

Cholesterol screening: observed cholesterol reduction in a prospective study in Norway

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The general public of the City of Bergen, Norway was invited to participate in a cholesterol screening programme in October 1988. Participants received the results of the cholesterol screening and nutritional information from trained health personnel. A short questionnaire was mailed to all 354 participants 1-2 weeks after the initial cholesterol screening. In March 1990, all participants were invited to have their cholesterol levels re-examined. Psychosocial factors believed to be predictive of future serum cholesterol changes were assessed at baseline along with demographic variables. The majority of participants (61%) reduced their cholesterol level from October 1988 to March 1990, and the average reduction in cholesterol level for the total population was 4.0%. Baseline cholesterol levels, being confident of one's own ability to change one's diet (self-efficacy), seeing heart disease risk reduction as very important, and marital status were factors that significantly predicted successful cholesterol reduction 18 months later.

Key words: cholesterol screening, cholesterol reduction, prospective study, Norway

Serum cholesterol is a significant predictor of the occurrence of coronary heart disease (CHD) (Gotto & Wittels 1983). Reducing the dietary intake of saturated fat while increasing consumption of complex carbohydrates can be an effective way of lowering elevated serum cholesterol levels (Hjermann et al. 1981, Blackburn 1984).

Since 1976, a National Nutrition and Food Policy (NNFP) has been in place in Norway (Report No. 32 to the Storting 1975-76, Report No. 11 to the Storting 1981-82). CHD has been and still is the leading cause of death in Norway, and one of the main objectives of the NNFP has been to lower the proportion of energy obtained from dietary fat. According to national food supply and consumption data, the proportion of energy from dietary fat was reduced by approximately 15% (from 41 to 35% of total energy intake) from 1976 to 1990 (Johansson & Dahle 1990). A further reduction towards 30% of energy from dietary fat is, in accordance with the Nordic Dietary Recommendations, currently promoted (National Nutrition Council 1989).

As part of the ongoing effort to reduce the dietary fat intake and thus the cholesterol level of the general population, a national cholesterol screening campaign was launched by the National Norwegian Public Health Association in 1988. The goal was to educate health personnel regarding cholesterol, diet and heart disease, and to provide the general public with an opportunity to partici-

pate in a cholesterol testing program and to receive dietary counselling from trained health personnel. Similar screening programs elsewhere have been found to significantly lower cholesterol levels among participating subjects (Murray et al. 1986, Van Beurden et al. 1990).

The Norwegian cholesterol screening program was controversial. A number of public health professionals, researchers and policy makers argued that screening healthy individuals in a population where virtually everyone would benefit from a moderate reduction of fat intake was a waste of scarce resources. Furthermore, it was argued that screening the general population could have a negative impact in that having a high cholesterol level could scare people unnecessarily. This was of concern particularly regarding older people. Also, a lack of observed reduction in cholesterol level following dietary changes could discourage people from continued dietary changes. It was felt that the limitations inherent in the rapid serum cholesterol test methods and the distinction between repeated cholesterol measures within an individual versus group levels assessments were poorly understood even by health personnel (Jacobs et al. 1983).

In order to investigate how participants perceived the screening program and the dietary counselling provided, and whether or not this was followed by any subsequent cholesterol reduction, an evaluation of a local campaign in the City of Bergen was conducted. The general public in the City of Bergen was invited to participate in cholesterol testing one Saturday in October 1988. Each participant received the results of his/her cholesterol test and was offered nutritional information by trained health personnel. In order to evaluate the impact of this local event, a questionnaire was mailed to each of the participants 1-2 weeks after the initial cholesterol screening. It was found that the mean cholesterol level in this group of

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self-selected participants was 6.7 mmol/l, with one in five participants having a cholesterol level of 8 mmol/l or higher. As many as 79 per cent of the participants reported perceiving the campaign as informative and beneficial. As a result of the campaign, a majority reported being more motivated to make dietary changes. In terms of negative outcomes, six per cent reported that his/her immediate reaction, when given the cholesterol test result, was one of fear. Those who reported feeling most alarmed, and those with the highest cholesterol levels were as positive towards the campaign as were the other participants (Matthiesen et al. 1990).

At a one-year follow-up, the majority of participants reported having made one or more positive dietary changes during the past year. Subjects with the highest cholesterol levels at baseline and who perceived themselves as being at risk, reported changing their diets significantly more than did participants with lower cholesterol levels (Klepp et al. 1992).

In March 1990, 18 months after the initial cholesterol screening, all participants were invited to have their serum cholesterol remeasured. This paper presents the results from this 18 month follow-up study. In particular, changes in cholesterol levels and baseline demographic and psychosocial factors predictive of the observed cholesterol changes are presented.

METHODS

Subjects participating in the initial cholesterol screening in 1988 were informed about the event through local mass media. Approximately 450 people attended and of these, 354 had their cholesterol measured (on a first come first served basis). The baseline survey was mailed home to all those who participated in the cholesterol testing. Of these, a total of 336 subjects (94.9%) completed and returned the questionnaire. A year later, in October 1989, a short questionnaire was mailed home to the same 354 subjects. This time, 328 subjects participated (92.7%). At the follow-up screening in March 1990, a total of 280 subjects participated (79.1%). Of the original 354 subjects, eight (2.3%) had moved from Bergen and were therefore not contacted in March 1990, one person (0.3%) was hospitalized, and one had died (0.3%), while the remaining 64 subjects (18.1%) did not attend the screening centre at the time of the follow-up survey for other reasons. Of the 280 participants, 273 had participated in the baseline questionnaire survey. Thus, the cohort sample used in this 18 month follow-up study consists of 77.1% of the total eligible population.

The baseline questionnaire consisted of a number of questions assessing factors believed to be predictive of future cholesterol reduction. The design of these questions was guided by the theoretical frameworks provided by the Health Belief Model (Becker 1974, Rosenstock et al. 1988) and Social Cognitive Theory (Bandura 1986) and included the following constructs:

- Perceived risk: One question regarding whether or not subjects perceived their own cholesterol levels to be high compared to that of other people their own age (1=very low level; 5=very high level);

- Perceived susceptibility for heart disease: One question concerning how likely it was for them, if continuing their current lifestyle, to have premature heart disease (1=not likely at all; 3=very likely);
- Outcome expectations of dietary changes: A scale consisting of two questions assessing perceived likelihood of reduced cholesterol level and reduced risk for heart disease resulting from a reduced dietary fat intake (1=not likely at all; 7=most definite);
- Value of heart disease risk reduction: A scale consisting of two questions assessing the importance of reducing one's cholesterol level or one's risk for heart disease (1=not important; 7=very important);
- Motivation for dietary changes: A scale consisting of two questions regarding subject's motivation to adopt a healthier diet (1=disagree; 5=agree);
- Perceived barriers to changing diet: A scale consisting of three questions regarding taste, cost and preparation time as potential barriers to healthy eating (1=not at all; 10=to a large degree);
- Self-efficacy: A scale consisting of three questions assessing the degree to which a subject felt confident in his/her abilities to change his/her own diet (particularly reducing the intake of dietary fat) (1=disagree; 7=agree);
- Social support: One question about the frequency with which the subject had discussed his/her cholesterol level and his/her reactions with others (1=no one; 3=several people).

In addition to these theoretically derived factors, demographic variables including gender, age, educational level and marital status were collected through the 1988 questionnaire, as was smoking status. Self-reported dietary changes were obtained in 1989 by asking subjects whether, during the past year, they had begun eating more or less of a number of frequently consumed food items particularly high or low in fat content. The mean values of these predictor variables are presented for males and females separately in table 2.

At baseline, serum cholesterol levels were obtained from testing fingerprick capillary blood in one of three dry-chemistry Reflotron instruments (Boehringer Mannheim, FRG). The results were immediately presented to the subjects tested.

At follow-up, serum was separated from venous blood obtained by venipuncture, and cholesterol was analyzed by the standard method of the Laboratory of Clinical Biochemistry, Haukeland Hospital in a Chem-1 autoanalyzer from Technicon, using an enzymatic assay. Before testing, the internal consistency between the Reflotron instruments had been found to be satisfactory for serum cholesterol levels between 2.8 and 10.6 mmol/l. The correlation between the autoanalyzer (x) and the Reflotron (y) method was also high ($y=1.17x-1.17$; $r=0.98$) (Christensen et al. 1987). The coefficient of variation for the Reflotron method was 4.5%, while the Chem-1 method had a coefficient of variation of less than 1.0% (Christensen et al. 1987). Acceptable accuracy of both methods were confirmed by testing sera with a defined

cholesterol content (ranging from 3.2 to 7.2 mmol/l) from the National Bureau of Standards, London, from the Nordic Reference Committee's Quality Program, Copenhagen, and from the Norwegian Quality Control Program, Oslo.

The dependent measure used in this paper, Cholesterol change score, was created by subtracting subjects' 1988 cholesterol level from their 1990 value (mean value of the change score was -0.27 mmol/l \pm 1.01 mmol/l). This change score was then recoded to form a scale ranking from 1 (indicating an increase in cholesterol level of more than 1.0 mmol/l from 1988 to 1990) to 7 (indicating a reduction in cholesterol level of 2.0 mmol/l or more) (table 1).

Participants with higher reported serum cholesterol values were more likely to return for the second visit; response status related significantly ($p=0.018$) to initial cholesterol by the logistic model in which the probability of response = $1/(1+\exp(-1(0.0219 + 0.2196 \times \text{cholesterol})))$. Thus there exists the possibility that the treatment effect is partly regression to the mean. That is, those for whom within-person error happened to be high at the first measurement occasion were more likely to return and, even in the absence of any treatment effect, would tend to have lower cholesterol on the second measurement.

We estimated the possible magnitude of regression to the mean in these data by 106 Monte Carlo simulations. In each simulation we added a random value corresponding to within-person error (with standard deviation 0.776 mmol/l) to each observed value at the initial visit (Jacobs et al. 1983). We assigned these Monte Carlo values to pseudo-response or pseudo-non-response status with the logistic probability depending on the Monte Carlo value of cholesterol. The mean error among the pseudo-response cases tends to be positive and estimates the magnitude of the regression to the mean (Hannan et al. 1992).

RESULTS

Subjects who did not participate in the follow-up cholesterol screening conducted in March 1990 were, on the average, younger (44.1 vs 53.2 years; $p<0.001$), and had lower 1988 cholesterol levels (6.3 vs 6.8 mmol/l; $p<0.02$) than did the 1990 participants. The 1990 non-participants also reported in 1988 that they perceived their 1988 cholesterol levels to be low more often than did the 1990 participants (54.5% vs 28.5%; $p<0.001$). The two groups

Table 1 Cholesterol change score: change in serum cholesterol level from 1988 to 1990 by gender (per cent)

Change in cholesterol level	Males (N=141)	Females (N=130)
1 Increase ≥ 1.01 mmol/l	5.7	7.7
2 0.51 mmol/l \leq increase ≤ 1.00 mmol/l	12.1	10.0
3 0.01 mmol/l \leq increase ≤ 0.50 mmol/l	19.1	25.4
4 0.00 mmol/l \leq reduction ≤ 0.49 mmol/l	22.7	21.5
5 0.50 mmol/l \leq reduction ≤ 0.99 mmol/l	19.1	12.3
6 1.00 mmol/l \leq reduction ≤ 1.99 mmol/l	15.6	17.7
7 Reduction ≥ 2.00 mmol/l	5.7	5.4

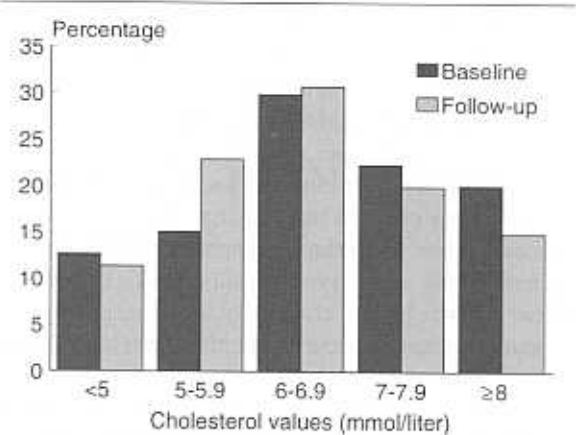


Figure The distribution of cholesterol values at baseline and at follow-up.

did not differ with respect to any other baseline variables. Participating women had, on the average, somewhat higher cholesterol values than did participating males, both in 1988 (7.1 vs 6.5 mmol/l; $p<0.01$) and in 1990 (6.8 vs 6.2 mmol/l; $p<0.001$). There was, however, no gender difference in the cholesterol change score from 1988 to 1990 (table 1). The distribution of cholesterol values at baseline and at follow-up are presented in the figure. The average cholesterol reduction from 1988 to 1990 was 0.27 mmol/l or 4.0% (paired $t=4.45$; $p<0.001$). The Monte Carlo estimate of regression towards the mean was 0.012 ± 0.032 mmol/l. Thus the estimate of the intervention effect corrected for the estimated regression towards the mean is 0.259 ± 0.069 mmol/l.

The mean values of the independent variables measured in 1988 are presented separately for males and females in table 2. As can be seen, in 1988 more women than men

Table 2 Predictor variables by gender (mean values) and Pearson's correlation coefficients (r) between the predictor variables and the cholesterol change score

		Males N=142		Females N=131	
		Mean	r	Mean	r
Marital status	(1-2)	1.86	.13	1.78	.20
Education	(1-2)	1.57	-.12	1.51	-.13
Smoking	(1-3)	1.39	.10	1.41	.07
Age	(1-5)	3.38	.15	3.25	.20
Perceived risk for CHD	(1-5) ^a	2.87	.30**	3.13	.35**
Perceived susceptibility	(1-3)	1.62	.32**	1.61	.22*
Outcome expectations	(1-7)	5.41	.02	5.54	.06
Value of risk reduction	(1-7) ^b	5.56	.14	6.05	.14
Motivation for changing diet	(1-5)	3.65	.17	3.84	.24*
Barriers to dietary change	(1-10)	3.58	-.07	4.03	.08
Self-efficacy	(1-7)	4.60	.09	4.84	.26*
Social support	(1-3)	2.15	-.02	2.28	-.02
Dietary change score	(0-5)	2.20	.12	2.44	.07
1988 Cholesterol value	(2.9-11.4) ^b	6.51	.41**	7.07	.54**

Gender difference for mean values: ^a $p<0.05$; ^b $p<0.01$
 Pearson's correlations coefficient: * $p<0.01$; ** $p<0.001$

Table 3 Multiple regression of baseline variables as predictors of the observed cholesterol change score

	B ^a	Beta ^b	T	R ²	p-value
1988 Cholesterol value	.005	.507	7.23	.216	.000
Self-efficacy	.158	.062	2.62	.228	.010
Value of risk reduction	-.202	.170	2.41	.244	.017
Marital status	.555	.258	2.15	.257	.033

^a Raw regression coefficient^b Standardized regression coefficient

perceived themselves to be at high risk compared with others their own age. Females also reported risk reduction to be more important than did participating males. Table 2 also presents the Pearson correlation coefficients (r) between the predictor variables and the cholesterol change score. Neither demographic variables nor smoking behaviour were significantly correlated with cholesterol changes for either men or women. The factors most strongly predictive of such changes for both genders were perceived risk and susceptibility for CHD. In addition, self-efficacy and motivation for changing dietary habits were significantly correlated with the cholesterol change score for women (table 2). When all the predictor variables were entered into a stepwise multiple regression analysis predicting the cholesterol change score, four factors significantly contributed to explain the observed variance in the change score. As can be seen in table 3, baseline cholesterol level was the strongest predictor variable, but self-efficacy, value of heart disease risk reduction and marital status all contributed significantly. Overall, these four factors explained 25.7% of the observed variance of the cholesterol change score.

DISCUSSION

This study was designed to evaluate the impact of a cholesterol screening campaign in the City of Bergen, Norway and to investigate what factors would be predictive of future serum cholesterol changes among the participants. The study was initiated on short notice to address some questions and concerns brought up during the Norwegian cholesterol screening program. Thus, due to time-constraints, a less than optimal research design was employed (a one group pretest-posttest design) (Cook & Campbell 1979). In an attempt to compensate for some of the design weaknesses, we critically discuss the outcome of this study in the light of other available studies.

The results demonstrated that the majority of participants (61%) in this study reduced their cholesterol levels from October 1988 to March 1990. The absolute cholesterol levels showed a modest but significant reduction of 0.27 mmol/l (4.0%). As the subjects participating in this follow-up study had particularly high cholesterol levels to start with, part of the observed decrease could reflect a regression to the mean. However, we found that an estimate of the effect of regression to the mean was much smaller than the observed treatment effect.

There are other potential sources of bias, such as changes due to seasonal variation (Gordon et al. 1987). The impact of seasonal variation has previously been investigated in Norwegian populations. Data from these studies are inconclusive, but indicate that serum cholesterol levels might be higher in the spring (March) than in the fall (October) rather than the other way around (Thelle et al. 1976, Norwegian National Health Screening Service 1988). Such a trend would be consistent with the fact that fresh fruits and vegetables tend to be more readily available in Norway during the fall than during the spring. Furthermore, the reported reduction in fat intake in the Norwegian population (Johansson & Dahle 1990) is likely to be associated with a reduction in serum cholesterol levels in the general population. Bjartveit and colleagues (1991) observed such a secular trend as cholesterol screenings of subjects aged 40–42 in four counties demonstrated a reduction in serum cholesterol levels of approximately five per cent over three years (during the period of 1985–1990). Data from a cohort sample included in the same study revealed, however, a much smaller reduction (1.6%) in serum cholesterol levels over three years (Bjartveit et al. 1991). Finally, different methods of cholesterol measurement were used in 1988 and 1990. Agreement between the two methods has been found to be high, and, applying the regression equation presented in the Methods section, we find that the average baseline cholesterol remains unchanged (6.77 vs 6.79 mmol/l).

Thus, even though this study suffer from a lack of comparison group, utilizing available and relevant data we conclude that the observed reduction in cholesterol levels from 1988 to 1990 cannot fully be explained by regression to the mean, seasonal variation, secular trends in the general population or measurement errors. Controlling for these factors, we estimate the average reduction in cholesterol levels to be approximately two to three per cent which is comparable to the effect observed in similar cholesterol screening studies (Murray et al. 1986, Van Beurden et al. 1990).

As participants in this study were self-selected, they were most likely more health conscious and health interested than the general adult population. Thus, even if the observed cholesterol reduction reflects a real reduction in overall cholesterol levels, we can not make the inference that this was caused only by participants taking part in the cholesterol screening program. This group of rather health conscious participants could have sought out other sources of information or participated in other activities which may have contributed in lowering their cholesterol levels. Seen in the context of other available studies, we do, however, believe that the data provided from this study provide further evidence that cholesterol screening offered to the general public is a useful strategy in promoting cardiovascular health. Such cholesterol screening should be offered by trained health personnel who can provide necessary information regarding the interpretation of test results as well as offering relevant nutrition information.

As expected, baseline cholesterol levels and perceived risk and susceptibility for CHD (which again were highly correlated with baseline cholesterol levels) were strongly predictive of future cholesterol reduction. By including baseline cholesterol levels in the stepwise multiple regression analysis, we found that being confident of one's ability to change one's own diet (self-efficacy) and seeing a CHD risk reduction as very important were factors that significantly added to the prediction of future cholesterol reduction. Furthermore, being married rather than single or widowed enhanced the likelihood of cholesterol reduction. We failed to obtain an unbiased baseline measure of eating habits in this study as subjects were asked about their eating habits one or more weeks after the initial cholesterol screening took place. The dietary change measure applied here was obtained in October 1989 when subjects reported whether they, during the past year, had started eating more or less of a number of food-items particularly high or low in fat. While this measure of dietary change was strongly associated with baseline intentions and motivation for dietary change and with 1990 cholesterol levels, it was not a significant predictor of cholesterol level changes observed in this study.

CONCLUSION

The results of this study indicated that a large proportion of participants had reduced their cholesterol levels 18 months after the initial cholesterol screening. Perceived importance of personal risk reduction and skills to increase perceived competence with respect to healthy eating seem to be important factors in enhancing the likelihood of successful cholesterol reduction. In spite of methodological weaknesses, this study seems to support the hypothesis that cholesterol screening offered to the general public may contribute to lower population risk for coronary heart disease.

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