Improvements in circulating cholesterol, antioxidants, and homocysteine after dietary intervention in an Australian Aboriginal community[1–3]

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ABSTRACT

Background: Poor nutrition contributes to high rates of coronary heart disease among Australian Aboriginal populations. Since late 1993, the Aboriginal community described here has operated a healthy lifestyle program aimed at reducing the risk of chronic disease.

Objective: We evaluated the effectiveness of a community-directed intervention program to reduce coronary heart disease risk through dietary modification.

Design: Intervention processes included store management policy changes, health promotion activities, and nutrition education aimed at high-risk individuals. Dietary advice was focused on decreasing saturated fat and sugar intake and increasing fruit and vegetable intake. Evaluation of the program included conducting sequential, cross-sectional risk factor surveys at 2-y intervals; measuring fasting cholesterol, lipid-soluble antioxidants, and homocysteine concentrations; and assessing smoking status. Nutrient intakes were estimated from analysis of food turnover in the single community store.

Results: There was a significant reduction in the prevalence of hypercholesterolemia (age-adjusted prevalences were 31%, 21%, and 15% at baseline, 2 y, and 4 y, respectively; $P < 0.001$). There were significant increases in plasma concentrations of α-tocopherol, lutein and zeaxanthin, cryptoxanthin, and β-carotene across the population. Retinol and lycopene concentrations did not change significantly. Mean plasma homocysteine concentrations decreased by 3 μmol/L. There was no significant change in smoking prevalence between the 2 follow-up surveys. There was an increase in the density of fresh fruit and vegetables and carotenoids in the food supply at the community store.

Conclusion: This community-directed dietary intervention program reduced the prevalence of coronary heart disease risk factors related to diet. *Am J Clin Nutr* 2001;74:442–8.

KEY WORDS Coronary heart disease, cardiovascular disease, healthy lifestyle program, Aboriginal population, dietary intervention, fruit, vegetables, cholesterol, antioxidants, homocysteine

INTRODUCTION

Smoking, hyperglycemia, and diets high in saturated fat are associated with increased coronary heart disease (CHD) mortality. This effect is probably mediated through hyperlipidemia and oxidative stress leading to the initiation and progression of atherosclerosis through the interaction of lipid oxidation, vascular endothelial damage, and the migration of leukocytes (including macrophages) across the endothelium (1–3). Conversely, there is clear evidence from epidemiologic studies, both cross-cultural and within populations, that a high consumption of fruit and vegetables is associated with a low risk of cardiovascular disease (CVD; 4). In addition, clinical trials have shown a strong protective effect of a diet high in fresh vegetables and fruit for the secondary prevention of coronary events (5).

CHD risk factors, including glucose intolerance, dyslipidemia, smoking, and hypertension, are highly prevalent among Australian Aboriginal persons (6). Furthermore, many Aboriginal and Torres Strait Islander populations consume diets high in meat and low in fresh vegetables and fruit (7, 8). Fresh vegetables and fruit provide major dietary sources of the antioxidants carotenoids and vitamin C and folate, and vegetable oils are the main source of vitamin E. Vitamin E, vitamin C, and carotenoids appear to interact with each other to protect LDL particles from oxidation (2, 9). Low folate status is associated with elevated plasma homocysteine concentrations, which are a strong risk factor for CHD and other vascular diseases (10). In Aboriginal populations in whom circulating carotenoid and folate concentrations have been examined, these dietary markers of CHD risk

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proved to be low on average (11). Hence, dietary factors are likely to contribute to the excessive premature mortality of indigenous Australians from CVD (12).

The Looma community in the remote northwest region of Australia has operated a healthy lifestyle intervention program since late 1993. The Looma Healthy Lifestyle Program has been associated with sustained improvements in diet and exercise habits of community members (13). Over 4 y of follow-up, there was no significant change in the prevalence of diabetes, but apparent insulin sensitivity improved. One aim of the Looma Healthy Lifestyle Program was to promote the intake of fresh vegetables and fruit and to encourage reduced intake of saturated fat as a means of lowering CHD risk among community members. The present study evaluates the effectiveness of this program among members of this community by examining trends in plasma markers of CHD risk (ie, concentrations of cholesterol, lipid-soluble antioxidants, and homocysteine) that are associated with diet.

SUBJECTS AND METHODS

The present study was approved by the Deakin University Ethics Committee. Participants gave written, informed consent to undergo screening procedures.

Intervention processes

Since late 1993, the Looma Aboriginal community in the remote Kimberley region of Western Australia has conducted a healthy lifestyle program based on improving the diets and physical activity of community members (14). The community identified its poor knowledge of nutrition and its relation to the prevention and management of diabetes and CHD and the lack of affordable, healthy food choices as factors contributing to high rates of chronic disease. A diabetes nurse educator was appointed to work with community members during the initial stages of the intervention. The program focused initially on a group of individuals at high risk of diabetes and CHD. It consisted of formal and informal education sessions, regular exercise groups, simple dietary advice (eg, cutting fat from meat before cooking), and recommendations for reducing intake of refined carbohydrate. Hunting and fishing activities were encouraged (13). Over the following years, messages about diet and exercise were disseminated to family members by those participating in the more direct intervention program. Sports festivals, nutrition and health lessons in the community school, and detailed feedback from community surveys all helped raise awareness about healthy lifestyles. In 1995 the Looma Council appointed a community member as manager of the only store in Looma, which supplies the community with most of the food consumed. After this appointment, in addition to the ongoing exercise and dietary modification strategies, more emphasis was placed on improving the quality of the available food supply and promoting increased fruit and vegetable consumption. The community council also instituted a nonsmoking policy in public buildings (13).

Program evaluation

Trends in risk factors across the community after the start of the intervention were examined in 3 voluntary, cross-sectional, community-based surveys of adults aged ≥15 y (conducted in November 1993 to January 1994, February 1996, and November 1997). The population at the time of the screening was determined by household census. Among persons aged ≥35 y, response rates for the 3 surveys were 100%, 90%, and 80% in 1993–1994, 1996, and 1997, respectively. For the 15–34-y-old age group, response rates were 74%, 61%, and 43% in 1993–1994, 1996, and 1997, respectively. Reasons for nonparticipation in 1996 and 1997, respectively, were absence from the community at the time of screening (28% and 45%), old age or frailty (7% and 2%), and declining to attend for unspecified reasons (65% and 53%) (13). The surveys included drawing a fasting blood sample to measure cholesterol. During the 1996 and 1997 surveys, concentrations of lipid-soluble antioxidants (ie, retinol, α-tocopherol, and carotenoids) and homocysteine were also measured. Smoking status was determined by a yes-or-no questionnaire during the 1996 and 1997 surveys. Individual results were returned to each participant after each screening and aggregate data were presented to community organizations in the form of plain language reports summarizing the major observations and trends in risk factors.

Changes in dietary quality at the population level were examined by using the store turnover method (15). Store receipts for the months of July, August, and September of each year were used as source data for apparent food consumption. Nutrient and carotenoid intakes were obtained from analysis of total food purchases by using MICRODIET (version 9, 1997; University of Salford, Lancashire, United Kingodom) and the USDA-NCC carotenoid database (1998; US Department of Agriculture and the Nutrition Coordinating Center, Washington, DC), respectively. Intakes were expressed per MJ energy intake and provided data on dietary quality at the community level.

Sample collection and biochemical methods

Blood samples were drawn in the morning after the subjects had fasted overnight and were iced until centrifuged (within 6 h) at room temperature for 10 min at ≥800 × *g*. Plasma was frozen immediately thereafter and stored at −20°C until transferred to Melbourne (within 2 wk of being drawn), where it was stored at −80°C until analyzed. Cholesterol was measured by using a Hitachi 704 autoanalyzer (Boehringer-Mannheim, Tokyo) and a standard enzymatic technique. Homocysteine was measured by an automated fluorescence polarization immunoassay method with an Abbot IMx analyzer (Abbott Laboratories, Abbott Park, IL) (16) (CV <5% across the range of the assay).

Lipid-soluble antioxidants were measured as described previously (17). Briefly, analytes were extracted by using 1 mL of hexane from 200 μL plasma after 200 μL ethanol containing internal standards (tocopherol acetate and retinol acetate) were added. Extracts were dried under nitrogen and reconstituted in 30 μL chloroform, after which 70 μL methanol:acetonitrile was added. All procedures were performed under red-lighting conditions. Fifty microliters of sample was injected onto a 250 × 4.6 mm Spherisorb ODS-2 column (5 μm; Activon, Melbourne, Australia) by using a Waters 2690 Solvent Delivery System (Waters Australia, Box Hill, Australia). Solvent A was methanol (containing 0.05% ammonium acetate), solvent B was acetonitrile (containing 0.1% triethylamine), and solvent C was chloroform. Initial conditions were A:B, 50:50. Three linear gradient steps were used. From 0 to 5 min, solvent A was infused at a constant proportion (50%) throughout, the proportion of solvent B was reduced from 50% to 44%, and the proportion of solvent C was increased from 0% to 6%. From 5 to 16 min, the proportion of solvent A was increased from 50% to 55%, that of solvent B was reduced from 44% to 30%, and that of solvent C was

TABLE 1
Trends in plasma cholesterol concentrations, stratified by sex and age[1]

Age group	Men			Women			P for trend[2]		
	1993–1994	1996	1997	1993–1994	1996	1997	Year	Sex	Year × sex
		mmol/L			*mmol/L*				
15–34 y	4.8 (4.5, 5.1) [n = 51]	4.5 (4.2, 4.8) [n = 42]	4.2 (3.8, 4.6) [n = 28]	4.4 (4.1, 4.7) [n = 51]	4.1 (3.8, 4.3) [n = 52]	3.7 (3.2, 4.1) [n = 25]	0.001	0.002	0.910
≥35 y	5.3 (5.0, 5.6) [n = 47]	5.1 (4.8, 5.5) [n = 40]	4.8 (4.4, 5.2) [n = 29]	5.0 (4.7, 5.3) [n = 50]	4.9 (4.6, 5.2) [n = 47]	4.8 (4.5, 5.2) [n = 42]	0.148	0.239	0.606

[1] Age-adjusted estimated marginal means; 95% CIs in parentheses. *n* in brackets.
[2] ANOVA.

increased from 6% to 15%. From 16 to 21 min, the proportion of solvent A was reduced from 55% to 50%, that of solvent B was increased from 30% to 50%, and that of solvent C was reduced from 15% to 0%. Absorbance data were measured at 3 wavelengths by using a model 996 Photodiode Array detector (Waters Australia) as follows: retinol and retinol acetate at 325 nm, α-tocopherol and tocopheryl acetate at 292 nm, and lutein and zeaxanthin, cryptoxanthin, lycopene, α-carotene, and β-carotene at 450 nm.

Statistical analyses

Trends in continuous variables over time were tested by using the general linear models function of SPSS 9 statistical analysis software (SPSS Inc, Chicago). Time (year of the survey) and sex were entered as fixed effects and age and plasma cholesterol (for lipid-soluble antioxidants) were entered as covariates. The first-order interaction term (sex by year of survey) was also included. The survey samples were not purely cross sectional in the sense that the last survey sample included participants who had been screened on a previous occasion ($n = 80$). The survey samples were nevertheless treated as cross-sectional observations, a conservative assumption given that it would be more advantageous to consider the intercorrelation for repeated measures. Values for antioxidants (except retinol) and homocysteine were log transformed before analysis and data are expressed as geometric means. Changes in categorical variables were tested by using the Cochran-Mantel-Haenszel, age-weighted chi-square statistic test. Prevalence data were age adjusted by using the baseline survey sample as the reference population.

Because response rates were very different for those subjects aged 15–34 y and for those aged ≥35 y (*see* above), separate analyses were conducted for these 2 age groups. Response rates were high in the older age group at all time points and the survey sample was assumed to be representative of the older population in the community, whereas response rates were lower among younger participants and fell with time. As a result, there was possible selection bias because those subjects returning for repeat screenings may have been relatively healthy (or less healthy) when compared with the younger population as a whole. However, for the final survey sample, the proportion of subjects who responded (54%) did not differ from the proportion of subjects who did not respond (55%) and who had been screened previously. This suggests that there was no bias for inclusion of a healthy cohort in the follow-up survey samples. To explore this issue further, a dummy variable was coded for each participant to indicate whether that individual was screened once or whether he or she had returned for repeat screening. This variable was included as a fixed effect in the analysis of variance model. An interaction term of this dummy variable with the year of the survey was also included but was omitted from the final model when found to be nonsignificant. Baseline values for persons screened once and for those screened more than once were also compared.

RESULTS

Trends in plasma cholesterol concentrations

Plasma cholesterol concentrations decreased significantly in young persons (**Table 1**). This change was not significantly different between men and women. The change in mean cholesterol concentrations in older persons was not statistically significant. There was no significant difference in plasma cholesterol concentrations for persons screened once and those screened on multiple occasions. The prevalence of hypercholesterolemia decreased significantly over the follow-up period (chi-square for trend = 12.3, **Figure 1**).

Sensitivity analysis was conducted assuming that the prevalence of hypercholesterolemia among subjects who did not respond to the follow-up surveys was the same as that in the baseline survey sample. Assuming this, the trend of decreasing hypercholesterolemia prevalence remained highly significant (data not shown).

Plasma antioxidants

Average plasma lutein and zeaxanthin concentrations increased by ≈20% in both age and sex categories (**Table 2**). Plasma

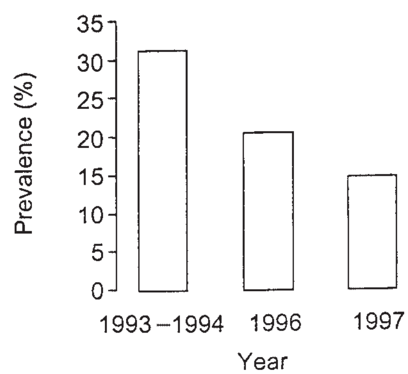

FIGURE 1. Trends in the prevalence of hypercholesterolemia in an Australian Aboriginal community. Data include all age groups and age-adjusted prevalence was derived by using the baseline survey sample as the reference population. n = 186, 181, and 123 in 1994, 1996, and 1997, respectively. P for trend < 0.001 (Cochran-Mantel-Haenszel, age-weighted chi-square statistic test for linear trend).

TABLE 2
Trends in plasma antioxidant concentrations, stratified by sex and age[1]

	Men		Women		*P* for trend[2]		
Age group and antioxidant	1996	1997	1996	1997	Year	Sex	Year × sex
15–34 y							
Lutein and zeaxanthin (nmol/L)	93 (83, 104)	116 (102, 133)	98 (89, 108)	117 (101, 135)	0.002	0.555	0.660
Cryptoxanthin (nmol/L)	37 (29, 48)	39 (29, 54)	47 (38, 59)	103 (74, 143)	0.003	0.002	0.012
β-Carotene (nmol/L)	89 (72, 110)	111 (85, 143)	126 (104, 152)	188 (143, 247)	0.010	0.003	0.438
α-Carotene (nmol/L)	36 (28, 46)	25 (19, 35)	51 (41, 64)	27 (19, 38)	0.001	0.084	0.303
Lycopene (nmol/L)	235 (200, 277)	223 (180, 275)	197 (171, 227)	227 (184, 280)	0.589	0.013	0.277
Retinol (μmol/L)	1.59 (1.46, 1.73)	1.47 (1.31, 1.63)	1.34 (1.22, 1.46)	1.24 (1.07, 1.41)	0.142	<0.001	0.842
α-Tocopherol (μmol/L)	20.7 (19.1, 22.5)	26.1 (23.7, 28.7)	20.1 (18.7, 21.6)	25.4 (22.5, 28.6)	<0.001	0.005	0.982
≥35 y							
Lutein and zeaxanthin (nmol/L)	91 (79, 104)	109 (93, 129)	103 (91, 117)	118 (103, 135)	0.030	0.114	0.717
Cryptoxanthin (nmol/L)	33 (26, 44)	47 (34, 65)	46 (36, 59)	102 (78, 133)	<0.001	<0.001	0.107
β-Carotene (nmol/L)	82 (65, 103)	105 (79, 139)	132 (107, 164)	263 (209, 331)	<0.001	<0.001	0.067
α-Carotene (nmol/L)	34 (25, 45)	20 (12, 24)	42 (33, 55)	21 (16, 28)	<0.001	0.280	0.991
Lycopene (nmol/L)	144 (117, 177)	142 (110, 184)	148 (121, 180)	158 (128, 195)	0.773	0.630	0.731
Retinol (μmol/L)	1.85 (1.69, 2.01)	1.71 (1.52, 1.90)	1.64 (1.49, 1.78)	1.64 (1.49, 1.80)	0.494	0.041	0.359
α-Tocopherol (μmol/L)	24.5 (22.7, 26.4)	31.2 (28.3, 34.3)	26.4 (24.6, 28.3)	30.7 (28.5, 33.2)	<0.001	0.294	0.278

[1] Age- and plasma cholesterol–adjusted estimated marginal means; 95% CIs in parentheses.
[2] ANOVA.

cryptoxanthin concentrations also rose between the 1996 and 1997 surveys, significantly so in women but not men aged 15–34 y. A similar pattern of change occurred among the older men and women, but the interaction term between sex and time was not significant. β-Carotene concentrations were higher in women than in men and rose significantly in both age groups. Average plasma concentrations of α-carotene decreased significantly in both age groups. There were no significant changes in mean plasma lycopene or retinol concentrations between the 1996 and 1997 surveys. Retinol concentrations indicating possible clinical deficiency (<0.7 μmol/L) were absent in 1996 yet occurred in 6 persons in 1997.

Mean plasma α-tocopherol concentrations rose significantly in both younger and older community members (Table 2). After adjustment for plasma cholesterol concentrations by using the formula of Gey et al (18) [(4.02 × absolute α-tocopherol in mmol/L)/cholesterol$^{0.8}$ in mmol/L], the prevalence of α-tocopherol concentrations believed to protect against CHD (>25 μmol/L) increased from 64% to 90% (chi-square = 22.0, $P < 0.0001$). The increase in α-tocopherol concentrations was highly significant even without adjustment for the decrease in plasma cholesterol concentrations (data not shown).

There were no significant differences in plasma antioxidant concentrations between young persons screened once and those screened on multiple occasions. When changes in mean concentration occurred, there were no interactions between this change over time and repeat screening (data not shown).

Plasma homocysteine and smoking

Mean plasma homocysteine concentrations decreased significantly in both young and old persons and this decrease was of similar magnitude in men and women (**Table 3**). Overall, the reduction in mean homocysteine between the 1996 and 1997 surveys was 3 μmol/L. There was no significant difference in mean homocysteine concentrations between younger persons screened once and those screened on multiple occasions, nor any interaction between change over time and repeat screening (data not shown). For the 1996 and 1997 surveys, there was no significant change in age-adjusted prevalence of smoking among men (54.9% and 42.8%, respectively; chi-square = 1.6) or women (38.5% and 39.4%, respectively; chi-square = 0.02).

Trends in dietary quality

Nutrient and carotenoid densities of the food supplied by the community store during the months of July through September in each year of the intervention period are shown in **Table 4**. Apparent total and saturated fat intake was slightly higher in 1993 (before the baseline survey) than it was in subsequent years. There were no apparent consistent trends for mono- and polyunsaturated fat intake. Major food sources of saturated fatty acids were mutton > margarine > chicken, those of monounsaturated fatty acids were margarine > mutton > chicken > eggs, and those of polyunsaturated fatty acids were margarine > bread > salted snacks.

TABLE 3
Trends in plasma homocysteine concentrations, stratified by sex and age[1]

	Men		Women		*P* for trend[2]		
Age group	1996	1997	1996	1997	Year	Sex	Year × sex
	μmol/L		*μmol/L*				
15–34 y	12.8 (11.1, 14.9)	9.6 (7.9, 11.7)	9.9 (8.6, 11.2)	7.9 (6.6, 9.5)	0.004	0.004	0.647
≥35 y	15.2 (13.4, 17.2)	12.5 (10.8, 14.5)	13.5 (12.1, 15.2)	10.5 (9.3, 11.8)	<0.001	0.014	0.636

[1] Age-adjusted estimated marginal means; 95% CIs in parentheses.
[2] ANOVA.

TABLE 4
Trends in selected nutrient, carotenoid, and food densities in the food supply at the single community store over the period of intervention

	Year				
	1993	1994	1995	1996	1997
Fat (g/MJ)					
Total	8.7	8.3	8.2	8.0	8.2
Saturated	3.3	3.0	3.5	2.6	3.1
Monounsaturated	3.5	3.4	3.2	3.3	3.2
Polyunsaturated	1.8	1.7	1.3	2.0	1.5
Fresh, raw vegetables and fruit (g/MJ)	11.0	17.6	13.4	16.9	17.8
Carotenoids (μg/MJ)					
Total	314	478	356	591	502
Lutein	31	48	32	48	47
Cryptoxanthin	4.6	6.2	6.1	6.8	9.0
β-Carotene	152	175	165	180	200
α-Carotene	30	29	30	48	36
Lycopene	97	220	123	309	211
Micronutrients (μg/MJ)					
α-Tocopherol	690	650	560	870	680
Retinol	58	49	56	66	52
Folate	13	12	16	15	14

The apparent intake of fresh, raw fruit and vegetables increased from 1993 to 1997 (Table 4). Consequently, the total carotenoids increased in density in the food supply. Lutein density was lower in 1993 than it was in the other years (major sources: pumpkins > other vegetables). Cryptoxanthin (from oranges and mandarins) and β-carotene (carrots > pumpkins > melons > other fruit) showed a clear rise in density with time, as did lycopene (melons > tomato and tomato products). α-Tocopherol intake peaked in 1996 (between the 2 follow-up surveys), mainly because of a greater consumption of margarine and eggs than was consumed during the other years. There were no consistent trends apparent in the density of retinol or folate (bread and flour > fruit and vegetables > milk > eggs) in the store's food supply.

DISCUSSION

The present study showed marked improvements in certain diet-related coronary disease risk factors in a population at high risk of CHD. The Aboriginal members of a community in the remote Kimberley region initiated and ultimately directed a healthy lifestyle program based on improving diet and physical activity through a combination of education, council and store management policy, and widespread support from community groups and individuals (13). This intervention was associated with a 50% lower prevalence of hypercholesterolemia, a decrease in plasma homocysteine of 3 μmol/L, and a rise in plasma α-tocopherol and certain carotenoid concentrations. Although we cannot totally exclude the possibility of a potential response bias contributing to increased antioxidant concentrations among young persons, we could find no evidence that participants returning for repeat screenings differed from those attending only once with respect to the outcome variables. Sensitivity analysis of changes in hypercholesterolemia prevalence indicated that the observed decrease was not an artifact of response bias.

The reduction in plasma cholesterol concentrations was consistent with the dietary advice to remove fat from meat before cooking. Store turnover data suggest some reduction in saturated fatty acid intake after 1993 but alterations in food preparation methods were more likely to be the main contributor to low cholesterol concentrations. Store turnover data would be insensitive to such changes and would not account for the consumption of bush foods such as fish, which may periodically contribute to the diet. The increased plasma α-tocopherol concentrations (which were apparent even before adjustment for low cholesterol concentrations; data not shown) were presumably due, at least in part, to increased vegetable oil intake (19). Although trials of α-tocopherol supplementation have largely proved to be ineffective in the primary and secondary prevention of coronary events (20, 21), epidemiologic studies suggest that diets with high amounts of α-tocopherol are associated with cardiovascular disease protection (22). The mean plasma α-tocopherol concentrations observed here was similar to those reported in other population-based studies (23, 24).

Plasma carotenoid concentrations are indicative of vegetable and fruit consumption and may be important protective agents against cardiovascular disease because of their antioxidant properties (25). Lutein, which is found in pumpkins, green leafy vegetables, peas, beans, and corn (26, 27) and is readily absorbed by the body, increased in concentration by ≈20% in all age- and sex-specific subgroups of the present survey samples. This increase can be attributed to the fact that the types of food providing the most lutein are those foods that are normally included in stews and other primary meals consumed communally. In contrast, concentrations of cryptoxanthin, which in this case was derived mainly from citrus fruit, increased only in women, in whom mean concentrations doubled. Because the consumption of oranges and other fruit was more of an individual choice, the advice to increase fruit intake, although clearly observed by women, was not observed by men, particularly young men, in the community. Although prevalent in a variety of vegetables and fruit, β-carotene appeared to be better absorbed from fruit (26). The observed rise in β-carotene concentrations probably reflected this increased fruit consumption by women. There were clear increases in the density of cryptoxanthin and β-carotene in the food supply. Lycopene, the major sources of which were melons and tomato products, did not change in plasma concentrations over the evaluation period, despite an apparent increase in density in the food supply. Circulating lycopene is only weakly related to dietary intake because of its dependence on the co-ingestion of fat to increase its bioavailability (28).

Despite these improvements, plasma carotenoid concentrations remained well below those observed in populations with a relatively low risk of cardiovascular mortality (29). Carotenoid concentrations defining minimum risk of mortality remain to be clearly defined, but greater fruit and vegetable intakes are probably required. Many factors hamper this process, including a lack of domestic refrigeration. Fresh produce in remote areas is expensive, especially when compared with the low median incomes, and the quality of produce can be poor because of the long transport times and great distances from suppliers (8).

A strong relation between plasma homocysteine concentrations and CHD mortality has been reported in many studies (10). Although results of clinical trials that aim to lower circulating homocysteine are not yet available, it would be reasonable to expect reduced coronary disease risk associated with low homocysteine concentrations on the basis of biochemical mechanisms and strong epidemiologic relations. A homocysteine concentration that decreases by 3–4 μmol/L, as observed here, may be associated with a ≤50% lower risk of vascular disease (30–32). Increased folate intake is likely the most plausible explanation for reduced mean homocysteine concentrations. However, although fruit and vegetable intake increased among the population of the present study, this was not reflected by major increases in the apparent density of dietary folate derived from store foods. Bread and flour were major contributors to the intake of folate in this community, whereas the proportional folate contribution from vegetables and fruit increased with time. Looma is subject to hot weather, and improved storage facilities at the store may have better preserved produce items, resulting in a higher dietary intake of folate and carotenoids. Another potential folate source is bush food, which would not have been accounted for in store turnover data. Increased folate intake from a very low baseline can have a major effect on plasma homocysteine concentrations, whereas smaller benefits are evidenced from further increases in dietary folate (31).

The prevalence of smoking remained high in this community, despite an apparent downward trend in men that was not significant. Smoking was more common among men than women and was a rare practice among older people. Interventions to address smoking among young people are required.

A limitation of the present study was the lack of a suitable control community. Given the clearly defined benefits of improving diet and exercise habits to reduce the risks of coronary disease (33), including a control community in which no intervention was attempted would have been difficult to ethically justify in such a high-risk population. The choice of community is not random, as the community itself initiated the intervention and its continuation is due to the high degree of motivation of the community members. The magnitude and rate of change in plasma cholesterol concentrations observed here far exceeded the general, secular trend in Australia (34). Similar comparative data for plasma antioxidant and homocysteine concentrations are unavailable. However, a spontaneous increase in fruit and vegetable intake and changes in antioxidant and homocysteine profiles unrelated to the educational and policy initiatives undertaken by the community appears implausible. The trends in food and dietary quality were largely consistent with changes in plasma markers among the survey samples.

The improvements in diet-related markers of coronary disease risk observed in the present study are in contrast with the lack of change in obesity and diabetes prevalence in response to community-based interventions, as reported in this (13) and other (35) communities. The results show that community-directed programs can achieve genuine reductions in cardiovascular disease risk, even when there is no change in the prevalence of diabetes and obesity, and highlight the need to set realistic short-term goals for such programs. The onset of diabetes and obesity require primary prevention in childhood and early adulthood: obesity is difficult to reverse once established and is a strong risk factor for type 2 diabetes. The appointment by the Looma Community Council of a store manager with a mandate to improve the food supply and other council policies regarding smoking, food availability, and physical activity were key aspects of the intervention enabling the improvements seen in this remote community.

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