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Scand J Prim Health Care 2002;20:219–223. ISSN 0281-3432

Objectives – To evaluate changes in plasma cholesterol following health screening and health discussions in general practice.
Design – Randomised prospective population-based study conducted over a period of 5 years.
Setting – Primary care, all general practitioners (GPs) in a well-defined area.
Subjects – A random sample of inhabitants aged 30–49 years in January 1991, registered with a local GP was invited to participate. The participants (1507 persons, or 75.4% of the 2000 invited) were randomly allocated to two intervention groups and a control group.
Main outcome measures – Plasma cholesterol, percentage of subjects with plasma cholesterol higher than 7 mmol/l.
Results – After 5 years of intervention, plasma cholesterol in the whole population was significantly lower in the intervention groups compared to the control group. The decrease was most pronounced (0.5 mmol/l) in subjects at high cardiovascular risk. The percentage of high-risk individuals with a cholesterol level higher than 7 mmol/l was significantly lower in the intervention groups compared to the control group (9.8% vs 6.2%, p = 0.04), corresponding to a 37% reduction.
Conclusions – The study shows that the health checks had a measurable impact on plasma cholesterol levels, the most pronounced effect is seen among individuals at high cardiovascular risk.

Key words: health checks, Ebeltoft project, lipid lowering, cholesterol, middle-aged, adult.

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Cardiovascular disease is one of the main causes of death in Western Europe and is known to be related to elevated plasma cholesterol, smoking, hypertension and obesity. It is possible to modify these risk factors by lifestyle changes (1), but there is a wide gap between potential and achievement in this area. Randomised controlled studies have shown a marked correlation between reduction of plasma cholesterol levels and reduction in coronary heart disease (2–4). Because a large number of primary coronary events are fatal or followed by cardiac symptoms and disability, primary prevention is important especially for individuals at high risk of coronary heart disease. Even though the benefits of health screening in general practice have been equivocal (5), there has been increasing pressure to introduce them as a general offer to the population. However, health screening consumes substantial resources, and these resources often have to be diverted from other activities carried out in general practice. In view of this, the benefits of health screening should be documented before being generally advocated. The aim of this paper is to describe the impact of health screening on plasma cholesterol, one of the most important risk factors for coronary heart disease.

METHODS

Study setting and inclusion of participants

The present study took place in the district of Ebeltoft, Aarhus County, Denmark. The district consists of a minor coastal town surrounded by rural areas with a total population of approximately 13 000 inhabitants at the onset of the study in 1991. All nine GPs from the district agreed to participate, and prior to the study they attended four teaching conferences on the prevention of heart and lung disease, dietary advice, and the carrying out of health discussions.

Three-thousand-four-hundred-and-sixty-four subjects aged 30–49 years in January 1991 were registered with the 9 GPs in the district. A total of 2000 were randomly selected on the basis of birth date, with an equal number of individuals from each practitioner and age group. In total, 1507 accepted to participate, and were randomly divided into three groups by proportional, stratified randomisation, based on their GP, sex, age, body mass index (BMI) and cohabitation status. The intervention group given the most intensive intervention received health screening, and was offered a preventive health discussion with their GP. Participants in the other intervention group received health screening but were not offered health discussions, and the control group only received a questionnaire.

Health screening

The health screening consisted of a screening programme including an evaluation of non-fasting plasma lipids, cardiovascular and pulmonary function, liver and kidney function, endocrine dysfunction, and BMI. The primary health screening was carried out between December 1991 and June 1992. Within 2–3 weeks after the health screening, all those tested received personal, written feedback from their GP, in which the test results were explained in easily understandable terms. Advice relating to lifestyle changes was incorporated when values were outside a predefined range (6). It was explained to the participants that a total cholesterol level lower than 6 mmol/l (which was considered acceptable at that time) was acceptable, while values between 6 and 7 mmol/l indicated a slightly increased risk of cardiovascular disease. Finally, subjects with total cholesterol levels higher than 7 mmol/l were recommended to alter their diet and to contact their GP. Individuals at increased cardiovascular risk (>9) according to the Anggaard score (7) were requested to contact their GP and to stop smoking, alter their diet, take more exercise, lose weight and get treatment for high blood pressure. In addition, all participants received leaflets on healthy lifestyle from the Danish Heart Foundation.

The health discussions

Participants from the health screening and discussion group who accepted the offer of health discussions had a 45-min consultation with their GP and were offered the chance to book an additional 30-min consultation 3 months later.

The follow-up

A follow-up was done 1 and 5 years after the primary intervention. Participants received follow-up questionnaires, health screening and health discussions according to their group of randomisation. Participants in the control group were promised a health screening and a health discussion at the end of the study period. Other details of the design are outlined elsewhere (6).

Data handling and statistics

Data were registered in the database Paradox and analysed with SPSS. Double data entry was carried out for the initial questionnaire and the laboratory tests. Plasma cholesterol values are given as mean $\pm$ standard deviation and with 95% confidence intervals. Differences in frequencies between groups were evaluated by chi-square test. Differences between means were evaluated for statistical significance by standard t-tests, mean versus baseline with paired t-test. All analyses were two-sided, and results were considered statistically significant at the level of $p < 0.05$.

Ethics

The Ethics Committee of Aarhus County and the Danish Registry Board gave approval and permission to conduct the study.

RESULTS

Participant flow and follow-up

The 1507 participants, 75.4% of the invited population, were randomised into 3 groups. After randomisation and health screening, 1370 (90.9%) were still participating (68.5% of the invited population), 905 subject in the intervention groups and 465 controls (Fig. 1). Of the baseline participants, 74.7% completed the planned interventions. Baseline characteristics for the study groups are given in Table I. There was no difference in statistical significance between the groups as far as any of the measured variables were concerned. Most of the subjects were without known ischaemic heart disease.

Analysis

There was no difference in plasma cholesterol levels between the two intervention groups either at baseline or follow-up (Table II). If we compare all randomised in the intervention groups with the control group at year 5 in an intention-to-treat analysis, a significantly lower plasma cholesterol was observed in the intervention groups ($p = 0.04$). Table II also indicates the changes in plasma cholesterol for the 690 subjects in the intervention groups who completed all three health checks at baseline, years 1 and 5. In the intervention groups, there were no significant changes in total cholesterol levels from baseline to year 1 ($p = 0.28$). After 5 years, a significant decrease was seen ($p = 0.001$). There was no significant difference in the decrease between the two intervention groups. The mean decrease over the 5 years in the two intervention groups was 0.10 mmol/l.

There was no significant difference in the baseline mean cholesterol level between those who completed all three health checks and those who dropped out during the follow-up period. When changes were analysed separately for high-risk subjects with cholesterol values higher and lower than 7 mmol/l, the significant decrease over time was observed only in the subjects with the highest cholesterol. In the intervention groups there was a significant reduction in the number of high-risk individuals with a cholesterol level >7 mmol/l (9.6% at baseline to 6.4% after 5 years, $p = 0.04$). Comparing the number of subjects
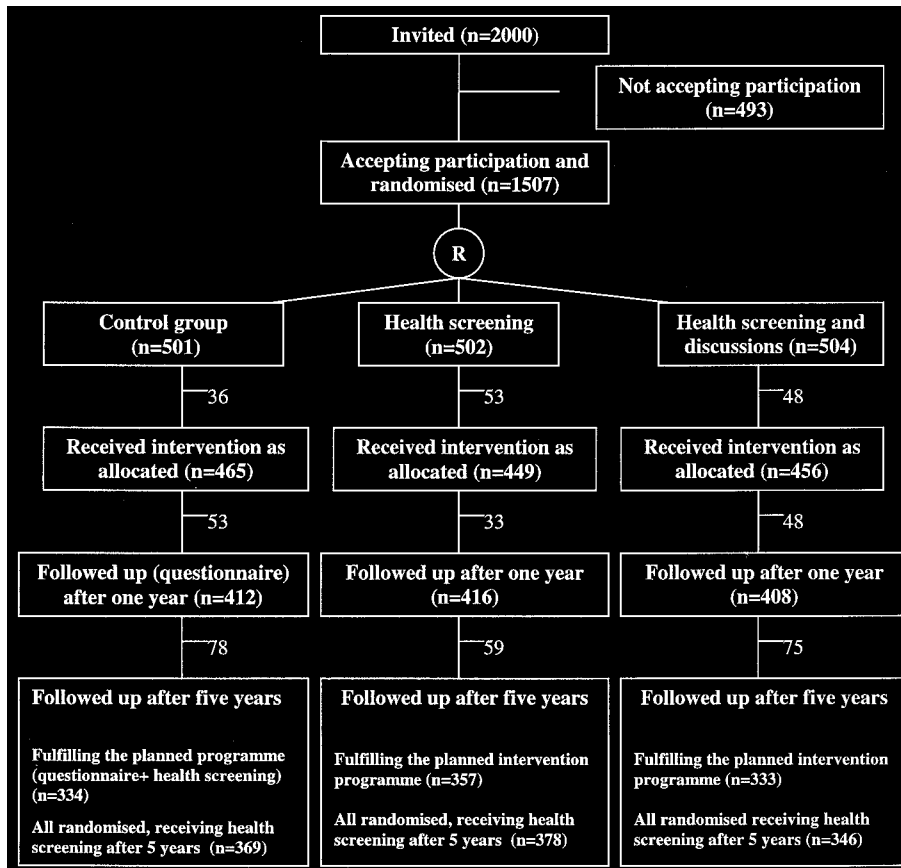
Fig. 1. Flow chart. At year 5, two numbers are stated because some had a cholesterol test at year 5 without fulfilling the whole programme.

Table I. Baseline characteristics in study groups (n = 1370).

	Control n = 465	Health check n = 449	Health check + discussion n = 456
Age (years)	40.3 ± 5.8	40.4 ± 5.7	40.6 ± 5.7
Gender			
Men (n, %)	222 (47.7)	212 (47.2)	218 (47.8)
Women (n, %)	243 (52.3)	237 (52.8)	238 (52.2)
Systolic BP		122.2 ± 14.5	123.0 ± 16.0
Diastolic BP		77.7 ± 9.5	77.2 ± 10.0
Smoking (n, %)	232 (50)	221 (49)	240 (53)
BMI (kg/m^2) > 30 (n, %)		46 (10.2)	62 (13.6)
Glucose (mmol/l)		5.3 ± 0.68	5.3 ± 0.70
Known IHD (n, %)		4 (0.9)	8 (1.8)

Mean ± SD. BP indicates blood pressure, BMI, body mass index, and IHD, ischemic heart disease.

with high cholesterol values at year 5 in the intervention groups to the control group confirms the significant lower number in the intervention groups (Table III). Looking at those with total cholesterol values higher than 7 mmol/l at baseline, 47.7% (42 subjects) had an increased cardiovascular risk score according to Anggaard (7), whereas in those with cholesterol less than 7 mmol/l only 7.8% (64 subjects) had an increased cardiovascular risk score. Analysing the subjects with high cardiovascular risk score separately irrespective of cholesterol level confirms the more pronounced reduction in the subjects with highest risk, showing a reduction of 0.50 mmol/l after 5 years (p < 0.001). Among those who were warned

Table II. Total cholesterol concentrations in study groups at baseline, 1 and 5 years.

	Control n = 334	Health check n = 357	Health check + discussion n = 333	Both intervention groups n = 690
Baseline				
Mean ± SD (mmol/l)		5.60 ± 1.03	5.69 ± 1.04	5.64 ± 1.04
Min., max.		2.8, 9.4	3.4, 9.5	2.8, 9.5
Year 1				
Mean ± SD (mmol/l)		5.56 ± 1.05	5.67 ± 1.01	5.61 ± 1.03
Change (mean ± SD)		−0.03 (± 0.64)	−0.02 (± 0.71)	−0.03 (± 0.67)
95% CI		−0.10–0.03	−0.10–0.06	−0.08–0.02
P vs baseline		p = 0.31	p = 0.60	p = 0.28
Year 5				
All fulfilling the planned intervention programme:				
Mean ± SD (mmol/l)	5.68 ± 1.07	5.55 ± 1.07	5.55 ± 1.00	5.55 ± 1.04
Change (mean ± SD)		−0.05 (± 0.76)	−0.14 (± 0.81)	−0.10 (± 0.78)
95% CI		−0.13–0.03	−0.23– −0.05	−0.15–0.04
P vs baseline		p = 0.2	p = 0.002	p = 0.001
P vs control group				p = 0.06
All randomised having a health check in year 5:	n = 369	n = 378	n = 346	n = 724
Mean ± SD (mmol/l)	5.68 ± 1.06	5.54 ± 1.07	5.54 ± 0.99	5.54 ± 1.03
P vs control group		p = 0.08	p = 0.06	p = 0.04

SD (standard deviation), CI (confidence intervals).

that they had both plasma cholesterol higher than 7 mmol/l, and a high cardiovascular risk score, plasma cholesterol decreased from mean 7.77 mmol/l at baseline to 7.29 mmol/l after 1 year (p = 0.006), and to 6.96 mmol/l after 5 years (p < 0.001, n = 27). Precise medication with lipid-lowering drugs was not stated by the doctors, but using the self-reported medication for other medications only 7 subjects reported that they were on lipid-lowering drugs. Omitting the 7 subjects on lipid-lowering medications from the analyses does not change the conclusions.

DISCUSSION

The study shows that the offer of health screening and advice to an unselected population in general practice led to a small but significant decrease in plasma cholesterol. A greater benefit was observed in subjects at high risk because of high cardiovascular risk score, or high risk because of plasma cholesterol levels higher than 7 mmol/l. The changes in plasma cholesterol in the total population in this study were comparable to those achieved in other studies involving primary care (8–11). Both the Family Heart Study and the OX-CHECK study in England, which are closest to our design and setting, showed small reductions in total cholesterol concentration in the general population. Most studies are hampered by the selection of only the most interested GPs, but that was not the case in this study, where all GPs from the district participated. The trial was in principle a primary preventive trial, since less than 2% of participants reported that they had known ischaemic heart disease. Baseline cholesterol measurements for the control group do not exist, since the measurement itself was part of the intervention.

Drop-outs among participants pose a particular problem, since in their case changes in risk factors cannot be assessed. Since follow-up analyses were possible only for those who returned, we probably overestimate the decrease in cholesterol that could be induced in the whole population in a 5-year period, as the non-attendees might be less motivated to change their lifestyle. Another cause of overesti-

Table III. Proportion of subjects with high cholesterol values in the intervention groups at year 5 compared to the control group.

	Control group (n = 369)	Intervention groups (n = 724)
≤ 5 mmol/l	27.9% (103)	33.0% (239)[1]
> 5 mmol/l ≤ 7 mmol/l	62.3% (230)	60.8% (440)[1]
> 7 mmol/l	9.8% (36)	6.2% (45)[2]

[1] NS.
[2] p < 0.05.

mation of the effectiveness of health screenings in lowering plasma cholesterol in individuals with high plasma cholesterol is the phenomenon of regression towards the mean, since the cholesterol value was the result of a single measurement. However, the significant fall in total plasma cholesterol was seen from baseline to year 5, not from baseline to year 1. The cholesterol level in the control group at year 5 was similar to the level found among the intervention groups at baseline. The difference between the control group and the intervention groups in mean cholesterol and number of subjects with plasma cholesterol higher than 7 mmol/l at year 5 supports a decrease due to intervention and not just due to regression, or a trend in the whole population. Since this study was carried out, several new studies have documented the effect of cholesterol reduction, and new guidelines and recommendations have been introduced. So health screening conducted today might have a greater impact than health screening conducted 5 years ago. It is also worth noting that the GPs received only brief training in personal interviewing techniques, and since the planning of this study new theories of motivational interviewing have been put forward. More research is needed to develop the practice of health consultations and to evaluate their impact.

SUMMARY

In this large randomised health promotion study conducted in an unselected general population, a modest decrease in plasma cholesterol concentration was observed after 5 years' follow-up. A more pronounced and important decrease in plasma cholesterol was seen in high-risk individuals with a high cardiovascular risk score, or plasma cholesterol levels higher than 7 mmol/l. The percentage of high-risk individuals with a cholesterol level higher than 7 mmol/l was significantly lower in the intervention groups compared to the control group after 5 years, corresponding to a 37% reduction. The benefit of health screening in primary care must be weighed against the costs involved, and might only by payable in high-risk subjects.

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