Factors associated with successful risk reduction after a community coronary risk factor screen

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Abstract: Debate continues over the effectiveness of coronary risk factor screening as a strategy for the prevention of coronary heart disease in the community. We reviewed changes in risk factors one year after a community coronary risk factor screen and found highly significant reductions in the blood cholesterol (mean reduction of 0.6 mmol/l) and body mass index (mean reduction of 1.03 kg/m^2) in those participants who at the initial screening were found to have elevated ($>$ 6.5 mmol/l) blood cholesterol concentrations. Comparison of this group with a reference group not given health advice and a group of hypercholesterolaemic clinic attenders showed that the blood cholesterol reduction could not be accounted for solely by regression to the mean, and was as good as the blood cholesterol reduction achieved by regular clinic attendance. Although there were many factors that could account for these reductions, we found that participants who received risk factor measurement and counselling during the screening process and who sought medical follow-up after the screen had a greater reduction in risk factors. (*Aust J Public Health* 1991; 15: 114–21)

Despite a decrease in incidence in the last two decades, coronary heart disease remains the greatest cause of premature death in Australia.[1] A recent study by the National Heart Foundation of Australia[2] of the known risk factors for heart disease in the Australian population revealed that one in five Australian adults has a blood cholesterol concentration above 6.5 mmol/l, which is unacceptably high. The study also showed that 43 per cent of the men and 35 per cent of the women were overweight or obese (body mass index $>$ 25 kg/m^2). Clearly a population-based strategy is required to reduce the high prevalence of coronary risk factors in the community.[3,4] Community-wide coronary risk factor screening is one of a number of preventive strategies being promoted to deal with this problem. However, its acceptance is not universal.[5,6]

Community coronary risk factor screening aims to identify individuals who are in the upper level of distribution for the known risk factors for coronary heart disease. Such persons can then receive appropriate advice or therapy. Factors which may affect the success of community coronary risk factor screening include: the availability and acceptability of the screening to all sections of the community; the prevalence of risk factors in that community; the willingness of the participant to accept intervention and make appropriate behavioural changes; and the effectiveness of intervention in the reduction of coronary heart disease risk.[5,6,7] The success of a community coronary risk factor screen can be measured by the extent of reduction of risk factors in those individuals identified as being at high risk.

Advances in dry chemistry technology have allowed the development of portable analysers which are capable of rapidly determining blood total cholesterol levels from a finger-prick sample of blood. This technique has good agreement with procedures for enzymic cholesterol determination.[8,9] Use of such technology in screening programs enables advice on lifestyle modifications or necessary medical intervention to be given immediately after an individual's risk factors have been assessed. Motivation to make changes may be improved by avoiding the usual delay between attending the screen and receiving the results of risk factor measurements.

We have previously examined the issues of availability and acceptability of community screens and the prevalence of risk factors detected, by comparing the demographics of screen participants with census

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data and the risk factor distribution with a reference population.[10] That analysis suggested that community coronary risk screening appeals more to health-conscious older age groups and to women and attracts fewer younger people, men and smokers. The analysis also revealed that 18.3 per cent of men and 27.7 per cent of women who presented for the screen had a blood cholesterol concentration over 6.5 mmol/l and that over 10 per cent of the population were obese (body mass index > 30 kg/m^2). To improve the effectiveness of community coronary risk factor screening we must broaden its reach and at the same time ensure that people who are identified during screening as being at high risk for coronary heart disease are given the necessary assistance to lower their risk factors successfully.

We have investigated the extent of risk factors reduction in individuals identified as having significantly elevated blood cholesterol concentrations at the initial screen. We also examined how intervention and advice offered on the day of the initial screen was used and if receiving such advice affected reduction in risk factors.

Subjects and methods

During Heart Week in April 1986, a coronary risk factor screen was established in a large shopping mall in the central business district of Melbourne. Self-referred subjects attended the screen for the assessment of their coronary risk factors. Subjects were initially enrolled and interviewed about their smoking habits. The following measures were then assessed by trained operators using a protocol previously outlined: repeated blood pressure measurements on a Dinamap 845 automated sphygmomanometer; a capillary whole blood cholesterol measurement using a reflectance analyser (Reflotron, Boehringer); height and weight in light street clothes and without shoes.[10] Body mass index was calculated by dividing weight by the square of height and was used as an assessment of body fatness. After these risk factors had been measured a physician and a dietitian assessed the results and advised subjects on appropriate lifestyle modification or medical care and distributed self-help literature.

One year later, all subjects who had been found to have significantly elevated blood cholesterol (> 6.5 mmol/l) at the initial screen were invited to attend a follow-up assessment at a hospital clinic. This assessment included reweighing subjects and performing a full lipid/lipoprotein analysis on a fasting venous blood sample. Before the follow-up assessment, participants completed a questionnaire giving details of any prescribed medications and their occupation, education, country of birth and marital status. They were also asked their views on the type and quality of advice offered at the original screen and how they acted on this advice after being informed of their coronary heart disease risk factors.

The results from this group of screen volunteers were compared to a reference group who volunteered in response to an invitation to participate in year-long monitoring of blood lipids, but without health care professional interaction other than blood sampling. A third group of regular clinic attenders, whose initial cholesterol values were comparable, and in whom targeted advice from physicians and dietitians was provided at three- to six-monthly intervals during the year of study, was also used for comparison.

In the screen group, differences in cholesterol concentration and body mass index after one year were tested for significance using Student's *t*-test (paired samples). Data relating to factors affecting risk factor reduction are presented as means with their associated 95 per cent confidence intervals. The percentage reduction in cholesterol concentration and body mass index after one year in the groups that did and did not seek advice at the time of the original screen, and in the groups that did and did not seek any further health care professional advice during the year, were tested for significance using the unpaired Student's *t*-test.

Results

The population sample

A total of 1125 self-referred subjects aged between 16 and 83 years attended the original Heart Week risk factor screen. Of these, 256 participants (66 men and 190 women) were found to have a capillary blood cholesterol concentration of 6.5 mmol/l or greater and were invited to attend a follow-up assessment. Seventy-two per cent of these subjects responded to the invitation (50 men and 133 women); their ages ranged from 30 to 82 years. There was no significant difference in age or initial risk factor prevalence between those who returned for the follow-up and those who failed to attend.

Population characteristics

The population characteristics of the repeat screen participants were compared with the metropolitan Melbourne population at the 1986 census. The outcome of this comparison is shown in Table 1. As in the original Heart Week screening sample, older people and women are overrepresented. Single people, full-time workers and people of Southern European or Asian origin are underrepresented, but tertiary-educated people and those with only primary school education are overrepresented.

Cholesterol

The mean blood cholesterol concentrations of subjects at the initial screen and at the one-year follow-up are shown in Figure 1. There is a significant decrease in mean cholesterol concentration at the one-year follow-up, with men showing a greater reduction (10.9 per cent) than women (7.7 per cent). A reduction in cholesterol concentration at the one-year follow-up was achieved by 70 per cent of the sample.

Table 2 compares the reduction in the screen cohort with blood cholesterol changes in the reference population and in the clinic group.

The effect of advice offered at the original screen on the extent of change of blood cholesterol concen-

Table 1: Characteristics of participants in follow-up assessment compared to the 1986 census

	1986 Census[a] %	Follow-up group %	*n*
Age			
mean		62.5	183
range	> 18	30–86	
distribution			
18–34 years	36.4	0.5	1
35–54 years	25.6	16.4	30
≥55 years	27.9	83.1	152
Gender			
men	40.9	27.3	50
women	50.1	63.7	133
Marital status			
single	21.2	10.9	20
married	64.4	56.8	104
divorced/separated	8.2	7.7	14
widowed	7.2	23.5	43
Country of birth			
Australia and Oceania	65.6	74.3	136
UK and Ireland	8.5	10.4	19
Northern Europe	4.8	8.7	16
Southern Europe	10.9	6.0	11
Asia	4.2	0.5	1
Africa	2.8	0.0	1
North and South America	0.9	0.0	0
Employment status			
employed full-time	51.9	13.1	24
employed part-time	7.3	4.4	8
unemployed	4.0	2.7	5
home duties	17.1	35.0	64
student	6.5	0.0	0
retired	13.0	43.7	80
Education[b]			
primary school only	11.0	17.5	32
some secondary school	30.7	32.8	60
completed secondary school or trade	34.0	22.4	41
tertiary diploma, certificate or degree	8.0	12.0	22

Sources:
(a) Australian Bureau of Statistics. Melbourne Metropolitan Region, persons aged 18 years and over. *Census of the Victorian population.* Canberra: ABS, 1986.
(b) Australian Bureau of Statistics. Educational attainment, persons aged 20–64 years. *Social indicators,* Victoria. Melbourne, ABS, 1986.

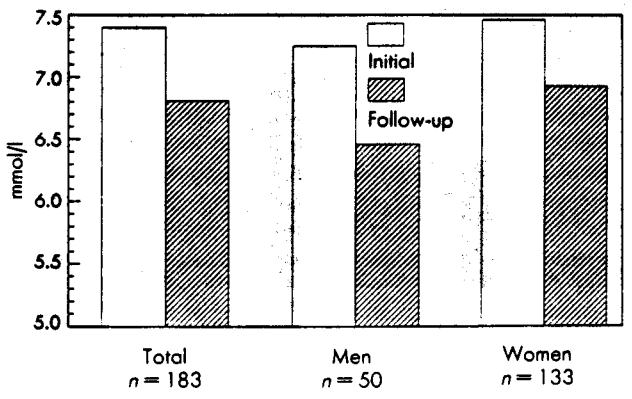

Figure 1: Change in blood cholesterol concentration after one year (all differences significant, $P < 0.0001$)

Table 2: Changes in blood cholesterol in different cohorts of hypercholesterolaemic[a] individuals

Group	Men Percentage change	*n*	Women Percentage change	*n*
Reference group[b] (no health advice)	−1.6	8	–	–
Screen group (one interaction)	−10.9	50	−7.7	133
Clinic group (regular clinic attendance)	−10.0	54	−9.1	51

Notes:
(a) Hypercholesterolaemic is defined as having a cholesterol of ≥6.5 mmol/l over one year, measured in the same clinical nutrition unit.
(b) Subjects who had no health advice had lipids measured in April, May or June of one year, repeated in the same month of the following year. When any of the initial blood cholesterol measurements were ≥6.5 mmol/l, the change over one year has been reported.

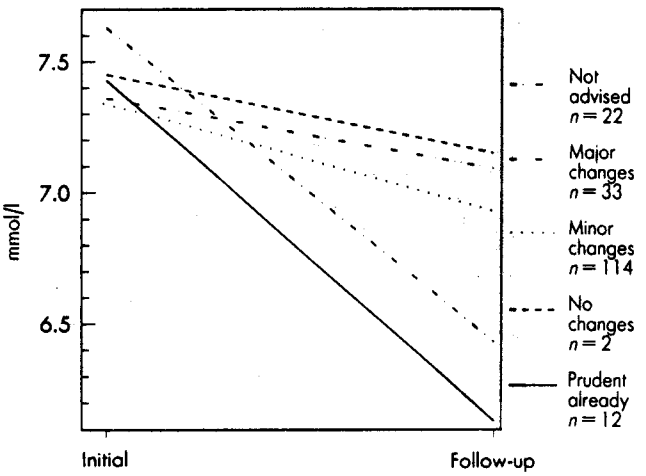

Figure 2: Self-reported dietary change effect on blood cholesterol

tration is examined in Table 3. Blood cholesterol values achieved by the screen group are lower in those who attended for advice. A reduction in mean cholesterol was observed in participants who sought medical follow-up after the initial screen, in contrast to those who did not take this action. Participants who were prescribed lipid-lowering drugs achieved a greater reduction in their mean cholesterol concentration after one year than the majority who received no drug therapy.

The most common medical services sought for further advice and treatment after the screen are listed in Table 4.

Figure 2 examines the relationship between self-reported dietary changes and the reduction in mean cholesterol concentration. Mean cholesterol values decreased most in those subjects who reported making major dietary changes or who were already following a prudent diet at the time of the initial screen. Smaller changes in cholesterol were found in subjects who reported minor dietary changes or no changes or who sought no advice. No clear relationship was

Table 3: Factors affecting change in cholesterol after one year

	n	Initial cholesterol mmol/l	Follow-up cholesterol mmol/l	*P*[b]	Percentage reduction	*P*[c]
Attended counselling at the initial screen						
Yes	161	7.41 7.29–7.53	6.77 6.61–6.93	<0.01	8.1 6.1–10.2	
No	22	7.36 7.03–7.69	7.09 6.45–7.73	n.s.	3.2 0–9.72	n.s.
Sought medical follow-up after the initial screen						
Yes	111	7.55 7.39–7.71	6.72 6.54–6.90	<0.01	10.4 8.1–12.7	
No	72	7.18 7.02–7.34	6.94 6.70–7.18	n.s.	3.1 0.0–6.27	<0.01
Used lipid-lowering drugs						
Yes	15	7.73 7.24–8.22	6.49 5.98–7.00	<0.01	15.1 6.6–23.7	
No	168	7.37 7.25–7.49	6.48 6.32–6.64	<0.01	6.9 4.9–8.8	n.s.

Notes:
(a) Results show mean concentrations, with 95% confidence intervals for the mean
(b) *P* calculated with paired Student's *t*-test
(c) *P* calculated with unpaired Student's *t*-test

Table 4: Type of medical follow-up sought after the screen

Source of advice	No. of respondents
Family doctor	102
Specialist physician	8
Dietitian	8
National Heart Foundation	5
Hospital heart disease clinic	2
Weight control clinic	1
Other	3
No follow-up sought	72

found between the self-reported changes in exercise level and the change in mean cholesterol concentration (Figure 3).

Body mass index

The changes in body mass index after one year are shown in Figure 4. There was a highly significant reduction in mean body mass index one year after the initial screen. The reduction is similar in both men and women (4 per cent) and 71 per cent of the sample had a lower body mass index at the follow-up.

The relationship between receiving and acting on advice at the initial screen and changes in body mass index is shown in Table 6. A smaller reduction in mean body mass index was found in those participants who received no advice at the screen. Subjects who sought medical follow-up and support after the screening had a greater reduction in mean body mass index than those who failed to do so.

Greater mean reductions in body mass index were observed in participants who reported making major changes to their dietary habits than in subjects who reported making only minor changes or no changes

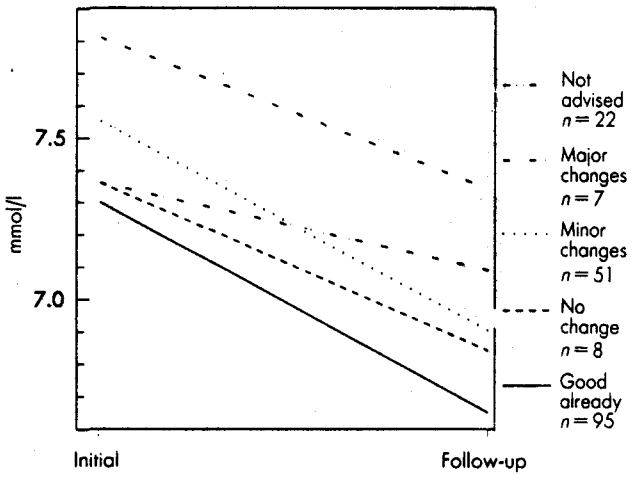

Figure 3: Self-reported exercise change effect on blood cholesterol

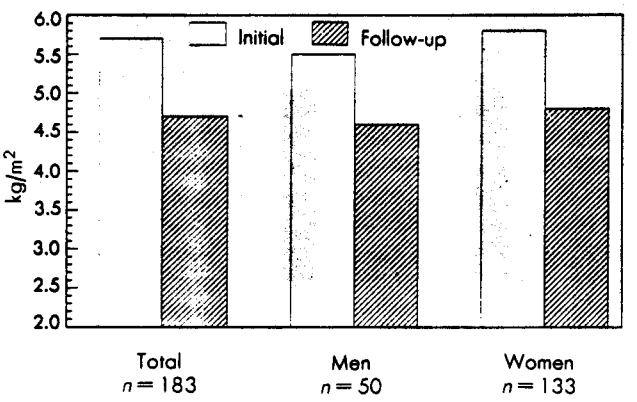

Figure 4: Change in body mass index after one year (all differences significant, $P < 0.0002$

Table 5: Factors affecting change in body mass index (BMI) after one year

	n	Initial BMI	Follow-up BMI	P[b]	% reduction	P[c]
Attended counselling at the initial screen						
Yes	161	25.6 25.1–26.2	24.5 23.9–25.2	<0.01	4.2 2.8–5.6	
No	22	26.2 24.2–28.1	25.8 23.5–28.1	n.s.	1.7 0.0–3.5	n.s.
Sought medical follow-up after the initial screen						
Yes	111	7.55 7.39–7.71	6.72 6.54–6.90	<0.01	4.5 3.5–5.5	
No	72	7.18 7.02–7.34	6.94 6.70–7.18	n.s.	3.0 0.2–5.7	n.s.

Notes:
(a) Results show mean BMI, with 95% confidence intervals for the mean
(b) Calculated with paired Student's *t*-test
(c) Calculated with unpaired Student's *t*-test

(Figure 5). Similar findings emerged in the relationship of self-reported changes in exercise patterns to changes in body mass index (Figure 6).

Smoking status

Only 10 participants (5.5 per cent) of the follow-up sample were smokers at the time of the initial screen.

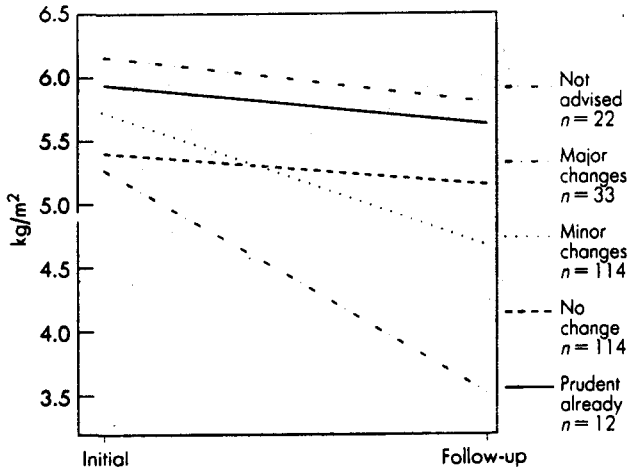

Figure 5: Self-reported dietary change effect on body mass index

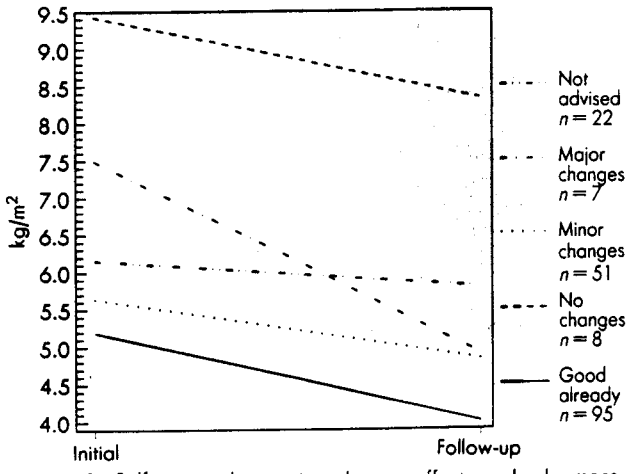

Figure 6: Self-reported exercise change effect on body mass index

All had been advised to quit smoking but not one smoker had achieved this before the follow-up. However, eight smokers reported they had made minor reductions in the number of cigarettes they smoked.

Other factors measured at follow-up visit

Subjects returning for the follow-up assessment were instructed to fast for the previous 12 hours. A venous blood sample was taken for determination of total cholesterol, high-density lipoprotein (HDL) cholesterol and triglyceride concentration. These measurements were compared with those of an urban Australian population observed by the National Heart Foundation of Australia during the Risk Factor Prevalence Study[2] (Table 7). The mean concentration of triglycerides for both men and women is greater in the screen participants than the reference population. But mean HDL cholesterol concentrations in both male and female screen participants are comparable with the reference population values (Table 7). As not all these measures were made at the initial screen it is not possible to analyse any changes over time.

Table 6: Lipid fractions at follow-up examination

Lipid fractions mmol/l)	Follow-up	Reference population[a]
Men		
Triglycerides	1.65 1.42–1.87	1.32
Total cholesterol	6.46 6.22–6.70	5.67
HDL cholesterol	1.26 1.17–1.35	1.25
Women		
Triglycerides	1.30 0.95–1.66	0.96
Total cholesterol	6.94 6.76–7.11	5.69
HDL cholesterol	1.54 1.47–1.61	1.55

Source:
(a) National Heart Foundation of Australia. Risk Factor prevalence study: report No. 2. Canberra: NHF, 1983.

Discussion

Comparability of study groups

The screen group and the reference group, being volunteers drawn from the population at large, had similar body mass index, blood pressure and socioeconomic status. The inclusion of the clinic group, drawn from the Melbourne-wide ambulatory care population of Prince Henry's Hospital, allowed us at least to make a judgment about the best outcomes possible in the community, when such individuals receive regular management from experts in the field. The order of reduction in blood cholesterol was comparable in the screen and clinic groups, and some six times that found in the reference group where no professional counselling had taken place, although the comparability of these groups is, intrinsically, not ideal. It is difficult to see how the screen groups could better be compared with other groups. Ethical considerations would have made it difficult to have made our groups more comparable, for example by randomising the screen participants to advice and non-advice groups. The likelihood of a non-advice screen group returning at one year for review is probably low, and so significant bias would have been introduced at follow-up. However, some, by choice, did not attend for counselling at initial screen.

Evaluation of outcome of a community screen

This evaluation of a community coronary risk factor screen has shown a favourable reduction after one year in both total blood cholesterol concentration and body mass index in those participants initially found to have a highly elevated blood cholesterol concentration. As this was not a controlled intervention trial, we are unable to say that the screening process was the only factor contributing to these reductions. Most likely there were many factors unassociated with the screening process that influenced blood cholesterol and body mass index levels in our follow-up group.

Factors not associated with the screening process

Reanalyses of elevated risk factor measurements at a later date are subject to regression to the mean, where a shift in extreme values towards the original population average results in a lower new mean value for the study group.[11] This shift can be pronounced when examining repeat cholesterol concentration measurements due to the high variability of blood cholesterol measurements for one individual.[12] The possibility that enhancement or diminution of regression to the mean may have occurred because groups with more or fewer variables of interest were compared is most unlikely for the groups chosen in this study.

Large prospective studies of heart disease risk such as the Multiple Risk Factor Trial,[13] Lipids Research Clinics Program,[14] the Oslo Study[15] and the Australian Therapeutic Trial in Mild Hypertension[15] have noted falls in cholesterol concentration or blood pressure of subjects who received no special intervention. Falls in cholesterol concentration after one year without study intervention by design where cholesterol levels were greater than 6.5 mmol/l have ranged from 2.6 per cent[13] through 4.4 per cent[15] to 5.6 per cent.[14] These studies probably evaluate the maximum potential for regression to the mean in our screen group. Our reference group, followed for one year without health advice, had a 1.6 per cent decrease in blood cholesterol, which is more likely to be the relevant expression of regression to the mean in the screen group (Table 2). In the screen group, the mean cholesterol concentration fell more than 10 per cent, with 70 per cent of study participants showing an improvement in their blood cholesterol concentrations at the one-year follow-up. This suggests that while regression to the mean may have contributed to these reductions, it is unlikely to provide a total explanation. However, the comparison groups in Table 3 consist of individuals who differ in whether and how health advice was obtained and acted upon.

Moreover, it is interesting that the screened population had similar reductions in blood cholesterol to the hypercholesterolaemic individuals who regularly attend our clinic for lifestyle counselling and drug treatment.

The reduction in mean cholesterol concentration is accompanied by an equally impressive reduction in mean body mass index. Over 71 per cent of participants had a lower body mass index at the one-year follow-up, although the reduction in mean body mass index (4 per cent) was not as large as the reduction in cholesterol concentration.

Methodological differences are also unlikely to account for the extent of the reduction in mean blood cholesterol concentration after one year. The reflectance method used at the initial screening has been shown to have acceptable agreement with laboratory methods for determining cholesterol concentration,[8,9] and our comparisons suggest that any systematic differences between the two methods would under- rather than overestimate the extent of the reduction.[8]

Total blood cholesterol has sometimes been criticised as an accurate marker of coronary heart disease risk, especially in women.[17,18] Total blood cholesterol concentration is a determination of a number of cholesterol fractions. Low-density lipoprotein (LDL) cholesterol has been positively associated with heart disease risk (at least in men), while HDL cholesterol has consistently shown protective value. Any reduction in total blood cholesterol concentration achieved through a reduction in mean HDL cholesterol concentration would not be desirable. Although we have no initial measurement of HDL cholesterol in the screen group, the repeat measurements compare favourably with National Heart Foundation reference values. Thus, change in HDL cholesterol as the major contributor to reduction in total cholesterol is unlikely.

Factors associated with the screening process

In the initial screening procedure it was intended that participants be directed to a physician and dietitian for interpretation of their risk factor measurements and advice on appropriate lifestyle

modification or medical care. Participants with elevated risk factors were advised to seek further counsel and attention from their local doctor. However, in practice 12 per cent of participants with elevated blood cholesterol concentrations did not receive assessment and advice at the original screen and 39 per cent failed to seek any medical or paramedical follow-up subsequently. Participants who received appropriate advice at the initial screen showed greater reduction in both cholesterol concentration and body mass index, indicating the importance of this feature of the screening process in successful risk factor reduction. The same observation can be made in relation to the better improvement in risk factors in participants who attended for further medical counsel and review after the screen.

Fifteen patients were prescribed lipid-lowering medications by their doctors after participating in the screen. As expected, these participants showed a larger reduction in mean cholesterol levels at the one-year follow-up.

Although receiving advice at the screen is by itself associated with better risk factor reduction, there are also marked differences in the degree of improvement in cholesterol concentration and body mass index associated with the extent to which the advice was acted upon. Participants who reported making major dietary or exercise changes in line with the advice they were given showed a much greater reduction in mean cholesterol concentration and body mass index than participants who reported making only minor changes or who made no changes. This effect is clear when examining self-reported changes in dietary habits (Figures 2 and 5). The exception was those participants who were already following a prudent diet at the time of the screen (and who were advised to continue this eating plan), who also showed an impressive reduction in cholesterol concentration. Possible explanations include an enhancement of earlier lifestyle change by the advice of the screen, continuation of risk factor improvement already under way or the recruitment of some other unidentified pathway for blood cholesterol lowering consequent on recognition by the subject of a blood cholesterol problem.

Self-reported change in exercise patterns also showed an association with the degree of reduction in body mass index (Figure 6), but there is no obvious relationship between changes in exercise and mean cholesterol concentration (Figure 2). The self-assessment of changes in diet and exercise patterns was made before the follow-up risk factor measurements were taken and suggests that self-assessment of gross lifestyle changes is a reliable measure. Clearly participants who were more motivated to act on the advice given to them at the screen showed a greater improvement in mean cholesterol concentration and body mass index. Such findings support the value of providing individually tailored advice to screen participants consistent with the assessment of their current risk factor measurements, even if that advice involves no more than reassurance about the appropriateness of current diet or exercise habits.

The screen appears to have acted as a catalyst for a decrease in blood cholesterol. The understanding of the various factors which may have enhanced or detracted from advice at screening certainly merits further investigation, but this study explored matters such as type of medical follow-up (doctor, dietitian, National Heart Foundation, hospital etc.) and various demographic factors, as an initial exploration of the mechanism by which improvements occurred in screening outcomes. It is also possible that there may be an adverse effect of screening on those with a low blood cholesterol, and subsequent studies will need to address this issue by tracking the low blood cholesterol group.

The small number of smokers precluded a meaningful analysis of changes in smoking habits, although eight out of the ten smokers in our sample did report minor reductions in the number of cigarettes smoked.

The population characteristics of the follow-up group differ from census data, and while they are not a guide to the population at large, they are indicative of what happens to screen participants. The original screen population contained a disproportionately large number of women and older people.[10] The follow-up showed additional bias toward groups which showed the highest cholesterol concentrations at the initial screen. The limited variation in population characteristics at the follow-up is a direct result of the overrepresentation of women and older age groups. As expected, the repeat screen contained a disproportionate number of retired people, widowed people, homemakers and early school leavers but a surprisingly high number of tertiary-educated people. Because of the small number of participants, meaningful analysis of the results in terms of social or demographic characteristics of the population is not possible.

Conclusions

Although community coronary risk factor screening is not equally acceptable to all sections of the population,[10,19] it attracts large numbers of participants and may be cost-efficient in the identification and management of high-risk individuals and in community education.[20] In our study, participants were given the results of their risk factor assessment immediately, together with individual advice on appropriate diet and lifestyle modifications or medical therapy. Improvements in body fatness and blood cholesterol concentrations followed. Participants who attended their local medical practitioner for further counsel benefited to a greater extent than those who did not. These findings provide indications as to the ways in which community coronary risk factor evaluation may lead to useful health outcomes.

Acknowledgments

The authors wish to acknowledge the generous support and involvement of Dr P. Jenkins, the Board of Management of Prince Henry's Hospital, the State Bank of Victoria (Ms J. Mier and Mr B. Moyle), medical and nursing staff, dietitians and chemical pathology staff at Prince Henry's Hospital, and Boehringer Mannheim Australia Pty Ltd.

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