 3) indicate a need for a long-term follow up through medical-record linkage of those individuals showing the widest ranges of change from the mean. Light might also be shed on the prognostic significance of the larger fluctuations by retrospective analysis of the characteristics of such people.

TABLE II—Proportion of Subjects above Three Different Levels of Diastolic Blood Pressure at Primary Screening in 1972

	No. Examined	Diastolic Blood Pressure (mm Hg)		
		$\geq 90$	$\geq 95$	$\geq 100$
Men	1,409	567 (40.2%)	367 (26.0%)	220 (15.6%)
Women	1,592	628 (39.5%)	407 (25.6%)	248 (15.6%)
Total	3,001	1,195 (39.8%)	774 (25.8%)	468 (15.6%)

By failing to show a bimodal distribution of blood pressure in an unselected population (fig. 2) the results are consistent with other epidemiological observations (Metropolitan Life Insurance Company, 1961; Finnerty *et al.*, 1973), supporting Pickering's contention that hypertension is not a separate disease entity (Pickering, 1968). This is not to say that increased blood pressure is harmless. The close association of morbidity and mortality with increasing levels of blood pressure is well known from insurance company data (Metropolitan Life Insurance Company, 1961) and from prospective epidemiological studies (Kannel *et al.*, 1972). The practical issue is whether reducing blood pressure also reduces risk. The case for reducing diastolic blood pressures of above 110 mm Hg is well established; below this level the evidence is suggestive, but not certain, and trials are currently in progress in this country and elsewhere (Peart, 1973). If these trials indicate that reduction of diastolic blood pressure from levels of between 100 and 110 mm Hg is beneficial it will follow from the results described here and elsewhere (Wilber *et al.*, 1972; Finnerty *et al.*, 1973) that screening programmes will be needed because most patients are either not aware that their blood pressure is increased or are not being adequately treated. The cost of such screening for high blood pressure alone would clearly be less than £4.31 per subject at current levels of costing, but the large-scale programmes of prevention that would be required would have important implications for National Health Service resources. The problems would be proportionately greater if benefit was shown to accrue from treating "mild" to "moderate" hypertension in the ranges 90 to 109 mm Hg diastolic.

The effect of screening on the psychological state of the population screened has not been measured. Awareness of disease is not always beneficial in apparently healthy subjects (Lorimer *et al.*, 1972; D. Christie, personal communication), and it may be necessary to set such a disadvantage against the benefits of treating hypertension. Alternatively, as nearly 80% of the population volunteered for examination it could be argued that screening surveys have value in reassuring a general population in whom four out of five are substantially concerned about the state of their health.

The study was made possible through the co-operation of the Provost and Town Council, residents, the M.O.H. and his staff, and the family doctors of the Burgh of Renfrew and through the help of the County of Renfrew Red Cross, the Boy Scouts, the local Rotary

club, the staffs of the N.H.S. Executive Council and the Electoral Register Office, the employers and trades unions, the local and national Press and many other people and groups.

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TABLE III—Mean (± S.D.) Systolic and Diastolic Blood Pressure in Men and Women examined in Renfrew Survey in 1972 and 1973

	Men								Women							
	45-49 yr		50-54 yr		55-59 yr		60-64 yr		45-49 yr		50-54 yr		55-59 yr		60-64 yr	
	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973
No. examined:	403	303	377	288	340	262	289	221	449	329	415	321	377	289	351	273
	<i>Systolic Blood Pressure</i>															
Mean ± S.D.	142.8 ± 20.4	141.4 ± 19.0	147.3 ± 22.9	145.9 ± 23.3	153.5 ± 24.1	153.0 ± 24.4	156.9 ± 25.1	153.6 ± 24.5	145.2 ± 21.9	144.2 ± 22.3	149.7 ± 22.9	151.3 ± 24.7	158.3 ± 24.7	158.8 ± 25.9	163.7 ± 23.9	164.9 ± 25.2
	<i>Diastolic Blood Pressure</i>															
Mean ± S.D.	86.5 ± 12.4	86.9 ± 11.6	87.3 ± 11.4	87.0 ± 10.8	88.0 ± 13.2	88.6 ± 13.5	87.6 ± 13.7	86.2 ± 12.6	84.0 ± 11.9	84.0 ± 11.1	85.8 ± 11.9	86.9 ± 11.1	88.7 ± 12.6	89.4 ± 12.2	90.9 ± 13.3	90.4 ± 13.0