The intervention effects of a community-based hypertension control programme in two rural South African towns: the CORIS study

K. STEYN, J. E. ROSSOUW, P. L. JOOSTE, D. O. CHALTON, E. R. JORDAAN, P. C. J. JORDAAN, M. STEYN, A. S. P. SWANEPOEL

Abstract **The objective of the hypertension programme of the Coronary Risk Factor Study (CORIS) was to evaluate the effectiveness of the first 4 years of community-based intervention.**

The hypertension intervention model comprised a blood pressure station where the whole population was screened for hypertension, non-drug management was provided and hypertensives were monitored after referral to general practitioners for drug therapy. Two levels of intervention were maintained: in the high-intensity intervention town (*N* = 2 278) hypertensives were actively followed up, and in the low-intensity intervention town (*N* = 2 620) no active follow-up procedure existed. A third town acted as control (*N* = 2 290).

In the cohort which was hypertensive at baseline, the net decreases in systolic blood pressure (mean ± SE) after correction for changes in the control town were 0,5 ± 2,2 mmHg (men) and 4,5 ± 2,2 mmHg (women) in the low-intensity intervention town, and 5,6 ± 2,3 mmHg (men) and 7,5 ± 2,2 mmHg (women) in the high-intensity intervention town. The net decrease in diastolic blood pressure was 3,4 ± 1,2 mmHg (men) and 4,4 ± 1,1 mmHg (women) in the low-intensity intervention town, and 6,1 ± 1,2 mmHg (men) and 5,9 ± 1,1 mmHg (women) in the high-intensity intervention town. These reductions were statistically significant with one exception. The changes in the total population in the 3 communities after 4 years of intervention were similar to those found in the hypertensive cohort.

Decreases in mean blood pressure were accompanied by marked increases in the proportion of hypertensives on drug treatment and the proportion under control (< 160/95 mmHg).

Distribution curves of blood pressure indicated a large effect in the subgroup above the cut-off point for hypertension; however, the entire curve also shifted to the left, indicating, in addition, benefit to the whole population. An increase in the appropriate knowledge and action for hypertension control was observed in the intervention towns compared with the control town.

The CORIS community-based hypertension control programme successfully reduced the risk for cardiovascular diseases in the intervention towns compared with the control town.

S Afr Med J 1993; **83:** 885-891.

Centre for Epidemiological Research in Southern Africa, Research Institute for Nutritional Diseases and Institute for Biostatistics of the South African Medical Research Council, Parowvallei, CP
K. STEYN, M.SC., N.E.D., M.D.
P. L. JOOSTE, B.SC. HONS (CLIN. EPIDEMIOL.)
D. O. CHALTON, PH.D.
E. R. JORDAAN, B.SC. HONS
Institute for Social Dynamics of the Human Sciences Research Council, Pretoria
P. C. J. JORDAAN, D.ED.
M. STEYN, B.A. HONS
Women's Health Initiative, National Institutes of Health, Bethesda, Md, USA
J. E. ROSSOUW, F.C.P. (S.A.), M.D.
Department of Health Services and Welfare, House of Assembly
A. S. P. SWANEPOEL, M.SC.

Accepted 14 Sep 1992.

The benefit of treating hypertension has been shown in adults of all ages, both sexes and many ethnic groups in prospective studies across the world[1-10] and is thought to have contributed to the decline in hypertension-associated mortality in the USA. Feinleib[11] pointed out that a mild 6 mmHg drop in the mean diastolic pressure of the American population could lead to an expected decline of 4,3% in the coronary heart disease (CHD) mortality rate. Meta-analysis of 14 randomised trials for hypertension control by Collins *et al.*[1] estimated that a long-term lowering of 5 - 6 mmHg in usual blood pressure is associated with 35 - 40% fewer strokes and 20 - 25% less CHD. These estimates had very wide confidence intervals and must be used with caution. The necessity of population control programmes was suggested in projects like the Hypertension Detection and Follow-up Program[5-6] in the USA, the Australian National BP Study,[4] and the MRC trial in the UK.[12] The efficacy of community-based hypertension control programmes has been demonstrated by the Karelia Study,[13] the Stanford Five-City Project,[14] the Minnesota Heart Health Program[15] and the Pawtucket Heart Health Program.[16]

The high incidence of CHD among white South Africans[17] prompted the planning of a 3-community Coronary Risk Factor Study (CORIS) which revealed that these communities of Afrikaans-speaking whites had a high prevalence of CHD risk factors including hypertension at baseline.[18] For white South Africans the age-adjusted prevalence of definite hypertension (systolic ⩾ 160 mmHg and/or diastolic ⩾ 95 mmHg and/or antihypertensive medication) was 18%, similar to the prevalence in American whites aged 18 - 64 years.[19] The unadjusted prevalence rates for definite hypertension in the study population were 23,3% and 25,3% for men and women respectively. At baseline, most hypertensives were undiagnosed and 90,7% of those with hypertension were uncontrolled.[18]

The baseline survey was followed by an active 4-year community-based multifactorial CHD risk factor intervention programme. The overall intervention results[20] improved the CHD risk profile of the populations in the 2 intervention towns compared with that of a third, control town. This article focuses on the effects of the 4-year (1979 - 1983) community-based hypertension control programme of CORIS. It also compares the graded high and low intensity of hypertension intervention in the intervention towns with each other and with the control town that received no intervention at all. The 4-year active intervention programme was followed by a 7-year community-initiated programme that evaluated to what degree risk factor changes achieved during the active phase were maintained. A final survey in 1991 completed this programme.

Population and methods

The detailed methodology of the CORIS is described elsewhere.[20] The study had a quasi-experimental design[21] and comprised cross-sectional surveys in 3 communities before and after a 4-year intervention programme of graded intensity in 2 communities; the third served as control.

Study population

The white populations of 3 rural towns and their magisterial districts in the south-western Cape Province were selected for the study on the basis of their similar age structure, language and culture (over 95% Afrikaans-speaking), population size, relative population stability, and accessibility. Riversdale (white population 6 049, 1980 census) was selected as the control town because it was separated from the intervention towns by a non-study area. Swellendam (6 176) was chosen for low-intensity intervention (LII) that focused on the use of small mass media (billboards, posters, pamphlets and brochures) as a means of reaching the community. Robertson (5 526) received high-intensity intervention (HII), and hypertensives were actively followed up by the research team in addition to the provision of small mass media exposure.

All white men and women aged 15 - 64 years were invited to participate in the baseline risk factor survey. Names and addresses were obtained from municipal and electricity consumers' records and a postal census was conducted. In Riversdale 1 082 men (60% of 1980 official census population) and 1 208 women (68%), in Swellendam 1 224 (65%) men and 1 396 (74%) women, and in Robertson 1 051 (64%) men and 1 227 (71%) women responded. The overall response rate of those actually approached by the team was considerably higher (82% of the postal census), probably indicative of an under-enumeration in the postal census.

At the resurvey after 4 years of intervention, the age range was extended to 15 - 68 years, to accommodate the ageing of participants. Ascertainment procedure was similar to that of the baseline survey. In Riversdale 1 109 (62% of 1980 census) men and 1 150 (64%) women, in Swellendam 1 171 (65%) men and 1 323 (70%) women, and in Robertson 914 (56%) men and 1 126 (67%) women in the age range 15 - 64 responded. A hypertensive cohort of 472 men and 629 women participated in both surveys. This represents 60,4% of men and 64,9% of women who were hypertensive at the baseline survey.

Intervention

The community-based hypertension control programme interacted with the community, medical practitioners and other medical services, and the CORIS blood pressure stations. Blood pressure stations, staffed by locally recruited, trained registered nurses, were set up in the 2 intervention towns. The public had unlimited access to these, free of charge. Patients with hypertension were invited to return to the stations at monthly intervals for monitoring of their blood pressure as well as for advice on non-drug management which included weight control, reduction in alcohol, dietary salt, fat and cholesterol consumption, increased exercise, smoking control and stress management. In addition all uncontrolled hypertensive patients were referred to general practitioners who provided the necessary medical care, including drug prescriptions. During the 4-year intervention period this screening procedure identified previously undiagnosed hypertensive patients in the 2 towns, in addition to monitoring the pressures of known hypertensives.

Fig. 1 illustrates the CORIS hypertension control programme in more detail and indicates the differences in intervention procedures between the LII and HII towns. The CHD risk factors including hypertension were addressed by means of posters, billboards and mailings in both intervention towns, and also at public meetings and through local community organisations in the HII town. In addition, hypertensives in the HII town were actively followed up to ensure regular monthly checks of their blood pressure. Each patient in the HII town received a personal booklet for record keeping. Hypertensives with other CHD risk factors received the necessary advice regarding these other risk factors.

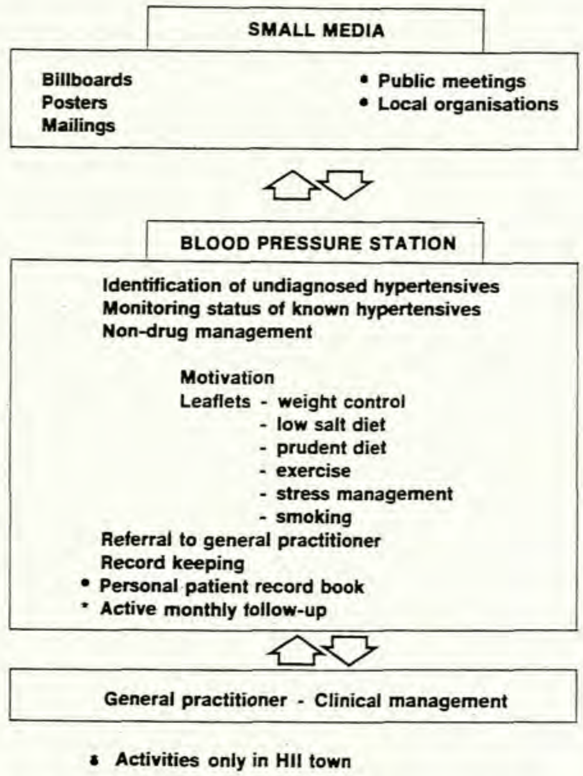

FIG. 1.
CORIS community-based hypertension control programme.

Measurements, cut-off points and presentation of data

During the baseline and follow-up studies, respondents completed a questionnaire on knowledge of risk factors and smoking habits. Medical history was also recorded. Body weight in light clothing was measured on a beam balance scale and height (without shoes) with a rod anthropometer. Results were expressed as body mass index (BMI) (weight in kilograms/height in metres squared). Blood pressures were measured after subjects had been seated for 5 minutes. A standard 12,5 × 23 cm cuff connected to a mercury manometer was used. The American Heart Association guidelines for measuring blood pressure[22] were followed. The diastolic pressure was taken as the point of muffling of the Korotkoff sounds (phase IV). Readings were taken three times and the lowest reading recorded.

All interviewers and observers were trained and standardised by the same core team before and during both surveys. It was impossible for blood pressure readers not to be aware of which town they were working in; steps were therefore taken to reduce observer bias. The readers were specially employed for the surveys and did not participate in the intervention phase of the study. They were standardised by an experienced clinician, who used a double headed stethoscope; they were monitored weekly. The reference clinician conducted spot blood pressure checks during the survey and emphasis was placed on avoiding bias. The same observers were used throughout in all 3 communities. No systematic inter-observer variation or end-digit preference of blood pressure readings was encountered. Test-retest of 100 subjects randomly recalled after 1 week to determine combined biological and technique variation showed correlation coefficients of $r = 0{,}78$ for systolic and 0,77 for diastolic blood pressure.

For the purpose of this study definite hypertension was defined as a systolic blood pressure $\geqslant$ 160 mmHg and/or diastolic blood pressure $\geqslant$ 95 mmHg; any person who reported taking antihypertensive medication was considered hypertensive.[23] A patient with controlled hypertension was defined as one with systolic blood pressure < 160 mmHg and diastolic blood pressure < 95 mmHg who was taking appropriate antihypertensive medication. Borderline hypertension was defined as a systolic blood pressure 140 - 159 mmHg inclusive and/or diastolic blood pressure 90 - 94 mmHg inclusive.

The effect of the hypertension intervention was assessed in two ways. Firstly, all participants aged 15 - 64 years at baseline were compared with all participants aged 15 - 64 observed 4 years later. The findings reflect mean blood pressures, hypertension prevalence and hypertension treatment status in the communities before and after intervention. The unadjusted within-community (in measurement units) changes were calculated for each area stratified by sex. As the whole population had been measured with no sampling error in the estimates, and also because the total population comprised both paired and unpaired observations, statistical tests were not appropriate. Secondly, the hypertensive cohort, comprising all participants who were classified as hypertensive at baseline and who participated in both surveys, was studied. The cohort reflects the changes that had occurred in hypertensives during the ensuing 4 years of intervention. The hypertensive cohort was aged 15 - 64 years at baseline and 19 - 68 years at resurvey. Statistical comparisons of change within the cohort were made by means of two-tailed paired t-tests.

Net change in the hypertensive cohort was defined as the residual change in an intervention area after change in the control area had been allowed for. This was used as a measure of the intervention effect, as the change within a community includes also secular trends and the effect of survey participation.

Attrition bias in the hypertensive cohort was partly examined by comparison of their risk factor levels at baseline with those of the baseline hypertensive population who did not participate after 4 years. Jooste *et al.*[24] showed that the prevalence of hypertension and hypercholesterolaemia did not differ between subjects who were lost to follow-up and those who participated in the CORIS follow-up survey. The age distribution of each population sample was similar to the census population, but men were somewhat under-represented.

Results

The comparability of the 3 study populations at baseline is shown in Table I. They were similar in terms of age and sex distribution, average cholesterol levels, blood pressure, body mass index and smoking habits.

Total population analyses

Table II shows the changes in the total populations aged 15 - 64 years at baseline and aged 15 - 64 years after 4 years of intervention. The change in total population systolic and diastolic blood pressure was greater in the 2 intervention towns than in the control town for both men and women. In men, systolic blood pressure decreased by 4,5 mmHg in both intervention towns compared with 1,8 mmHg in the control town; diastolic blood pressure decreased by 1,5 and 2,3 mmHg in the LII and HII towns respectively while it increased by 2,2 mmHg in the control town. In women, mean systolic blood pressure decreased by 6,3 and 8,0 mmHg in the 2 intervention towns, compared with a decrease of 4,9 mmHg in the control town; diastolic blood pressure decreased by 3,4 and 3,8 mmHg against 0,7 in the control town.

The prevalence of borderline hypertension changed little, except for an 8 percentage point increase in men in the control town. In the intervention towns the prevalence of definite hypertension decreased by 3 - 5 percentage points, compared with an increase of 1 - 8 percentage points in the control town. The prevalence of persons with uncontrolled hypertension (blood pressures exceeding 160 mmHg systolic and/or 95 mmHg diastolic) decreased markedly in women from both intervention areas, and in HII men. This was the result of marked increases in the proportion of hypertensives on medication (22 - 25%) and the proportion with controlled hypertension (20 - 25%) in these 3 area/sex groups. LII men did less well than HII men, while men in the control group showed the least improvement in proportions on treatment and control. Women showed similar percentage improvements to men, even though they started out with higher proportions of hypertensives controlled on treatment.

The distribution curves of the diastolic blood pres-

TABLE I.
Mean (SD) baseline risk factor levels of total study population aged 15 - 64 in the 3 study communities

	Men			Women		
	Control	LII	HII	Control	LII	HII
No. of participants	1 082	1 224	1 051	1 208	1 396	1 227
Age (years)	39,2 (15,8)	40,7 (14,1)	40,6 (14,4)	40,8 (14,8)	40,5 (14,0)	40,2 (14,1)
Cholesterol (mmol/l)	6,14 (1,53)	6,19 (1,41)	6,37 (1,43)	6,56 (1,65)	6,34 (1,5)	6,55 (1,49)
HDL cholesterol (mmol/l)	1,24 (0,30)	1,21 (0,30)	1,27 (0,32)	1,52 (0,33)	1,47 (0,36)	1,61 (0,39)
Systolic blood pressure (mmHg)	135,7 (18,6)	134,7 (18,1)	138,3 (20,2)	137,0 (22,4)	134,6 (21,5)	135,8 (21,9)
Diastolic blood pressure (mmHg)	85,5 (12,2)	86,4 (11,1)	86,4 (12,6)	86,5 (11,0)	85,3 (10,6)	84,5 (11,3)
Smokers (%)	44,4	46,6	49,21	4,5	14,7	17,0
BMI (kg/m^2)	25,7 (4,0)	26,0 (3,9)	26,1 (3,9)	26,2 (5,2)	25,7 (5,0)	25,6 (5,0)

LII = low intensity intervention; HII = high intensity intervention.
No statistical tests performed, since total population had been measured.

TABLE II.
Comparison of the blood pressure and treatment status of the total population aged 15 - 64 years both at baseline and after 4 years

	Control town		LII town		HII town	
	Baseline	4 years	Baseline	4 years	Baseline	4 years
Men						
No.	1 082	1 109	1 224	1 171	1 051	914
Body mass index (SD)	25,7 (4,0)	25,8 (4,4)	26,0 (4,2)	26,0 (4,2)	26,1 (3,9)	26,2 (4,0)
Mean systolic blood pressure (mmHg) (SD)	135,7 (18,6)	133,9 (18,2)	134,7 (19,3)	130,2 (16,7)	138,3 (20,2)	133,8 (16,1)
Mean diastolic blood pressure (mmHg) (SD)	85,5 (12,2)	87,7 (12,1)	86,4 (11,8)	84,9 (11,5)	86,4 (12,5)	84,1 (10,6)
Systolic > 160 and/or diastolic > 95 mmHg (%)	19,3	27,3	20,5	18,1	24,0	16,6
Borderline hypertension (%)*	30,5	38,5	27,9	30,4	29,7	32,1
Definite hypertension (%)†	21,0	29,0	23,7	20,4	25,4	22,3
On medication (%)‡	14,9	20,4	13,8	27,6	24,3	49,5
Controlled on medication (%)‡	3,9	5,6	5,2	11,3	5,6	25,5
Women						
No.	1 208	1 150	1 396	1 323	1 227	1 120
Body mass index (SD)	26,2 (5,2)	26,0 (5,4)	25,7 (5,4)	25,0 (4,8)	25,6 (5,0)	25,2 (4,8)
Mean systolic blood pressure (mmHg) (SD)	137,0 (22,4)	132,1 (21,4)	134,6 (23,1)	126,6 (20,4)	135,8 (22,1)	129,5 (18,2)
Mean diastolic blood pressure (mmHg) (SD)	86,5 (11,6)	85,8 (11,5)	85,3 (12,1)	81,4 (11,5)	84,5 (12,0)	81,1 (10,0)
Systolic > 160 and/or diastolic > 95 mmHg (%)	25,1	23,9	21,9	13,3	19,95	11,4
Borderline hypertension (%)*	25,3	23,9	24,6	23,7	22,5	21,8
Definite hypertension (%)†	27,6	28,9	23,6	18,5	25,1	20,8
On medication (%)‡	37,2	46,8	28,9	51,0	49,7	71,8
Controlled on medication (%)‡	9,0	17,4	7,0	28,2	20,6	45,3

* Systolic BP ≥ 140 < 160 and/or diastolic BP ≥ 90 < 95 mmHg.[19]
† Systolic BP ≥ 160 and/or diastolic BP ≥ 95 mmHg and/or on medication.[19]
‡ As percentage of definite hypertensives.

sure in women at baseline and at follow-up in the control, LII and HII towns (Fig. 2) illustrate that the area under the curve above the cut-off point of 95 mmHg decreased the most in the HII town and the least in the control town. There was also some shift to the left at lower levels of blood pressure, indicating the benefit to the entire population. The shift in the blood pressure of the men was similar to that of women.

At follow-up more subjects in the intervention towns reported having had their blood pressures measured than in the control town. In the control town, with no blood pressure station, there was an increase in blood pressure measurements by doctors.

Both hypertensive men and women indicated their awareness of their hypertension most frequently in the HII town and least frequently in the control town. About 90% of the subjects in both the intervention towns indicated their preference for retaining the blood pressure station as a service to the community after completion of the study.

At follow-up it was found that the most commonly prescribed drugs for men were β-blockers (25,3% of hypertensives), followed by diuretics (22,3%) and reserpine-containing preparations (6,4%). For women the most commonly prescribed drugs were diuretics (43,2% of hypertensives), followed by reserpine-containing preparations (15%) and then β-blockers (14,6%). Participants receiving β-blockers or diuretics had higher serum cholesterol and triglyceride levels than those receiving other antihypertensive drugs, and women on β-blockers also had lower high density lipoprotein cholesterol levels (data not shown).

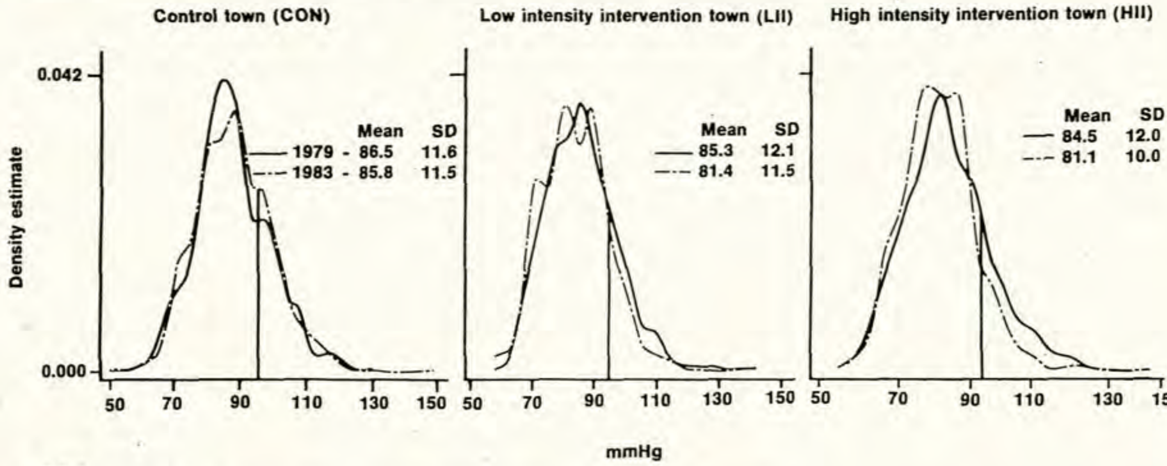

FIG. 2.
Observed shift in diastolic blood pressure frequency distribution in women.

Cohort analyses

Attrition bias could not be shown as the hypertensive cohort did not differ significantly from the non-cohort hypertensives who participated only in the baseline survey. Comparisons were made for the sex ratio, age distribution, mean systolic and diastolic blood pressures and the percentage of hypertensives on drug treatment, or the percentage with controlled blood pressure at baseline (data not shown).

Table III reflects the changes in the hypertensive cohort aged 15 - 64 years at baseline and aged 19 - 68 years after 4 years of intervention in each of the three communities.

For hypertensive male and female cohorts in the intervention towns the decreases in mean diastolic and systolic blood pressure after 4 years of intervention were usually larger than those observed in the control population. In men, systolic blood pressures decreased by 5,1 and 10,2 mmHg in the LII and HII towns respectively; diastolic blood pressures decreased by 4,1 and 6,7 mmHg, compared with decreases of 4,5 mmHg systolic and 0,6 mmHg diastolic in hypertensive men in the control town. In hypertensive women, the differences were considerably larger: systolic blood pressure decreased by 10,1 and 12,1 mmHg, and diastolic by 6,7 and 8,0 mmHg in the intervention towns compared with decreases of 5,5 mmHg in systolic and 2,2 mmHg in diastolic in the control town. In both men and women decreases were consistently larger in the HII than the LII town. Decreases in mean BPs were accompanied by marked increases in the proportion of hypertensives on drug treatment, and especially in the proportion with controlled hypertension (systolic blood pressure < 160 mmHg and diastolic < 95 mmHg). Whereas none of the hypertensives had blood pressures below 140/90 mmHg at baseline, about one-quarter achieved this level of control after intervention; of these slightly over half were on drug treatment.

The net changes in blood pressure, prevalence of hypertension and treatment status, including the residual changes in the intervention areas after changes in the control area were allowed for, are summarised in Table IV. The net reductions in systolic and diastolic blood pressures were significant ($P \leqslant 0,05$) in men and women (with the exception of systolic in LII men).

The net change for hypertensives on drugs increased significantly for men in both LII and HII towns while for women the increase almost reached significance ($P \leqslant 0,0517$) in the LII town. In contrast the net change for controlled hypertension increased significantly for women in both LII and HII towns while for men it increased significantly only in the HII town.

A significant decrease in the net prevalence of hypertension was found for both men and women in both the intervention towns.

Discussion

The CORIS community-based hypertension control programme successfully and significantly reduced systolic and diastolic blood pressure in the HII and LII towns compared with changes in the control town during the 4-year intervention programme. The degree of net blood pressure reduction reported in this study for the hypertensive cohort (Table IV) if maintained, allows for a cautious estimate of a 30 - 40% reduction in strokes and 15 - 25% fewer coronary heart disease events according to estimates by Collins *et al.*[1] Women are anticipated to do better than the men.

The benefit of the intervention programme is probably not confined to the hypertensive cohort, since favourable reductions in the blood pressure of the total population were also observed. Less than one-half of the net change in the population mean blood pressures after intervention could be attributed to the changes in the

TABLE III.
Comparison of the blood pressure and treatment status of the hypertensive cohort originally aged 15 - 64 years, at baseline and after 4 years*

	Control town		LII town		HII town	
	Baseline	4 years	Baseline	4 years	Baseline	4 years
Men						
No.	147	167	158			
Body mass index	28,6 (3,8)	28,7 (4,2)	27,8 (3,9)	28,1 (4,1)	28,0 (3,9)	28,1 (4,0)
Mean systolic blood pressure (mmHg) (SD)	159,8 (20,6)	155,3 (21,4)	156,6 (19,6)	151,5 (19,9)	162,2 (19,5)	152,0 (20,1)
Mean diastolic blood pressure (mmHg) (SD)	102,9 (11,2)	102,3 (11,9)	100,9 (8,7)	96,8 (11,2)	101,0 (8,6)	94,3 (8,6)
On medication (%)	17,7	35,2	13,2	43,1	26,6	65,8
Controlled on medication (%)	5,4	9,6	5,4	15,4	6,3	30,7
BP < 140/90 mmHg on medication (%)	0	9,0	0	13,2	0	15,6
BP < 140/90 mmHg on/or off medication (%)	0	14,3	0	26,4	0	26,0
Women						
No.	223	203	203			
Body mass index	29,8 (5,7)	29,9 (5,9)	28,7 (5,6)	28,6 (5,5)	28,8 (5,3)	28,4 (5,6)
Mean systolic blood pressure (mmHg) (SD)	163,7 (18,7)	158,2 (22,8)	162,8 (19,5)	152,7 (23,1)	163,4 (22,8)	151,3 (18,8)
Mean diastolic diastolic blood pressure (mmHg) (SD)	99,9 (9,0)	97,7 (10,7)	100,6 (9,2)	93,9 (11,2)	98,7 (10,4)	90,7 (9,4)
On medication (%)	37,7	64,0	28,6	64,9	50,7	79,6
Controlled on medication (%)	10,3	19,5	6,9	29,1	21,2	49,7
BP < 140/90 mmHg on medication (%)	0	7,0	0	17,3	0	16,0
BP < 140/90 mmHg on/or off medication (%)	0	10,3	0	25,6	0	22,7

* Hypertension = systolic BP ≥ 160 mmHg and/or diastolic BP > 95 mmHg and/or on antihypertensive drug treatment.

TABLE IV.
Net change and standard error (net Δ, SE) in blood pressure and hypertensive treatment status in hypertensive cohort originally aged 15 - 64 at baseline, relative to change in control population

	Men						Women					
	LII			HII			LII			HII		
	Net Δ	(SE)	*P*	Net Δ	(SE)	*P*	Net Δ	(SE)	*P*	Net Δ	(SE)	*P*
No.		(167)			(158)			(203)			(203)	
Systolic blood pressure (mmHg)	–0,51	(2,16)	0,813	–5,59	(2,27)	0,014	–4,54	(2,17)	0,0366	–7,52	(2,24)	0,0008
Diastolic blood pressure (mmHg)	–3,4	(1,22)	0,0056	–6,08	(1,22)	<0,0001	–4,42	(1,12)	<0,0001	–5,92	(1,11)	<0,0001
% Hypertensives*	–12,1	(4,48)	0,0073	–11,7	(4,54)	0,0104	–15,3	(3,69)	<0,0001	–12,3	(3,58)	0,0006
% Hypertensives† on drugs	12,7	(5,44)	0,0198	22,0	(6,00)	0,0002	10,0	(5,14)	0,0517	2,55	(5,05)	0,6136
% Hypertensives† controlled	5,97	(4,12)	0,1473	20,36	(5,31)	0,0001	13,06	(4,71)	0,0056	19,31	(5,30)	0,0003

P = values determined by two-tailed *t*-tests; net Δ = change in intervention town minus the change in the control town over 4 years.
* Hypertensives = BP ≥ 160/95 and/or on antihypertensive drugs.
† The denominator = excluded cohort participants who were normotensive at follow-up without taking medication.

hypertensive cohort. Since the risk of stroke is continuously related to blood pressure, with no discernible lower threshold[25] even a 3 - 4 mmHg decrease in blood pressure will translate over the longer term into a reduced population risk of stroke. Some reduction in the risk of coronary disease is also likely, since some of the net reduction in blood pressure was due to non-drug measures that include a prudent diet and other measures that reduce overall risk for CHD.

The categorisation of individuals as hypertensive was based on readings at a single visit; random biological and technique variability could therefore have resulted in some misclassification in that blood pressure readings at the baseline visit could have been higher than at follow-up, due to unfamiliarity of participants with the procedure and the staff. A focus on the net change partly overcomes this problem, because this systematic bias was likely to be present in the control town also. Regression to the mean adds another source of bias in the cohort analyses, which may in part account for the lower blood pressures at follow-up, particularly in the control town. The net change variable eliminates this source of bias.

In this integrated system of community control of hypertension the staff at the blood pressure stations played a pivotal role in enhancing the clinical care provided by the general practitioners in the intervention towns. The efforts of the staff at the stations, to whom the community had unlimited access without charge for screening, monitoring, referral for medical care, education and provision of non-drug management for hypertension, resulted in increased community awareness of cardiovascular disease risk factors and lifestyle management as well as improved diagnoses, treatment and compliance of hypertensive patients. From Fig. 2 it would seem that most of the change in mean diastolic blood pressure levels could be due to the change above 95 mmHg. This strengthens the case for the role of the blood pressure station in community-based hypertension control in addition to the implementation of lifestyle changes in the entire population.

An important limitation of the generalisability of this study is that the hypertension programme formed part of a more extensive multifactorial risk factor intervention.[20] The model needs to be tested in a single factor intervention study, perhaps in a community which has hypertension as the predominant risk factor. The model also needs to be tested in populations of lower socio-economic status and from different ethnic backgrounds. Long-term follow-up to evaluate the endurance of the intervention achieved during the 4 years commenced during the 7-year community-initiated intervention period that will be reported later.

From the changes in systolic and diastolic blood pressure and the changes in hypertension prevalence in the LII and HII towns, it is clear that the differences in results between LII and HII are relatively small. This suggests that the less labour-intensive intervention of the LII town that involved mainly small media communication and free access to the blood pressure station was almost as effective as that of the HII town during the 4-year intervention period. In the HII town hypertensives were actively followed up and this doubled the staff requirements. From Table IV nevertheless, it is evident that more hypertensives were placed on drugs and were under control in the HII town than in the LII town, and for men the HII results were clearly better. To decide on the relative long-term benefit of the intervention in the HII and LII towns, follow-up will be necessary. The 7-year community-initiated intervention period and final survey during 1991 will possibly provide answers to this question. Available resources and local conditions will also determine which approach is feasible in a particular setting; if resources are limited then the LII approach may well be considered adequate.

CORIS is a project in collaboration with the Medical Research Council, the Human Sciences Research Council and the Department of Health Services and Welfare, House of Assembly. The funding of the project by these organisations is gratefully acknowledged. Without the dedicated work of the staff of the CORIS blood pressure stations this project would not have been possible. The co-operation of the medical practitioners of the districts of Robertson, Swellendam and Riversdale was essential to the project. The thorough work of the two fieldwork teams during the community surveys ensured collection of good quality data. We would like to thank the study communities for their willing participation. We are indebted to Jean Fourie for editing this manuscript.

REFERENCES

1. Collins R, Peto R, MacMahon S, *et al.* Blood pressure, stroke and coronary heart disease. Part 2. Short-term reductions in blood pressure: overview of randomised drug trials in their epidemiological context. *Lancet* 1990; **335:** 827-838.
2. Keys A, Menotti A, Aravanis C, *et al.* The seven countries study: 2 289 deaths in 15 years. *Prev Med* 1984; **13:** 141-154.
3. Prentice RL, Shimizu Y, Lin CH, *et al.* Serial blood pressure measurements and cardiovascular disease in a Japanese cohort. *Am J Epidemiol* 1982; **116:** 1-28.
4. Australian National Blood Pressure Management Committee. The Australian therapeutic trial in mild hypertension. *Lancet* 1980; **1:** 1261-1267.

5. Hypertension Detection and Follow-up Program Cooperative Group. Five-year findings of the Hypertension Detection and Follow-up Program. I. Reduction in mortality of persons with high blood pressure including mild hypertension. *JAMA* 1979; **242:** 2562-2571.
6. Hypertension Detection and Follow-up Program Cooperative Group. Five-year findings of the Hypertension Detection and Follow-up Program. II. Mortality by race-sex and age. *JAMA* 1979; **242:** 2572-2577.
7. Veterans Administration Cooperative Study Group on Antihypertensive Agents. Effects of treatment on morbidity in hypertension. II. Results in patients with diastolic pressure averaging 90 through 114 mmHg. *JAMA* 1970; **213:** 1143-1152.
8. Veterans Administration Cooperative Study Group on Antihypertensive Agents. Effects of treatment on morbidity — hypertension II. Influence of age, diastolic pressure, and prior cardiovascular disease: further analysis of side-effects. *Circulation* 1972; **45:** 991-1004.
9. McAlister NH. Should we treat 'mild' hypertension? *JAMA* 1983; **249:** 379-382.
10. WHO/ISH, Mild Hypertension Liaison Committee. Trials of the treatment of mild hypertension: an interim analysis. *Lancet* 1982; **1:** 149-156.
11. Feinleib M. Changes in cardiovascular epidemiology since 1950. *Bull NY Acad Med* 1984; **60:** 449-464.
12. Medical Research Council Working Party. Stroke and coronary heart disease in mild hypertension: risk factors and the value of treatment. *BMJ* 1988; **296:** 1564-1570.
13. Puska P, Tuomilehto J, Salonen JT, *et al.* Ten years of the North Karelia project results with community-based prevention of coronary heart disease in Finland. *Scand J Soc Med* 1983; **11:** 65-68.
14. Farquhar JW, Fortmann SP, Maccoby N, *et al.* The Stanford five-city project: design and methods. *Am J Epidemiol* 1985; **122:** 323-334.
15. Blackburn H, Luepker RV, Kline FG. The Minnesota Heart Health Program: A research and demonstration project in cardiovascular disease prevention. In: Matarazzo JD, ed. *Behavioral Health: A Handbook for Health Enhancement and Disease Prevention.* New York: John Wiley, 1984; 1171-1178.
16. Lefevre RC, Lasater TM, Carleton RA, *et al.* Theory and practice of health programming in the community: The Pawtucket Heart Health program. *Prev Med* 1987; **16:** 80-95.
17. Wyndham CH. Trends with time of cardiovascular mortality rates in the populations of the RSA for the period 1968 - 1977. *S Afr Med J* 1982; **61:** 987-993.
18. Rossouw JE, du Plessis JP, Benadé AJS, *et al.* Coronary risk factor screening in three rural communities. The CORIS baseline study. *S Afr Med J* 1983; **64:** 430-436.
19. Drizd T. *Blood Pressure Levels in Persons 18 - 74 Years of Age in 1976 - 80, and Trends in Blood Pressure from 1960 to 1980 in the United States. Vital and Health Statistics* (Series 11. No. 234 DHHS Pub. No. (PHS) 86-1684). Washington, DC: US Government Printing Office, Public Health Service, July 1986.
20. Rossouw JE, Jooste PL, Chalton DO, *et al.* Results after four years of community-based intervention: The coronary risk factor study (CORIS). *Int J Epidemiol* 1993; **22:** 428-438.
21. Kenny DA. A quasi-experimental approach to assessing treatment effects in the nonequivalent control group design. *Psychol Bull* 1975; **82:** 92-99.
22. American Heart Association. *Recommendations for Human Blood Pressure Determination by Sphygmomanometers.* Dallas: AHA, 1967.
23. World Health Organisation Expert Committee. *Arterial Hypertension* (Technical Report Series No. 628). Geneva: WHO, 1978.
24. Jooste PL, Yach D, Steenkamp HJ, Botha JL, Rossouw JE. Drop-out and newcomer bias in a community cardiovascular follow-up study. *Int J Epidemiol* 1990; **19:** 284-289.
25. MacMahon S, Peto R, Cutler J, *et al.* Blood pressure, stroke and coronary heart disease. Part 1. Prolonged differences in blood pressure: prospective observational studies corrected for the regression dilution bias. *Lancet* 1990; **335:** 765-774.