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Living Longer on the Land
A health program that works

An economic evaluation of the Sustainable Farm Families Program

by Jonathan Boymal, Patricia Rogers, Susan Brumby and Stuart Willder

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Researcher Contact Details
Ms. Susan Brumby
Western District Health Service
PO Box 283
Hamilton VIC 3300

Phone: 03 5551 8460
Fax: 03 5572 5371
Email: susan.brumby@wdhs.net

In submitting this report, the researcher has agreed to RIRDC publishing this material in its edited form.

RIRDC Contact Details
Rural Industries Research and Development Corporation
Level 2, 15 National Circuit
BARTON ACT 2600
PO Box 4776
KINGSTON ACT 2604

Phone: 02 6271 4100
Fax: 02 6271 4199
Email: rirdc@rirdc.gov.au.
Web: http://www.rirdc.gov.au

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Foreword

By urban standards, the general health of rural people is poor. Rural and farming populations have above average rates of premature morbidity and mortality through heart disease, cancer and suicide. Health related behaviours are an important determinant of avoidable mortality and morbidity. Improvements in farming family health can be expected to generate benefits that include:

- reduced morbidity and premature mortality
- healthier farming communities
- improved workforce health
- greater farm output
- financial benefits to all three levels of government related to reduced health and other service expenditure.

It is in this context that the Sustainable Farm Families (SFF) project of the Western District Health Service, Hamilton, Victoria has been working with farming families in a number of industries including dairy, cotton, sugar and grains since 2003. The SFF project is designed to influence farmers' behaviour with respect to their family health, wellbeing and safety by focussing on the human resource in the triple bottom line.

This report describes a benefit:cost analysis of the Sustainable Farm Families Program. It found that as a result of improved health outcomes, the SFF project was cost effective in reducing mortality associated with Type 2 diabetes and cardiovascular disease amongst the participants, providing cost savings to government, and to the community.

The results of this research will inform resource allocation decisions by local, state and federal policy makers to ensure the greatest possible contribution to improving rural health from a limited budget, by suggesting that interventions designed to influence health related behaviours may be particularly effective. The report also provides a methodology to guide benefit:cost evaluations of the effectiveness of other health interventions to improve the sustainability of the farming workforce through better health.

This project was funded by the RIRDC-managed Joint Research Venture for Farm Health and Safety with the vision of enhancing the well being and productivity in rural industries through improved occupational health and safety status of Australian agriculture delivered by the establishment of safe systems of work on farms. The partners in the Joint Venture are Grains Research and Development Corporation, Sugar Research and Development Corporation, Meat and Livestock Australia, Australian Wool Innovation, Cotton Research and Development Corporation and Rural Industries Research and Development Corporation.

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Peter O'Brien
Managing Director
Rural Industries Research and Development Corporation

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Professor John Martin, Director, Centre for Sustainable Regional Communities, LaTrobe University, assisted the project and provided comments on an earlier draft of this report.

Abbreviations

BMI	Body Mass Index
CVD	Cardiovascular Disease
ICER	Incremental Cost-Effectiveness Ratios
MBC	(Commonwealth) Medicare Benefit Schedule
QALY	Quality Adjusted Life Year
R&D	Research and Development
RCT	Randomised Control Trial
RIRDC	Rural Industries Research and Development Corporation
SFF	Sustainable Farm Families

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Executive Summary

What the report is about

This report presents the results of an economic evaluation of the Sustainable Farm Families (SFF) project, which is designed to influence farmers' behaviours with respect to health, safety and well being. The report sets out four different types of economic analysis:

- cost analysis
- cost-effectiveness analysis
- cost-utility analysis
- cost-savings analysis.

Who is the report targeted at?

The report is targeted at those involved in rural health, agricultural industries and the rural workforce, particularly those with responsibilities for policy development and resource allocation. It provides specific information about a particular project and provides a methodology that could be adapted and further developed for similar projects.

Background

The general health of rural people is, by urban standards, poor, with rural and farming populations having above average rates of premature morbidity and mortality through heart disease, cancer and suicide. Improvements in rural health can be expected to generate benefits that include: greater farm output, financial benefits to all three levels of government related to reduced health and other service expenditure and healthier farming communities and reduced morbidity and premature mortality.

The SFF project is designed for people who have farmed for more than five years and are aged between 18 and 75 years. It is open to any member of a farming family business and participants are self -selecting. The SFF project engages with farming families through annual workshops, newsletters and their industry associations. Participants are tracked over three years using baseline health data, pre and post-knowledge surveys and personal action plans.

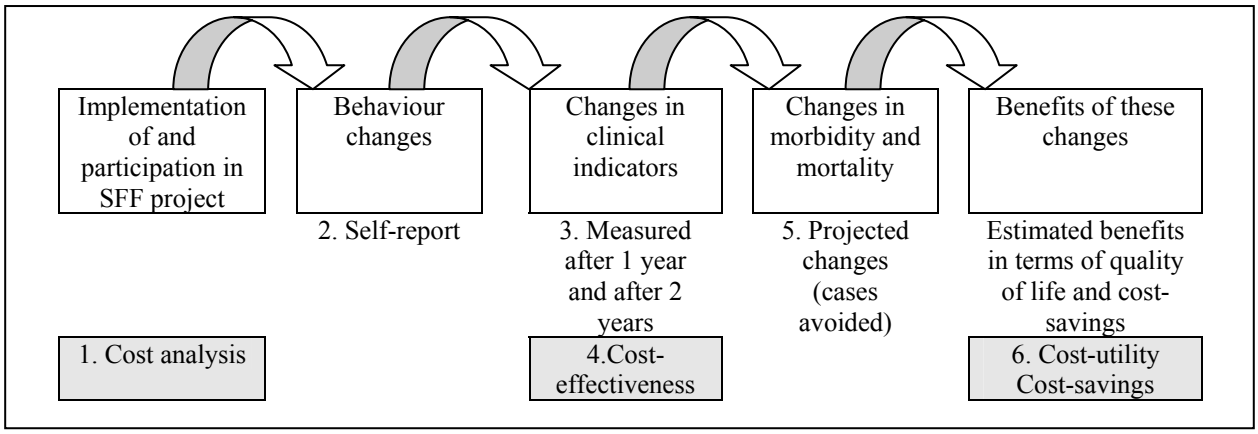
Aims

The aim of the project was to provide an economic model of the impact and cost effectiveness of the Sustainable Farm Families program which can then be used in a number of industries, for example sugar, dairy and cotton.

Methods used

Data were collected on 128 participants involved in broad acre farming in five locations: Benalla, Clare (SA), Hamilton, Horsham and Swan Hill. Evidence of changes in clinical indicators came from three annual health assessments which provided data on fasting cholesterol; fasting blood sugar; four indicators related to obesity – body mass index, waist hip ratio, waist measurement, and percentage of fat in body mass; systolic and diastolic blood pressure; and pulse rate. In addition, the evaluation is based on analysis of the costs of implementing the project (from records and reported purchases), evidence about changes in behaviour (from self-report), projected changes to morbidity and mortality (based on published research on risk factors), and on the estimated value of these changes in terms of quality of life (based on published research) and cost-savings (based on published research about the costs of cardiovascular events and diabetes).

Figure 1 Overview of evidence and economic analyses of the SFF project



Results

The total costs of running the project, consisting of project delivery costs, direct costs to participants, and costs of additional health service utilisation, were calculated as $141,189 for 128 participants across five sites. Participants in the SFF project reported behaviour changes in terms of eating healthier food, undertaking more exercise and safer farming work practices.

Measured clinical indicators, including body mass index, systolic blood pressure, total cholesterol level, waist circumference and waist hip ratio, showed statistically significant ($p \leq 0.05$) average improvements over 12 and 24 months. Costs per risk factor eliminated ranged from $1,426 (total cholesterol) to $4,706 (weight).

On the basis of these changes in clinical indicators, it is projected that eight cases of diabetes per year and two cardio-vascular events over 10 years have been avoided.

In order to facilitate a comparison of the SFF project with other health projects that may involve qualitatively different outputs, a 'Quality Adjusted Life Year' (QALY) outcome measure was used. A Quality Adjusted Life Year is a measure of the additional length of life produced by health interventions, adjusted for the quality of life. Perfect health is rated as 1; death is rated as zero; different health states are rated with reference to these – usually some number between 0 and 1 but a negative score for health states was considered to be worse than death! QALYs can be added and compared – so that an intervention that leads to 10 extra years of life rated as 0.5 in quality would produce a total outcome of 5 QALYs.

Published weights in the literature were utilised for this report. In order to explicitly compare QALYs that are gained at different points in time, future QALYs are 'factored down' so that they can be expressed in present values. This 'factoring down' is known as 'discounting', and is consistent with the treatment of future benefits and costs in all economic evaluations.

The total gain in discounted QALYs over 10 years from the SFF project is calculated to be 4.33. This means that the equivalent of nearly 4 ½ years of perfect health.

Where half of the total costs of the SFF project are attributed to these outcomes (and half to other outcomes), the cost per discounted QALY gained is $16,304. These costs per QALY do not include downstream cost savings. The SFF project therefore achieves the $40,000 per QALY acceptability threshold (used as a standard for drug approvals) largely due to its contribution to reduced incidence of Type 2 diabetes.

Cost savings from the predicted reduced incidence of Type 2 diabetes (and subsequent savings in related health care) over 10 years are estimated at $154,929, which exceeds the total cost of the SFF project itself. This indicates that the SFF project generates net cost savings, even if we only consider its outcome in terms of diabetes incidence.

Implications for relevant stakeholders

The economic analysis indicates that the SFF project is good value for money in terms of changing behaviours and thus improving health outcomes for rural Australians and saving government's money. This suggests it may be worthwhile expanding the project beyond the study group.

In order for the economic analysis to be undertaken a robust methodology was developed that can be readily adapted to other projects that seek to influence health-related behaviours.

This report will assist in informing resource allocation decisions to ensure the greatest contribution to rural health improvement possible from a limited budget, by determining whether interventions designed to influence health related behaviours are particularly effective. Evaluation results will be used to inform future implementation of the SFF project and to inform the development of other projects to reduce morbidity and mortality among farming families.

Recommendations

Based on the findings of this report, it is recommended that:

- behavioural change projects related to health such as the Sustainable Farming Families project be continued and extended
- the methodology developed in this project be further developed and used to evaluate similar projects
- further investigation of other health outcomes of the SFF should be documented and analysed
- participants should be reassessed in five years to determine whether improvements in clinical indicators have been maintained and possibly to gather evidence about morbidity and mortality.

Introduction

The research project had two purposes:

- to undertake an economic evaluation of the Sustainable Farm Families (SFF) project, assessing its cost-effectiveness, cost-utility, and cost-savings, and
- to develop a methodology for future economic evaluations.

The report sets out the methodology for the economic evaluation. It begins with an overview of the different types of economic evaluation – cost-effectiveness, cost-utility, cost-benefit and cost-savings. It then provides details of the data sources and methods of analysis used. This section is intended to provide guidance for future economic evaluations of similar projects.

This is followed by an overview of the SFF project, including the rationale and need for the project and a description of its activities and outcomes in terms of reported changes in health behaviours and measures of changes in clinical indicators.

An economic evaluation of the SFF project in terms of changes in clinical indicators and their consequences is then described. It begins by calculating the costs of the project, and the cost per participant and per participant for whom three years of data are available.

Three types of economic evaluation are then presented. Cost-effectiveness calculates the cost of reducing or eliminating each risk factor, using evidence of changes in these indicators from the reported project outcomes. Cost utility calculates the cost for each QALY (quality-adjusted life year), using projections of changes in morbidity and mortality, specifically cardio-vascular events, death from cardio-vascular events, and Type 2 diabetes, based on observed changes in clinical indicators. Cost savings analysis estimates the net cost to government taking into account the costs of the project and the savings in terms of reduced health care costs.

In conclusion, there is a summary of the economic evaluation and a discussion of the implications of the methodology for future evaluations of projects.

Methodology

This section sets out the different types of economic analysis, describes the overall research design, discusses the evidence to support the argument that the SFF project contributed to the observed changes in clinical indicators, and describes the sources of evidence and the methods of analysis.

Types of economic analysis

Economic evaluation is essentially concerned with a comparison of the benefits and costs of an intervention. Different economic evaluation approaches essentially reflect different approaches to the measurement and valuation of costs and benefits.

Costs can be understood in terms of:
- financial values of the resources used, including money, in-kind support, and time
- foregone opportunities in not using these resources for other purposes
- any negative outcomes (either expressed in qualitative terms or converted to monetary terms).

This economic evaluation analyses the cost of the intervention in terms of the first of these options, the total resources used, expressed in financial terms.

Benefits can be understood in terms of:
- achievement of a specific short-term or long-term outcome, such as specific reductions in clinical indicators
- achievement of outcomes in terms of the quality and quantity of additional years of life produced
- achievement of outcomes expressed in monetary terms
- savings due to avoiding negative outcomes or costs (either expressed qualitatively or in monetary terms).

The quality and quantity of quality adjusted life years is expressed in terms of quality-adjusted life years (QALY). A QALY is a measure of the additional length of life produced by health interventions, adjusted for the quality of life. Perfect health is rated as 1; death is rated as zero; different health states are rated with reference to these – usually, these are some number between 0 and 1 but health states that are considered to be worse than death will have a negative score. For example, based on the self-reports of respondents with Type 2 diabetes, the DiabCost study (Colagiuri et al., 2003) reported that macrovascular complications (such as heart disease, stroke and peripheral vascular disease) reduced respondents' quality of life score by 0.16, while microvascular complications (such as nerve damage, kidney disease and vision disorders) reduced respondents' quality of life score by 0.2. QALYs can be added and compared – so that an intervention that leads to 10 extra years of life rated as 0.5 in quality would produce a total outcome of 5 QALYs. An intervention may increase QALYs by extending life, increasing the quality of life, or some combination of the two.

In addition to these benefits that relate to the direct health outcomes for participants, there are likely to be additional health benefits to family members and to the wider community – for example, the cost of volunteer time to look after ill people at home or to support them in hospital. It is not, however, common to capture these wider influences in economic evaluations, and measuring individual benefit will, for many health interventions, represent an acceptable simplification. This does mean that the total benefits of these interventions are likely to be understated. In this economic evaluation, potential broader effects of the SFF project that extend beyond the direct health outcomes of participants are not included in the analysis, including reported strengthening of community capacity.

Four commonly recognised economic evaluation models reflect different approaches to the measurement and valuation of benefits.

Table 1 A typology of economic analysis

Cost-effectiveness analysis	The relationship between program costs and program effectiveness, in terms of a specific short-term or long-term outcome.
Cost-utility analysis	The relationship between costs and outcomes expressed in terms of the Quality Adjusted Life Year – (QALY) which takes into account both quantity and quality of extended life.
Cost-benefit analysis	The measurement of both costs and benefits in monetary terms.
Cost-savings analysis	The measurement of net fiscal savings as a result of a program

Cost-effectiveness analysis is useful for comparing alternative ways of pursuing a specific objective. Cost-effectiveness analysis does not require program outcomes to be expressed in dollar terms, but in terms of an appropriate health status attribute. This represents an intermediate step in cost-benefit analysis. This type of analysis is most commonly applied where a number of alternative health programs, designed to contribute to the same health objective are to be compared, such as a number of programs targeted at smoking cessation or weight control. Final health outcome measures of a more generic nature are also commonly used in cost-effectiveness analysis, such as fatal events avoided, change in risk of death or non-fatal events and life years 'saved'. There are numerous examples of cost-effectiveness analysis of health programs, which illustrate how in practice the implementation issues are addressed (see for example, Segal, *et al*, 2005, Farquhar, *et al*, 1990; Hatziandreu, *et al*, 1988; Lindgren *et. al*, 2003; Munro, *et al*, 2002).

Cost-utility analysis is a particular type of cost-effectiveness analysis, where the unit of outcome is the quality adjusted life year (QALY), which is obtained by multiplying a quality of life index by the number of calendar years of life. The quality of life index comes from ratings from a sample of people. This method of evaluation requires measurement of the change in health status of participants attributable to the intervention. This approach is attractive in that it offers a single, universally applicable description of health outcome, broadening the range of health interventions which can be directly compared. The QALY encompasses all aspects of health status in a single measure, which can then be related to program cost to yield a dollar cost/quality adjusted life year. Cost/QALY can be compared across any health programs to establish relative performance. A program yielding a lower cost/QALY would be preferred to a program costing more per QALY gain.

Cost-benefit analysis addresses the question of whether, or to what extent, any policy or program is worth pursuing. It does this by identifying all costs and benefits and weighing one against the other. In its pure form this requires the translation of all effects, cost and benefits into dollar values. Performance can then simply be expressed in dollars, either as a net present value estimate, or rate of return. Results of the program under review can be compared with rates of return or net present value achievable from other types of investments/programs to establish relative performance. Cost-benefit analysis has been unpopular in the evaluation of health programs due to concerns about the ability to translate health outcomes, like enhanced quality of life or reduction in risk of premature death, into dollars. This type of analysis is not included in the economic evaluation of SFF.

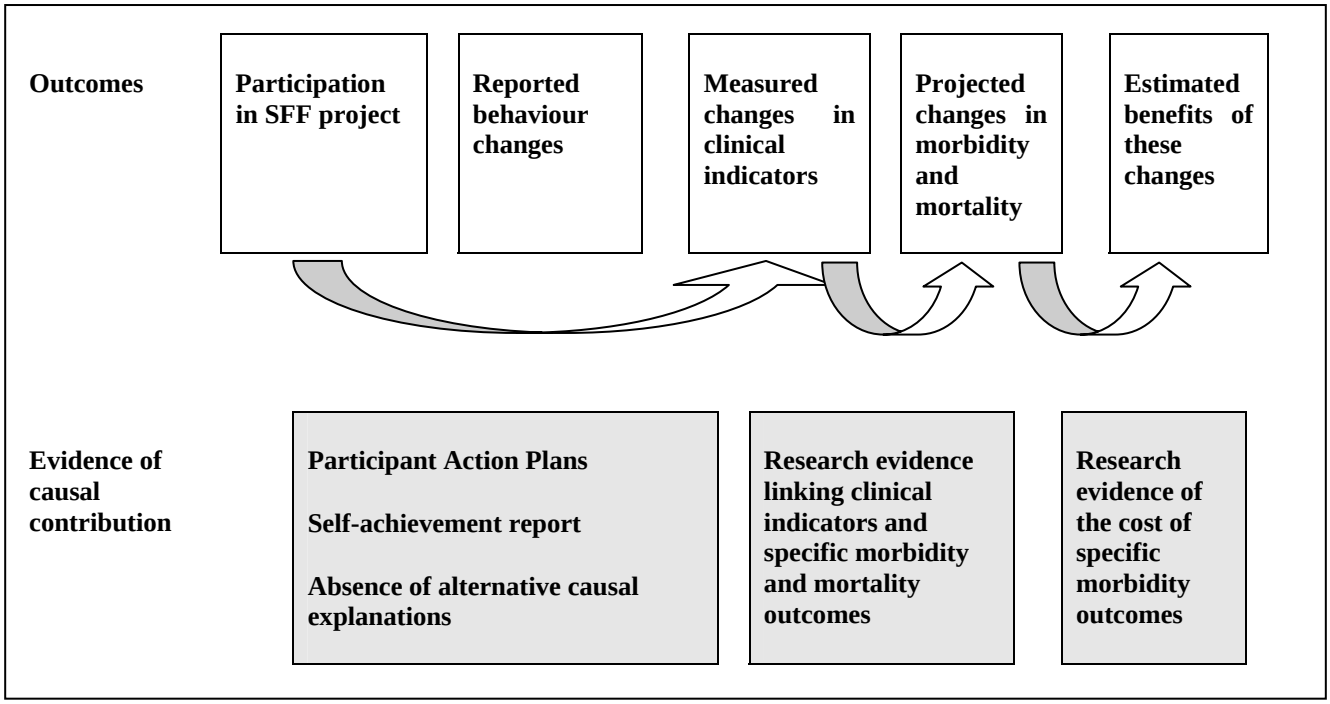
Cost savings analysis investigates whether public expenditures for such programs could be justified, at least in part, by the savings to government they generate. If the savings generated by such programs are greater than their costs, government fiscal support for such programs may be considered a worthwhile investment of public funds, regardless of the need to demonstrate other broader benefits to society. Care is needed to ensure that apparent cost-savings are not in fact due to cost-shifting to other parties or to other levels of government.

Research design and analysis of causal contribution

Evidence of the impact of the SFF project was based on a before-and-after longitudinal observational study, with no control group.

The study provided evidence of changes in clinical indicators, but not of changes in morbidity and mortality, which would require a longer timeframe. Instead projected changes in morbidity and mortality were calculated using research evidence linking these with clinical indicators. This is an established practice in the health evaluation literature when considering preventative interventions, as it is unusual for participants to be followed up for the requisite time for an expected change in risk of death or quality of life to be able to be observed.

Figure 2 Overview of evidence for causal contribution of the SFF project



The study provides evidence to support the conclusion that the SFF project contributed to observed changes in clinical indicators. Although the design does not include a control group, support for causal contribution comes from participants' accounts of their health-related behaviour changes as part of their personal action plans, which they attributed to participation in the project.

More convincing evidence of the causal contribution of the SFF project comes from systematic investigation of alternative explanations for the observed changes in clinical indicators, drawing on Campbell and Stanley's (1963) classic list of threats to internal validity:

- history
- maturation
- repeated testing
- instrumentation
- regression to the mean
- experimental mortality
- selection
- interactions between selection and other factors.

History refers to another event during the period that is the actual cause of the observed changes. No other similar project or event was reported during the period of implementation of SFF that could have produced these changes. Some broader social marketing campaigns around specific diseases or nutrition may have contributed to creating a conducive environment for change, but since these have occurred at other times before SFF was implemented without leading to improvements in clinical indicators, it does not seem likely that they have caused the changes.

Maturation refers to natural development that leads to performance improvement – most commonly seen in children who are likely to grow, and perform better due to maturation. In the case of the SFF project, the reverse is more likely – that with increasing age, participants would be more likely to have worse clinical indicators.

Repeated testing can have an effect where knowledge or behaviour appears to improve due to familiarity with testing procedures. Measures used to collect evidence of clinical indicators are not susceptible to this threat as they are objective measures of physical conditions.

Instrumentation refers to the impact of changes in the continuity of instruments used to collect data. This is more likely to be an issue where there have been changes in the personnel collecting data, where research scales have been used over a long time and need to be reformed, or where evidence comes from methods such as observer ratings which can vary over time. Measures used to collect evidence of clinical indicators are not susceptible to this threat due to the stability of the measures, the continuity of staff undertaking the measurements, and the relatively short time frame.

Regression to the mean is a threat where participants have been selected on the basis of lower than average performance on an indicator with considerable error in its measurement. A number of those with performance measured just below the average are likely to have higher levels of actual performance than measured performance. The next time they are measured, if the measured performance more accurately reflects their actual performance, the result will be an increase in measured performance which can be mistaken for an increase in actual performance.

Experimental mortality refers to differential drop-out rates between groups that are being compared, as well as to mortality in terms of actual death. For example, if participants for whom the SFF project was not successful dropped out, average clinical indicators among those who finished would be better than the average of those who started even if there were no actual changes for individual participants. For this reason, the analysis of outcomes only includes changes among the 97 participants who completed the project and provided three years of outcome data.

Selection can threaten validity if two groups which are being compared are different in terms of an important variable which by itself could explain the difference in observed performance. Although there is no explicit comparison between SFF participants and another group, there is an implicit comparison with those who chose not to participate. Clearly, participants in SFF might be expected to be more highly motivated to make changes in health behaviours than non-participants, even though some participants were apparently initially reluctant to attend. However this is not sufficient to

invalidate the findings, as there is not evidence that this higher level of motivation had translated into sustained behaviour changes before participation in the SFF project.

Selection interactions refer to interactions between the selection to participate and the other threats. No such interactions were identified.

This analysis demonstrates that a credible argument for causal contribution of the SFF project can be made despite the absence of a common design for impact evaluation, the randomised control trial (RCT). RCTs are difficult to implement both logistically and ethically, particularly in small rural communities and in projects with small evaluation budgets.

In addition, for projects such as the SFF project, the motivation of participants is likely to be a legitimate contributory factor, unlike the impact of interventions such as water fluoridisation, where active participation is not required for the intervention to work.

Data sources for evidence of outcomes

Participants

Out of a total of 128 participants, there were 104 project completers. Although year one and year three data were sourced for these 104 participants, complete three-year data were sourced for only 97 out of the 128 project participants, including all outcome measures related to clinical and behavioural parameters.

Evidence of behaviour change

Participants reported changes in their health behaviours using a behaviourally-anchored self-achievement scale in terms of:

- healthier eating
- increased exercise
- health checks
- safer work practices.

As there was no external validation of these self-reports, the focus of the evaluation is on changes in clinical indicators. These do however provide evidence to support the causal contribution of the SFF project to the observed changes in clinical indicators.

Evidence of changes in clinical indicators

The SFF project included measurement of clinical indicators as part of its implementation. Evidence of changes in clinical indicators came from three annual health assessments, which provided data on:

- fasting cholesterol
- fasting blood sugar
- four indicators related to obesity - body mass index, waist hip ratio, waist measurement, and percentage of fat in body mass
- systolic and diastolic blood pressure
- pulse rate.

Evidence of projected impact on morbidity and mortality

The analysis has focused on the likely consequences of the project in terms of changes in the incidence of cardiovascular disease and Type 2 diabetes. The project also demonstrated changes in stress, work safety practices, alcohol consumption and undertaking first aid courses. These were not included in the economic analysis due to limitations in the data available about all participants and in the research literature about their implications for morbidity and mortality.

The projected impact on morbidity and mortality has been calculated using clinical parameters as predictors. This is commonly applied in the economic evaluation literature and relies on the application of published risk equations derived from large-scale cohort studies (eg, Anderson et al,

1991; Griffin et al 2000). These published risk equations provide valuable information as to the determinants of disease-specific mortality or morbidity.

For the purposes of estimating changes in the incidence of cardiovascular disease and Type 2 diabetes, it was assumed that any changes in clinical parameters achieved over the life of the project are maintained for 10 years.

Sources for economic analyses

Costs analysis

The costs incurred in implementing the project were calculated by adding the actual cost of project delivery, and the estimated cost to participants of buying equipment for exercise and healthier eating, and the additional cost of increased use of medical services for health checks. This did not include the additional costs of developing and piloting the project.

Cost effectiveness analysis

The first economic analysis undertaken was cost-effectiveness in which the SFF project was analysed in terms of the cost to achieve an observed change in clinical parameters.

Cost utility analysis

The second economic analysis estimated the incremental gain in participants' quality adjusted life years as a result of the SFF project. In order to explicitly compare QALYs that are gained at different points in time, future QALYs are 'factored down' so that they can be expressed in present values. This 'factoring down' is known as 'discounting', and is consistent with the treatment of future benefits and costs in all economic evaluations.

Cost savings analysis

Finally, the predicted downstream cost savings in terms of health care utilisation was calculated. Interventions may also result in changes in downstream health service use resulting from a change in disease incidence. The benefits of any downstream cost savings is in the freeing up of resources that can then be reallocated to yield benefits elsewhere. Where the impact on clinical outcomes occurred during the project itself and resource impacts were collected through participants' responses to questionnaires, then the consequential effect on resource use can be estimated with some confidence. In this case, unit costs are derived from a range of sources including the Commonwealth Medicare Benefits Schedule (MBS) published charge-out rates for specific health disciplines. With regards to downstream cost savings beyond the lifetime of the project, while the steps and assumptions required in the modelling are many, and as a result estimates are both complex and uncertain, a review of the literature has provided estimates that can be applied to the SFF project. Future costs savings are 'factored down' or 'discounted' so that they can be expressed in present values.

The Sustainable Farm Families Project

Need for the project

Across Australia, living in regional, rural and remote areas is associated with higher rates of avoidable mortality among males and females. In particular, rural populations have above average rates of premature mortality and death through heart disease, cancer and suicide (AIHW, 2002). In terms of morbidity, for example, those living in remote areas are hospitalised for diabetes at over twice the rate of their counterparts in metropolitan areas (AIHW, 1998).

Health related behaviours are an important determinant of avoidable mortality. The possible means to influence health related behaviours are wide ranging and include:

- programs to inform, educate and empower citizens and patients
- information and training for providers
- modification to financial incentives, for instance through taxation and subsidies or adjusting the level of co-payments
- direct service provision
- regulatory arrangements and enforcement.

Each set of policies or strategies for influencing lifestyle behaviours will have cost or resource use implications, for individuals, the community and governments, and a level of influence on lifestyle behaviours and subsequent health status of individuals directly affected and for the wider community.

Participants

The Sustainable Farm Families (SFF) project, conducted by the Western District Health Service, Hamilton, is designed to influence farmers' behaviour with respect to their family health and well being (Brumby et al, 2005). The SFF project is for people who have farmed for more than five years and are aged between 18 and 75 years. It is open to any member of a family farming business and participants are self-selecting. Data were collected on 128 participants in five locations: Benalla, Clare (SA), Hamilton, Horsham and Swan Hill.

The average baseline characteristics of the participants are presented in Table 2, over page. It shows that the mean baseline was above the risk threshold for body mass index (26 compared to a risk threshold of 25), and total cholesterol (5.5 compared to a risk threshold of 4.5 or 5.5).

Table 2 Average baseline characteristics of SFF participants

Variable	Number of participants (n = 128)	Percentage of participants
Male	69	54%
Female	59	46%
Born in Australia	121	95%
Current smoker	5	4%
Previous smoker	28	22%
	Mean	**Standard deviation**
Age	47	8.79
General health score (where 1 = excellent and 5 = poor)	2.56	0.08
Body mass index (kg/m^2)	26.06	3.44
Total cholesterol (mmol/L)	5.49	1.10
Waist circumference (cm)	91.18	10.79
Waist-hip ratio	0.89	0.09
Blood sugar level	4.88	0.63
Blood pressure (systolic) (mm Hg)	126.28	15.13
Blood pressure (diastolic) (mm Hg)	79.34	9.08
Pulse rate	72.89	9.26

The numbers of participants at risk in terms of particular clinical indicators are shown in Table 3.

Table 3 Participants at risk in base year in terms of particular clinical indicators

Participants at risk in base year	Number of participants
Body mass index ≥ 25	67
Total cholesterol level ≥ 5.5 mmol/L	45
Total cholesterol level ≥ 4.5 mmol/L	80
Waist-hip ratio Men > 0.90 Women > 0.80	70
Waist circumference Women > 88 cm Men > 102 cm	30
Blood pressure (systolic) (mm Hg) ≥140	26

Activities

The SFF project engaged with farming families through annual workshops, newsletters and their industry association over three years, and participants are tracked over three years using baseline health data, pre and post-knowledge surveys and personal action plans.

Workshop presentations and activities included the epidemiology of rural health, cardiovascular disease, cancer, stress, diet, farm health and safety, physical activity, diabetes, anxiety, depression, gender specific topics and action planning.

Outcomes

Any change in lifestyle resulting from participation in the SFF project may potentially influence health in a number of ways, including indirectly and over time (through disease pathways, often mediated through changes in clinical parameters); directly and contemporaneously (e.g. improvement in sense of taste if a person stops smoking); and through externalities (e.g. adoption of safe drinking [alcohol] practices which can have consequences for family members and others in the community).

The disease pathway is the primary focus of this evaluation. Examples of this pathway are improved nutrition and exercise resulting in a lower incidence of Type 2 diabetes and cardio-vascular disease, avoiding associated losses in quality of life and life expectancy. The sequential nature of the relationship between changes in behaviour and health benefits explored in this evaluation is represented in Figure 3 below, which also provides a summary of the outcomes considered as part of the behaviour-health pathway considered in this evaluation.

Figure 3 Sequence of intended outcomes from the SFF project

Participation in SFF project	Behaviour changes	Changes in clinical indicators	Changes in morbidity and mortality	Benefits of these changes
	Self-report	Measured after 1 year and after 2 years	Projected changes	Estimated benefits
	• Eating healthier food • More exercise • Safer farming work practices • Health follow up checks	• Obesity-related indicators: o Waist circumference o Body mass index o Waist-hip ratio o Percentage of fat in body mass • Blood sugar level • Blood pressure o Systolic o Diastolic • Cholesterol level • Pulse rate • General health score (not measured in Year 2)	Reduced risk of • Cardio-vascular event • Death due to cardio-vascular event • Diabetes In addition, given the content of the sessions, there are likely to be reductions in • Farming accidents • Cancer • Anxiety and Depression	• Increased Quality Adjusted Life Years • Downstream cost savings

Estimated reductions in farming accidents, cancer and mental health were not included in the economic evaluation, which will therefore under-estimate the impact of the SFF project. Given their inclusion in the program, through information provision and screening, there are likely to have been additional benefits in terms of these outcomes. For example, several participants, as a result of the screening and assessment component of the program, identified health issues in the early stages, including melanoma, bowel cancer, anxiety and depression. Treatment was sought, increasing the likelihood of a successful outcome.

There are several statistically significant outcomes of the SFF project. As the SFF project is a multi-risk factor intervention, and does not nominate a primary outcome measure of interest, changes in a range of parameter measures at the second and third measurement period are summarised in Table 4.

Table 4 Mean change in clinical parameters and risk parameters from baseline to Year 2 and Year 3 for all participants

	Change from baseline to			
	Year 2		Year 3	
	Mean (± Standard Error)		Mean (± Standard Error)	
All participants (n=97)[1]				
General health score (where 1 = excellent and 5 = poor)			- 0.09 (0.78)	
Body mass index (kg/m^2)	- 0.25 (0.10)	*	- 0.27 (0.13)	*
Total cholesterol level (mmol/L)	- 0.43 (0.10)	***	- 0.70 (0.09)	***
Waist circumference (cm)	- 1.16 (0.40)	***	- 1.59 (0.39)	***
Waist-hip ratio	- 0.01 (0.00)	***	- 0.01 (0.00)	***
Blood sugar level	- 0.06 (0.06)		0.09 (0.06)	
Blood pressure (systolic) (mm Hg)	- 2.722 (1.07)	*	-3.39 (1.23)	**
Blood pressure (diastolic) (mm Hg)	0.92 (0.77)		0.82 (0.83)	
Pulse rate	- 0.58 (0.86)		- 0.41 (0.90)	

Significance values *** $p \leq 0.001$, ** $p \leq 0.01$, *$p \leq 0.05$. Based on two-tailed significance tests.

Table 5 Mean change in clinical parameters and risk parameters from baseline to year 2 and year 3 for those at risk

	Change from baseline to			
	Year 2		Year 3	
	Mean (± Standard Error)		Mean (± Standard Error)	
Participants at risk in base year				
Body mass index ≥ 25 (n=67)	- 0.42 (0.13)	**	- 0.44 (0.16)	**
Total cholesterol level ≥ 5.5 mmol/L (n=45)	- 0.91 (0.13)	***	- 1.26 (0.12)	***
Total cholesterol level ≥ 4.5 mmol/L (n=80)	- 0.59 (0.1)	***	- 0.92 (0.09)	***
Total Blood sugar level ≥ 5.5 mmol/L (n=13)	- 0.62 (0.13)	***	- 0.56 (0.15)	**
Waist-hip ratio Men > 0.90, Women > 0.80 (n = 70)	- 0.015 (0.00)	***	- 0.016 (0.00)	***
Waist circumference Women > 88 cm , Men > 102 cm (n = 30)	-3.50 (0.81)	***	-3.17 (0.69)	***
Total Blood sugar level ≥ 5.5 mmol/L (n=13)	- 0.62 (0.13)	***	- 0.56 (0.15)	**
Blood pressure (systolic) (mm Hg) ≥140 (n=26)	-10.38 (1.44)	***	- 12.5 (1.91)	***

Significance values *** $p \leq 0.001$, ** $p \leq 0.01$, *$p \leq 0.05$. Based on two-tailed significance tests.

[1] All participants refer to those 97 for whom data were available in each year.

Table 6 Numbers of at risk participants reducing clinical indicators below risk thresholds

Clinical indicator	Number reduced below risk threshold
Body mass index ≥ 25 (n=67)	19
Total cholesterol level ≥ 5.5 mmol/L (n=45)	33
Total cholesterol level ≥ 4.5 mmol/L (n=80)	25
Waist-hip ratio Men > 0.90 Women > 0.80 (n = 70)	11
Waist circumference Women > 88 cm Men > 102 cm (n = 30)	10
Blood pressure (systolic) (mm Hg) ≥140 (n=26)	10

Statistically significant ($p \leq 0.05$) mean changes over 12 and 24 month were identified in a range of clinical parameters for the whole cohort, including body mass index, systolic blood pressure, total cholesterol level, waist circumference and waist hip ratio. Highly significant reductions were recorded in the latter three clinical parameters. Mean changes in clinical parameters for those participants who were considered 'at risk' in the base year were also highly statistically significant. Those at risk achieved greater mean reductions in all the five clinical parameters considered compared to the reductions of all participants. For all participants, the general health score showed a very slight, and not statistically significant, improvement.

The relatively short follow up period (24 months), however, restricts the conclusions that can be made about how long the effects of the SFF project persist. The improvements in clinical indicators achieved in Year 2 were maintained in Year 3 and, in the case of cholesterol, increased. Comments from participants suggest that the third year was important in consolidating the changes, even where it did not increase improvements.

Economic Evaluation

Program costs

Determining costs requires an understanding and capacity to estimate the resource inputs for delivering the intervention in question. The range of costs considered in the evaluation of the SFF project is listed in Table 7 below.

Table 7 Costs associated with the SFF project

Cost Category	Type of Costs Included
Project delivery costs	• Salaries and on costs • Travel and accommodation • Venue and food costs • Printing • Capital equipment
Health Service Utilisation	• Changes in GP and specialist visits during the project. • Downstream changes in utilisation

Three categories of costs were included. Firstly, project delivery costs such as salary costs, travel costs (if delivering locally), accommodation if needed overnight, venue costs, printing costs and capital costs were calculated2. Secondly, participants' costs related to cooking and exercise equipment were estimated. Thirdly, additional costs in health service utilisation were estimated.

Details on the three categories of costs are contained in Appendix A. The first, contained in Table A1, are the project delivery costs. Costs were obtained for a 26 participant workshop, and then adjusted to account for the multiple sites covered in this evaluation. Table A2 contains costs for the self-reported net changes in health service utilisation, and Table A3 contains costs for the self-reported changes in participant costs.

A summary of costs is reported below.

Table 8 SFF Project Costs Summary

	Total Cost	Average Cost Per Person (n = 97)
Project Delivery Costs	$105,468	$1,087
Health Service Utilisation	$14,153	$145
Participant Costs – Cooking equipment	$3,422	$35
Participant Costs – Exercise equipment	$18,164	$187
Total	$141,189	$1,456

The average cost per person based on resource use depends on whether we use the number of baseline participants, or those 97 participants for which we have three years of data. Given that all the self reported participant cost data was generated at the end of the program, 97 participants are considered, and the average cost per person equals $1,456.

[2] Start up costs, such as research and piloting costs, have been excluded from the analysis.

Cost-effectiveness analysis – clinical parameters and risk factors

This section considers some intermediate measures of the performance of the SFF project. Economic performance is described in terms of incremental cost-effectiveness ratios (ICER) relating to changes in clinical parameters, and cost per additional person who eliminated a risk factor over the life of the SFF project.

The costs of the program have been evenly split between the three parameters addressed in this analysis: cholesterol, blood pressure and obesity-related indicators.

The ICER per parameter point reduction is calculated as the program cost/mean parameter change. These have been calculated for all participants (reported in Table 6), and for those considered 'at risk' at the baseline (reported in Table 7). The relevant parameter point unit of measure will obviously differ, depending on which parameter is considered. For example, with regard to total cholesterol, the ICER measures the cost to achieve a 1 mmol/L reduction in total cholesterol, while the waist circumference ICER measures the cost to achieve a 1 cm reduction in waist circumference.

For example, the calculations for reductions in cholesterol are as follows:

Mean change (for 97 participants)	**Total project cost**	**A third of this cost (assuming the costs are evenly spread between the three sets of parameters)**	**Cost to achieve reduction of 1 mmol/L across all participants**
-0.7 mmol/L	$141,189	$47,063	$67,233

Using the costs estimated in section 4.3, the ICER ratios outlined in Table 9 were obtained.

Table 9 Incremental cost effectiveness ratio for all participants

		Incremental cost-effectiveness ratio based on	
Clinical Parameter	**Mean Change (all participants, n = 97)**	**A third of total project cost (assuming the costs are evenly spread between the three sets of parameters)**	**Cost to achieve a one unit reduction in the parameter across all participants.**
Cholesterol level (mmol/L)	- 0.70	$47,063	$67,233
Blood pressure – systolic (mm Hg)	- 3.39	$47,063	$13,883
Obesity-related indicators			
Body mass index	- 0.27	$47,063	$174,307
Waist-hip ratio	- 0.01	$47,063	$47,063
Waist circumference (cm)	- 1.59	$47,063	$29,599

Three of the indicators related to obesity were analysed as these have been used as predictive tools in health estimates.

Of particular interest are the changes for the participants identified as being at risk.

Table 10 Incremental cost effective ratio for participants at risk in base year

		Incremental cost-effectiveness ratio based on	
Clinical Parameter	**Mean Change (Participants at risk in base year)**	**A third of total project cost (assuming the costs are evenly spread between the three sets of parameters)**	**Cost to achieve a one unit reduction in the parameter across all at risk participants.**
Cholesterol level ≥ 5.5 mmol/L	- 1.26 (n = 45)	$47,063	$37,352
Cholesterol level ≥ 4.5 mmol/L	- 0.92 (n=80)	$47,063	$51,155
Blood pressure – systolic (mm Hg) ≥140	- 12.5 (n = 26)	$47,063	$3,765
Body mass index ≥ 25	- 0.44 (n = 67)	$47,063	$106,961
Waist-hip ratio Men > 0.90 Women > 0.80	- 0.016 (n = 70)	$47,063	$29,414
Waist circumference (cm) Women > 88 cm Men > 102 cm	- 3.17 (n = 30)	$47,063	$14,849

Two clinical parameters, total cholesterol and waist circumference, can be considered for explanatory purposes. Attributing one-third of the program cost to changes in total cholesterol, we can calculate $66,757 per mmol/L reduction in total cholesterol for all participants. Alternatively, focusing on those considered at risk (those participants with total cholesterol ≥ 5.5 mmol/L at the baseline), and attributing one-third of the program cost to changes in total cholesterol, we can calculate $37,087 per mmol/L reduction in total cholesterol.

Attributing one-third of the program cost to changes in waist circumference, we can calculate $29,390 per cm reduction in waist circumference for all participants. Alternatively, focusing on those considered at risk, and attributing one-third of the program cost to changes in waist circumference, we can calculate $14,741 per cm reduction in waist circumference.

Using the costs estimated previously, the following costs per risk factor eliminated were obtained (see Table 11).

Table 11 Preliminary cost effectiveness estimates of eliminating risk factors

		Cost per changer based on	
Risk Factor and target	**Number and percentage of people who changed**	**A third of total project cost (assuming the costs are evenly spread between the three sets of parameters)**	**Cost per changer**
Blood Pressure Systolic (mm Hg) <140	19 (20%)	$47,063	$2,477
Total cholesterol level (mmol/L) < 5.5 mmols	33 (34%)	$47,063	$1,426
Total cholesterol level (mmol/L) < 4.5 mmols	23 (24%)	$47,063	$2,046
Waist-hip ratio Men ≤ 0.90 Women ≤ 0.80	11 (11%)	$47,063	$4,278
Waist circumference Women ≤ 88 cm Men ≤ 102 cm	10 (10%)	$47,063	$4,706
Body mass index < 25	10 (10%)	$47,063	$4,706

Nineteen participants with systolic blood pressure ≥ 140 mm Hg in the base year reduced their levels to below 140mm Hg at the conclusion of the project, resulting in a cost of $2,477 per person who eliminated this particular risk factor. The 33 participants with total cholesterol equal to or greater than 5.5 mmols in the base year reduced their levels to < 5.5 mmols at the conclusion of the project, resulting in a cost of $1,426 per person who eliminated this particular risk factor. The three measures of overweight status were consistent, with 10–11 individuals eliminating this risk factor, depending upon which measure were used, resulting in a cost of $4,278–$4,706 per person who eliminated this risk factor.

It should be noted that this analysis will understate the cost effectiveness of the project by including the cost for all participants, but only the benefits for at-risk participants. There would be additional benefits for the other participants. This analysis does not represent an argument for targeting the project to 'at-risk' participant, as there can be reasons for including a broader range of participants in the project, such as encouraging participation by not stigmatising participation.

Cost-effectiveness analysis – disease incidence avoided and life years saved

In this section, the projected effect on cardiovascular disease and Type 2 diabetes resulting from the statistically significant changes in total cholesterol, systolic blood pressure and body mass index over the life of the project are estimated, and cost effectiveness ratios relating to disease incidence avoided and life years saved are developed.

Cardiovascular disease

Cardiovascular disease was responsible for almost 18% of the total disease burden in Victoria in 2001 (Victoria Department of Human Services, 2005), with ischaemic heart disease (53%) and stroke (29%) being the major contributors.

Changes in both the expected prevalence of cardiovascular disease (to capture attributable morbidity reductions) and the expected cumulative deaths attributable to cardiovascular disease (to capture the impact upon life-expectancy) as a result of participation in the SFF project were estimated, using the reported changes in total cholesterol and systolic blood pressure. The model relied on the four equations in Anderson et al (1990), derived from the Framingham Heart Study along with derived coefficients for each variable to estimate the change in the prevalence of cardiovascular disease and cardiovascular attributive deaths3. A 10-year modelling time frame is assumed. An Excel spreadsheet was prepared for this purpose4. Given that HDL cholesterol concentrations are not reported, we assume that they conform to the gender specific average (1.5 mmol/L for women, 1.2 mmol/L for men) and remained unchanged over the life of the project

The model was run separately for female non-smokers, female smokers, male non-smokers and male smokers. A weighted average of these four sub-populations was then obtained. The model was run for Year 1 and Year 3 clinical parameters, and the difference in predicted values represented the mean change in the probability of a cardiovascular event and mortality, respectively.

The model generates the cumulative probability of a cardiovascular event each year. Thus, a first cardiovascular event is interpreted as newly diagnosed cardiovascular disease and the beginning of management of the disease:

- the cumulative probability represents the prevalence of cardiovascular disease by year
- the incremental difference between the cumulative probability from year *n* to year *n+1* can be interpreted as the incidence of cardiovascular disease in year *n+1*
- the sum of the cumulative probabilities can be interpreted as the number of years of cardiovascular disease management.

Table 12 Mean change in ten-year risk of cardiovascular disease events and cardiovascular disease mortality, by baseline total cholesterol level

	All participants (n=97)	**Participants with total cholesterol above 5 mmol/L (n = 71)**	**Participants with total cholesterol 5.5 mmol/L or above (n= 45)**	**Participants with total cholesterol above 6.5 mmol/L (n=15)**
Average change in probability of cardiovascular disease event	- 2.12%	- 4.11%	- 4.75%	- 5.77%
Average change in estimated life-years over 10 years.	- 0.22%	- 0.52%	- 0.92%	- 1.2%

This method generated mortality differences that were quite modest, as expected, consistent with both the age profile of the participants and the modest changes in total cholesterol and systolic blood pressure being modelled. Of course, the changes in morbidity due to cardiovascular disease show a larger response than the changes in mortality. The change in absolute risk for both outcomes increases as baseline cholesterol levels increase.

Using the average baseline risk and changes in clinical parameters experienced by all participants, on average each participant faces a 2.12% reduction in the chance of having a cardiovascular disease event in the following 10 years, while each participant gains 0.22% of a life year over 10 years due to lower probability of cardiovascular disease related mortality, which is approximately 17 additional

[3] See Appendix B. The coefficients have been reviewed in the literature, and the results are mixed. For instance Liao et al., 1999 confirmed their relevance to the USA, but both Brindle et al., 2003 and Cappuccio et al., 2002 found that the absolute risk of coronary heart disease from these equations are overestimated in the USA.

[4] See Appendix D. An electronic version is available to assist with future SFF modelling, both at a participant and project level.

hours. Using the average baseline risk and changes in the clinical parameters experienced by participants with total cholesterol above 5.5 mmols in Year 1, on average each participant in that subgroup faces a 4.75% reduction in the chance of having a cardiovascular disease event in the following 10 years, and gains 0.92% of a life year, which is approximately 3 days and 8 hours. Using the costs estimated in section 4.3 and the mean changes contained Table 9, we can calculate the cost per cardiovascular event and mortality avoided. The results are reported in tables 11 and 12, respectively.

Table 13 Cost effectiveness of SFF in reducing the risk of CVD events over 10 years

Participants	Average change in probability of a CVD event	Total change in number of CVD events	Cost per CVD event avoided, total cost attributed to CVD	Cost per CVD event avoided, one-half of total cost attributed to CVD
All participants (n = 97)	- 2.12%	-2.06	$68,052	$34,026
Participants with total cholesterol above 5 mmol/L (n = 71)	- 4.11%	- 2.92	$48,009	$24,004
Participants with total cholesterol 5.5 mmol/L or above (n = 45)	- 4.75%	- 2.14	$65,509	$32,755
Participants with total cholesterol above 6.5 mmol/L (n = 15)	- 5.77%	- 0.87	$209,237	$104,619

Using the average baseline risk and changes of clinical parameters experienced by all participants, it is estimated that over 10 years, two cardiovascular disease events will be avoided as a result of involvement in the SFF project5. Using average baseline risk and changes in clinical parameters experienced by those participants with total cholesterol above 5 mmols in the base year, almost three cardiovascular events will be avoided as a result of their involvement in the SFF project.

Depending upon which subgroup is considered, the cost per cardiovascular disease event avoided ranges from $24,004 to $104,619, assuming that one-half of total project costs are attributed to reducing cardiovascular disease (the other half being attributed to reducing diabetes). For example, if we consider the at risk subgroup (total cholesterol equal to or greater than 5.5 mmols), the cost per cardiovascular disease event avoided is $32,755.

Table 14 Cost effectiveness of SFF in terms of life years saved

Participants	Mean change in estimated life years over 10 years	Total change in estimated life years over 10 years	Cost per life-year gained, total cost attributed to CVD	Cost per life year gained, one-half of total cost attributed to CVD
All participants (n = 97)	- 0.22%	- 0.21	$618,164	$309,082
Participants with total cholesterol above 5 mmol/L (n = 71)	- 0.52%	- 0.37	$379,710	$189,855
Participants with total cholesterol 5.5 mmol/L or above (n = 45)	- 0.92%	- 0.41	$338,620	$169,310
Participants with total cholesterol above 6.5 mmol/L (n = 15)	- 1.2%	- 0.18	$934,593	$467,297

[5] Calculated by multiplying the average change in probability of an event by the number of participants.

Consistent with the modest mortality differences, the cost per cardiovascular disease death avoided is significantly higher than the cost per cardiovascular disease event avoided. Taking the at risk subgroup (total cholesterol equal to or greater than 5.5 mmols), the SFF project generated an estimated incremental gain of 41.4% of a life year, and the cost per life year gained is $169,310, assuming that one-half of total project costs are attributed to cardiovascular disease.

Type 2 diabetes mellitus

Type 2 diabetes is the second leading cause of disease burden in males and sixth in females in Victoria (Victorian Government Department of Human Services, 2005). When the attributable burden is taken into account (diabetes increases the risk of cardiovascular disease conditions, such as ischaemic heart disease, stroke and peripheral vascular disease) diabetes is the top ranked cause of disease burden in both men and women.

Using the diabetes risk score of Griffin et al (2002)6, changes in BMI were used to predict changes in participant risk of Type 2 diabetes for SFF project participants. The model was run separately for female non-smokers, female smokers, female former smokers, male non-smokers, male smokers and male former smokers. A weighted average of these six sub-populations was then obtained.

The model was run separately for Year 1 and Year 3 clinical parameters and the difference in predicted values represents the mean change in the probability of an individual developing Type 2 diabetes over the period of the project.

Table 15 Cost effectiveness of SFF in reducing the risk of Type 2 diabetes

Participants	Mean change in probability of Type 2 diabetes	Total change in cases of Type 2 diabetes	Type 2 diabetes avoided, total cost attributed to diabetes	Type 2 diabetes avoided, one-half of total cost attributed to diabetes
All participants (n = 97)	0%	0	-	-
Participants with body mass index ≥ 25 (n=67)	12%	8.04	$17,436	$8,718

The model was run for various subgroups, based on participants' BMI. Relatively low baseline risk and mean changes in BMI for all participants did not allow the model to generate changes in the probability of Type 2 diabetes. Taking the at risk subgroup, with BMI ≥ 25, 8 cases of Type 2 diabetes were avoided. The cost per case of Type 2 diabetes avoided equals $8,7187.

Cost-utility analysis

Overview

Using the estimates from the section above, 'Cost-effectiveness analysis – disease incidence avoided and life years saved', disease specific mortality and morbidity avoided are now expressed in terms of the gain in participants' quality adjusted life years (QALYs). This provides a measure of life years saved, adjusted for the health and other conditions of that life. A Quality Adjusted Life Year is a measure of the additional length of life produced by health interventions, adjusted for the quality of life. Perfect health is rated as 1; death is rated as zero; different health states are rated with reference to these – usually some number between 0 and 1 but a negative score for health states considered to be worse than death. QALYs can be added and compared – so that an intervention that leads to 10 extra years of life rated as 0.5 in quality would produce a total outcome of 5 QALYs. These index numbers, reflecting the utility or strength of preference for various health states, have been sourced from the literature.

[6] See Appendix C. An Excel spreadsheet has been provided to assist with future SFF modelling. See Appendix E.
[7] Calculated by dividing total project costs by the eight cases avoided.

By summing the QALYs gained as a result in the reduction in CVD and Type 2 diabetes, the incremental gains in QALYs as a result of the SFF project can then be estimated.

Cardiovascular disease

Total QALYs were estimated as the sum of years alive and without cardiovascular disease, as a result of both improvements in mortality and morbidity, plus years as survivors with cardiovascular disease. The quality adjustment index numbers for these two different health states were taken from Tengs and Wallace (2000)8. In order to explicitly compare QALYs that are gained at different points in time, future QALYs are 'factored down' or 'discounted' so that they can be expressed in present values. Total QALYs, both undiscounted and discounted at 5% per annum, are shown in Table 16.

Table 16 Estimated QALYs gained over 10 years – cardio-vascular disease

Participants	Undiscounted QALYs gained over 10 years	Discounted QALYs gained over 10 years
All participants (n = 97)	0.74	0.57
Participants with total cholesterol above 5 mmol/L (n = 71)	0.89	0.69
Participants with total cholesterol 5.5 mmol/L or above (n = 45)	0.77	0.59
Participants with total cholesterol above 6.5 mmol/L (n = 15)	0.26	0.20

It is interesting to compare these gains in QALY with the modest increases in life years gained that were set out in the previous section. This makes clear the importance of including the impacts upon quality of life from morbidity, and not just the extension of life.

Over 10 years, the incremental gain in QALYs from the SFF program for all participants as a result of cardiovascular disease avoided is 0.74 undiscounted (0.57 discounted), while for those participants with total cholesterol above 5 mmols the incremental gain in undiscounted QALYs is 0.89, (0.69 in discounted QALYs). For participants at risk, the predicted mean change was much greater than for the whole group, resulting in the larger absolute estimate of QALYs gained.

Using the total project cost data, the estimated cost per QALY gained can be calculated. The results will depend upon the attribution of costs, and are reported in Table 17.

Table 17 Estimated cost per QALY gained – cardiovascular disease

Participants	Cost per QALY gained, total cost attributed to CVD	Cost per QALY, one-half of total cost attributed to CVD	Cost per QALY, one-quarter of total cost attributed to CVD
All participants (n = 97)			
Undiscounted QALYs	$190,795	$95,398	$47,699
Discounted QALYs	$247,700	$123,850	$61,925
Participants with total cholesterol above 5 mmol/L (n = 71)			
Undiscounted QALYs	$158,639	$79,319	$39,659
Discounted QALYs	$204,622	$102,311	$51,155
Participants with total cholesterol equal to or above 5.5 mmol/L (n = 45)			
Undiscounted QALYs	$183,362	$91,681	$45,841
Discounted QALYs	$239,303	$119,652	$59,826

[8] As deaths due to CVD events are a subset of CVD events, we deduct 'years of death' from years in which CVD events occurred.

Participants	Cost per QALY gained, total cost attributed to CVD	Cost per QALY, one-half of total cost attributed to CVD	Cost per QALY, one-quarter of total cost attributed to CVD
Participants with total cholesterol above 6.5 mmol/L (n = 15)			
Undiscounted QALYs	$543,035	$271,157	$135,759
Discounted QALYs	$705,945	$352,973	$176,486

Allocating half of total project costs to the reduction in the incidence of cardiovascular disease (the other half being allocated to diabetes reduction) the cost per undiscounted QALY gained is $95,398 ($123,850 per discounted QALY) for all participants and $79,319 per undiscounted QALY ($102,311 per discounted QALY) for participants with total cholesterol above 5 mmols.

Allocating one quarter of the total projects costs to the reduction in the incidence of cardiovascular disease (the rest being allocated to diabetes and to other outcomes such as reduced accidents and cancer), cost per undiscounted QALY gained equals $39,659 ($51,155 per discounted QALY) for this latter subgroup

Type 2 diabetes mellitus

We can also estimate the incremental gain in participants' quality adjusted life years as a result of Type 2 diabetes mellitus avoided. Taking the eight cases of Type 2 diabetes avoided by project participants per year predicted by the model, and assuming that the changes in BMI achieved are maintained for ten years, the SFF project generates 80 Type 2 diabetes-free life years. Using the DiabCost (Colagiuri et al, 2003) data on complication prevalence and quality of life, the undiscounted incremental gain in QALYs over 10 years as a result of the SFF project equals 4.72. Using a 5% rate of discount, total QALYs over 10 years equal 3.64. Results for cost per incremental QALY gained are reported in Table 18.

Table 18 Estimated cost per QALY gained – Type 2 diabetes

Participants with body mass index ≥ 25 (n=67)	Cost per QALY gained, total cost attributed to diabetes	Cost per QALY, one-half of total cost attributed to diabetes	Cost per QALY, one-quarter of total cost attributed to diabetes
Undiscounted QALYs	$29,912	$14,956	$7,478
Discounted QALYs	$38,787	$19,393	$9,397

Where half of the project costs are allocated to the reduced incidence of Type 2 diabetes, the cost per QALY gained as a result of predicted reduced incidence of Type 2 diabetes amongst SFF project participants is $14, 956 undiscounted and $19,393 discounted.

If instead one quarter of total project costs are allocated to the incremental gain in QALYs flowing from the reduction in the incidence of diabetes, cost per QALY gained is $7,478 undiscounted and $9,397 discounted.

Total QALYs Gained

By summing the QALYs gained as a result in the reduction in cardiovascular disease and Type 2 diabetes, the incremental gains in undiscounted QALYs over 10 years as a result of the SFF project sum to 5.619, while the gain in discounted QALYs equals 4.33. Cost per QALY depends upon assumptions regarding subgroup and attribution of costs, and is presented in Table 19 below.

[9] The sum of the 4.72 gain from the reduction in the incidence of diabetes and the 0.89 gain from the reduction in the incidence of cardiovascular disease.

Table 19 Estimate cost per QALY gained- cardiovascular disease (participants with total cholesterol > 5 mmol/L, n = 71) and Type 2 diabetes (participants with BMI ≥ 25, n = 67)

	Cost per QALY gained, total cost attributed to CVD and diabetes	Cost per QALY, one-half of total cost attributed to CVD and diabetes	Cost per QALY, one-quarter of total cost attributed to CVD and diabetes
Undiscounted	$29,912	$14,956	$7,478
Discounted	$32,607	$16,304	$8,152

If half of the total costs of the SFF project are allocated to reduced incidence of cardiovascular disease and Type 2 diabetes, the cost per undiscounted QALY gained is $14,956, and $16,304 per discounted QALY gained. If instead one quarter of the total costs of the SFF project are allocated to these outcomes, the cost per undiscounted QALY gained is $7,478, and $8,152 per discounted QALY gained.

A thorough search of the literature was unable to find comparable rural health risk factor projects for comparison, particularly where QALYs gained were reported. Drugs, however, are typically listed in the Pharmaceutical Benefits Scheme where cost per QALY is less than $40,000 (George et al, 2000). On this basis, regardless of the assumptions about cost allocation, the cost per QALY gained in the SFF project overall passes this performance threshold.

It should be noted that under all cost allocation assumptions10, the estimated contribution of the SFF project to the reduction in the incidence of diabetes alone would enable the project to fall well within this acceptable cost per QALY range.

In contrast, the estimated contribution of the SFF project to the reduction in the incidence of cardiovascular disease on its own would allow the SFF project to pass this performance threshold only under very specific assumptions (where baseline risk and clinical parameter changes of those participants above 5 mmols are considered, with an assumption of one quarter cost allocation, and where incremental QALYs gained over 10 years are undiscounted)11.

Downstream cost savings

Changes in downstream health service use resulting from a change in the incidence of Type 2 diabetes and cardiovascular disease can also be expected beyond the lifetime of the SFF project. A review of the literature has provided estimates of cost savings to government that can be applied to the SFF project.

Downstream cardiovascular disease management cost savings

Some insights into the cost of managing a person with cardiovascular disease can be derived from the literature. Mathers and Penm (1995) reported cardiovascular disease health care costs for Australia in 1993–4. From Appendix C of their publication, the direct health care costs per patient with cardiovascular disease can be derived at approximately $811 per anum, or approximately $1,090 per patient per year in 2003 prices.

[10] There are, of course, a number of reasons to assume that total project costs should not be allocated solely to changes in the predicted incidence of CVD and diabetes, the most of important of which is that the SFF project has generated more reported outcomes than changes in the expected incidence of CVD and Type 2 diabetes, such as those related to farm safety and cancer.

[11] Exploratory estimations, using a 15-year rather than a 10-year time horizon, generated more significant reductions in the incidence of CVD. There results were not reported, however, as the Anderson et al equations were based on 10 years of data. Furthermore, the predicted reduction in the incidence of Type 2 diabetes, itself a risk factor for CVD, was not included in the modelling in section 5.3.1, resulting in a potential understatement of the SFF project's contribution to reducing the incidence of CVD.

Downstream management costs avoided were calculated by multiplying the predicted number of patients each year with a cardiovascular disease event by the $1,090 cost of management. Cost savings are extremely modest, in line with the modest change in predicted cardiovascular disease events. Undiscounted, the cost savings over 10 years based on baseline risk and clinical parameter changes for all participants equals $2,235, and $3,172 for those with total cholesterol above 5 mmols. Discounted at 5%, the cost savings are $1,725 and $2,449 respectively.

Downstream Type 2 diabetes management cost savings

Two sources of data were used to estimate the downstream Type 2 diabetes costs savings.

The DiabCost study (Colagiuri et al 2003) estimates the average cost of treating a person with Type 2 diabetes is $5,325 per annum. Hospitalisation, outpatient/primary care/specialist care and medications each accounted for approximately 30% of total health care costs, with consumables such as insulin administering equipment and blood glucose testing accounting for 10%. Insulin (3%) and oral hypoglycaemic agents (4%) accounted for only 21% of the total costs of medication, with the majority of medication costs coming from non-diabetes medication such as lipid lowering and blood pressure lowering agents, non-steroidal anti-inflammatory drugs and anti-depressant agents.

As people in 'normal' health still use health care for a range of conditions and illnesses unrelated to diabetes, these costs require adjustment. The Australian Institute of Health and Welfare have estimated the average health care cost per person in Australia to be $2,817 per annum (AIHW, 2002). Thus the incremental cost attributable to Type 2 diabetes may be considered the difference between these two figures, or $2,508 per patient per annum.

Mathers and Penm (1995) reported diabetes related health care costs for Australia in 1993-4. The estimate average annual health system cost was $1,925. In 2003 dollars, this is approximately $2,587. While estimates based on Colagiuri et al (2003) and Mathers and Penm (1995) provide very similar management costs, the costs contained in Colagiuri et al were used, as they are more likely to accurately reflect recent treatment practice.

Total downstream cost savings

Given the predicted number of years free of Type 2 diabetes, then, assuming a discount rate of 5%, the SFF project results in a net cost saving of $154,929, or $1,597 person12 over ten years. This exceeds the total costs of the SFF service delivery.

Overview of results

Statistically significant ($p \leq 0.05$) mean changes over 12 and 24 month were identified in a range of clinical parameters for all participants in the Sustainable Farm Families project, including body mass index, systolic blood pressure, total cholesterol level, waist circumference and waist hip ratio. Importantly, initial improvements in clinical parameters were maintained over the duration of the project. These sustained changes were used to predict changes in participant risk of cardiovascular disease and Type 2 diabetes mellitus.

A three-stage cost-effectiveness analysis was used based on calculated project costs. Costs per parameter change in clinical indicator were calculated. Costs per risk factor eliminated ranged from $1,426 (total cholesterol) to $4,706 (weight).

Using the mean changes in clinical parameters experienced by subgroups considered to be 'at risk', the cost per cardiovascular disease event avoided over 10 years was calculated at $32,755, the cost per CVD death avoided at $189,855, and the cost per case of Type 2 diabetes avoided at $8,718.

Over 10 years, the incremental gain in discounted QALYs from the SFF program for all participants as a result of cardiovascular disease avoided is 0.57, while for those participants with total cholesterol

[12] Based on the 97 participants for which complete data is available.

above 5 mmols the incremental gain in discounted QALYs is 0.69. The incremental gain in discounted QALYs from the SFF program due to the reduced incidence of Type 2 diabetes for participants with a BMI greater than or equal to 25 is 3.64. The total gain in discounted QALYs over 10 years as a result of the SFF project is therefore calculated to be 4.33.

If half of the total costs of the SFF project are allocated to these outcomes, the cost per discounted QALY gained is $16,304. If one quarter of the total costs of the SFF project are allocated to these outcomes, the cost per discounted QALY gained is $8,152. The SFF project therefore achieves the $40,000 per QALY acceptability threshold (used for decisions about pharmaceutical benefit support), largely due to its contribution to reduced incidence of Type 2 diabetes.

These cost per QALY figures do not include downstream cost savings, and are therefore somewhat overstated. Cost savings from the predicted reduced incidence of Type 2 diabetes over 10 years is estimated at $154,929, which exceeds the total cost of the SFF project itself.

This suggests that the SFF project generates net cost savings to government. This may understate the cost savings, as it does not include:

- additional cost savings to other parties due to morbidity and mortality avoided
- potential additional cost savings from improvements in other health outcomes of participants, including farm safety
- potential additional cost savings in health outcomes for participants' families.

Implications

This report provides evidence of sustained reductions in a range of clinical parameters of health for all participants in the Sustainable Farm Families project and for those participants considered at risk, as well as the elimination of risk factors that contribute to cardiovascular disease and Type 2 diabetes. One interpretation of the results is that participants' dietary and exercise behaviour were changed sufficiently and retained long enough to induce clinical changes. While the research design did not include a control group or comparison group, evidence to support the contribution of the Sustainable Farm Families project to measured improvements in clinical indicators comes from the reported behaviour changes and the absence of convincing alternative explanations for these changes. This is an important finding in itself. The longer the duration of changes in physical activity and dietary behaviour, the more likely are interventions such as the SFF project to yield significant or substantial health gains and downstream benefits.

The Sustainable Farm Families project achieved the $40,000 per QALY acceptability threshold utilised by the Australian Government for drugs on the Pharmaceutical Benefit Scheme (PBS), and generated net cost savings to government. On the basis of these two measures, the SFF project generated sufficient benefits to society and cost savings to government for it to be considered a worthwhile project. Of course, we recognise that in making decisions about resource allocation, criteria other than achieving cost effectiveness might be considered, particularly if there is a concern regarding distributional issues related to disparities in health outcomes between individuals in rural and remote areas and urban areas.

The evaluation results were based on the assumptions that changes in participants' health related behaviours would be maintained for 10 years, and that one half of project projects are attributed to changes in the incidence of Type 2 diabetes and cardiovascular disease. There is, however, no evidence about how long the observed changes in the participants' clinical indicators would be maintained beyond the life of the project. Cost-effectiveness of the SFF project will be responsive to the duration of behavioural change, as well as to the proportion of project costs that are attributed to these outcomes.

It should be noted that the cost-effectiveness of the SFF project would still be maintained provided that behavioural changes persist for five years. Assuming full attribution of project costs to changes in the incidence of Type 2 diabetes and cardiovascular disease would also see cost-effectiveness maintained if behavioural changes persist for 10 years.

Next steps

The report is intended to both inform future decision-making about the Sustainable Farm Families project, and to provide a methodology that can be used to evaluate future similar projects, including the implementation of the SFF project across new locations. By entering changes in clinical parameters, the spreadsheets developed as part of this evaluation can also assist to monitor participant level changes in the risk of Type 2 diabetes and cardiovascular disease over the life of their involvement in the project.

Recommendations

Based on the findings of this report, it is recommended that:

- Projects such as the Sustainable Farming Families project be continued and extended.
- The methodology developed in this project be developed further and used to evaluate similar projects.
- Further investigation of other health outcomes of the SFF should be documented and analysed.
- Participants should be reassessed in five years to determine whether improvements in clinical indicators have been maintained and possibly to gather evidence about morbidity and mortality.

Appendix A Cost analysis

	26 participant workshop	Adjusted – Total project costs
Salaries and on costs		
Medical Staff		
Year 1		
2 x Staff time - 5 days full cost recovery… Grade 4 nurses	$3,284	$13,136
1 x staff member 3 days full cost recovery	$ 985	$3,940
Year 2		
2 x Staff time - 4 days full cost recovery… Grade 4 nurses	$2,627	$10,508
1 x staff member 2 days full cost recovery	$ 657	$2628
Year 3		
2 x Staff time - 4 days full cost recovery… Grade 4 nurses	$2,627	$10,508
1 x staff member 2 days full cost recovery	$ 657	$$2628
Administration		
Recruitment, administrative support and health record/mailing/ system support personnel, networking. Newsletters, printing by 4 mail outs		
Year 1 - 7 days	$1,978	$7948
Year 2 - 4 days	$1,130	$4520
Year 3 - 4 days	$1,130	$4520
Data analysis		
Evaluation, data entry and statistical analysis by Biometrician		
Year 1 - 6 working days	$1,800	$7200
Year 2 - 4 working days	$1,200	$4800
Year 3 - 4 working days	$1,200	$4800
Travel and accommodation		
Year 1 - Accommodation etc for 3 staff for 3 nights @150.00	$1,350	$5400
Year 2 - Accommodation for 3 staff 1 night	$ 450	$1800
Year 3 - Accommodation for 3 staff 1 night	$ 450	$1800
Venue and Food Costs		
Year 1 - Food costing $45 per person for year one ($26 day one $19 day two)	$1,170	$4680
Year 2 - $25 per person for year two (one large day workshop only)	$650	$2600
Year 1 & 2- Venue costing Average $250 per day by three days	$750	$3000
Manuals		
Manual production (26 manuals at $45 per manual)	$1,170	$4680

Capital (equipment)		
Medical equipment testing $250 per annum Set up kits ($2500.00) (one off) Computer, phone data projector, etc	$7,000	$7000
Sub-total	**$32,265**	**$105, 468**

Table A2. Cost of net changes in participant costs

Cooking Equipment	
Health Grills 12 X $89.95	$1079
Cookbooks. 30 X $39.95	$1199
Juicer: 3 X $149.95	$450
Steamer. 7 X $45	$315
Wok: 8 X $25	$200
Mixmaster: 1 X $179	$179
Sub-total	$3,422
Exercise Equipment	
Exercise Balls 5 X $25	$125
Rowing Machine: 6 X $219	$1314
Cycling Bike 14 X $159	$2226
Shoes 20 X $119	$2380
Walking Machine: 5 X $1499	$7495
Exercise Bike 12 X $299	$3588
Weights: 3 X $75	$225
Tennis Racket 2 X $49	$98
Exercise Mats. 2 X $50	$100
Golf Clubs 2 X $299	$598
Stretchy Band X 1	$0
Skipping Rope X 2	$0
Gym Membership X 1	$0
Swimming pool fees X 1	negligible negligible negligible negligible
Sub-total	$18,146

Table A3. Cost of net changes in service utilisation

GP visits	
204 X $31.45 (level B, MBS)[13]	$6,415.80
Specialist Visits	
Initial consultation 66 X $74.05	$4,887.30
Subsequent Attendance 50 X 37.15	$1,850
Sub-total	$14,153

[13] While in some circumstances a Level C costing would have been appropriate, it was decided to use the lower Level B costing due to the potential overstatement by respondents of the impact of the SFF project on their ambulatory health care utilisation.

Appendix B Model for projecting morbidity and mortality associated with cardiovascular disease

Parameters:
(1) gender
(2) age as LN(age) and LN(age)^2
(3) systolic blood pressure, as natural logarithm, based on average of 2 values
(4) diastolic blood pressure, as natural logarithm, based on average of 2 values
(5) cigarette smoking (current or quit in last year)
(6) ratio of serum total cholesterol divided by HDL cholesterol, as natural logarithm
(7) diabetes mellitus
(8) left ventricular hypertrophy on ECG

Composite parameters:
(1) LN(age) and gender
(2) LN(age)^2 and gender
(3) diabetes and gender
(4) left ventricular hypertrophy and gender

Parameter	**Finding**	**Points**
gender	male	0
	female	1
age in years		LN(age in years)
		LN(age)^2
systolic blood pressure		LN(SBP)
diastolic blood pressure		LN(DBP)
cigarette smoking	no	0
	yes	1
ratio total cholesterol to HDL cholesterol		LN(ratio)
diabetes mellitus	absent	0
	present	1
left ventricular hypertrophy	absent	0
	present	1
age and gender	male	0
	female	LN(age)
LN(age)^2 and gender	male	0
	female	LN(age)^2
diabetes and gender	male	0
	female and nondiabetic	0
	female and diabetic	1
LVH and gender	female	0
	male and no LVH	0
	male and LVH	1

Outcomes:
(1) coronary heart disease (CHD)
(2) acute myocardial infarction
(3) death from coronary heart disease
(4) stroke
(5) cardiovascular disease (CVD = coronary artery disease, AMI, stroke, peripheral vascular disease and congestive heart failure)
(6) death from cardiovascular disease

W for coronary heart disease using systolic blood pressure =
= (28.4441 * (points for gender)) (1.4792 * LN(age)) (14.4588 * (points for LN(age) and gender)) + (1.8515 * (points for LN(age) squared and gender)) (0.9119 * LN(SBP)) (0.2767 * (points for cigarette smoking)) (0.7181 * (points for cholesterol ratio)) (0.1759 * (points for diabetes)) (0.1999 * (points for diabetes and gender)) (0.5865 * (points for LVH)) + 15.5305

W for AMI using systolic blood pressure =
= (10.5109 * (points for gender)) (0.7965 * LN(age)) (5.4216 * (points for LN(age) and gender)) + (0.7101 * (points for LN(age) squared and gender)) (0.6623 * LN(SBP)) (0.2675 * (points for cigarette smoking)) (0.4277 * (points for cholesterol ratio)) (0.1534 * (points for diabetes)) (0.1165 * (points for diabetes and gender)) (0.1588 * (points for LVH and male)) + 11.4712

W for death from coronary heart disease using systolic blood pressure =
= (0.2332 * (points for gender)) (0.9440 * LN(age)) (0.5880 * LN(SBP)) (0.1367 * (points for cigarette smoking)) (0.3448 * (points for cholesterol ratio)) (0.0474 * (points for diabetes)) (0.2233 * (points for diabetes and gender)) (0.1237 * (points for LVH)) + 11.2889

W for stroke using systolic blood pressure =
= (0.2019* (points for gender)) (2.3741 * LN(age)) (2.4643 * LN(SBP)) (0.3914 * (points for cigarette smoking)) (0.0229 * (points for cholesterol ratio)) (0.3087 * (points for diabetes)) (0.2627 * (points for diabetes and gender)) (0.2355 * (points for LVH)) + 26.5116

W for cardiovascular disease using systolic blood pressure =
= (-1.2146 * (points for gender)) (1.8443 * LN(age)) + (0.3668 * (points for LN(age) and gender)) (1.4032 * LN(SBP)) (0.3899 * (points for cigarette smoking)) (0.5390 * (points for cholesterol ratio)) (0.3036 * (points for diabetes)) (0.1697 * (points for diabetes and gender)) (0.3362 * (points for LVH)) + 18.8144

W for death from cardiovascular disease using systolic blood pressure =
= (0.2243 * (points for gender)) + (8.2370 * LN(age)) (1.2109 * $LN(age)^2$) (0.8383 * LN(SBP)) (0.1618 * (points for cigarette smoking)) (0.3493 * (points for cholesterol ratio)) (0.0833 * (points for diabetes)) (0.2067 * (points for diabetes and gender)) (0.2946 * (points for LVH)) 5.0385

W for coronary heart disease using diastolic blood pressure =
= (32.4811 * (points for gender)) (1.6346 * LN(age)) (16.4933 * (points for LN(age) and gender)) + (2.1059 * (points for LN(age) squared and gender)) (0.8670 * LN(DBP)) (0.2789 * (points for cigarette smoking)) (0.7142 * (points for cholesterol ratio)) (0.2082 * (points for diabetes)) (0.1973 * (points for diabetes and gender)) (0.7195 * (points for LVH)) + 15.5222

W for AMI using diastolic blood pressure =
= (5.1559 * (points for gender)) (0.9302 * LN(age)) (2.6310 * (points for LN(age) and gender)) + (0.3472 * (points for LN(age) squared and gender)) (0.5132 * LN(DBP)) (0.2721 * (points for cigarette smoking)) - (0.4228 * (points for cholesterol ratio)) (0.1764 * (points for diabetes)) (0.1184 * (points for diabetes and gender)) (0.1702 * (points for LVH and male)) + 11.0436

W for death from coronary heart disease using diastolic blood pressure =
= (0.2619 * (points for gender)) (1.3025 * LN(age)) (0.4762 * LN(DBP)) (0.1553 * (points for cigarette smoking)) (0.4056 * (points for cholesterol ratio)) (0.0860 * (points for diabetes)) (0.2539 * (points for diabetes and gender)) (0.1591 * (points for LVH)) + 12.0963

W for stroke using diastolic blood pressure =
= (0.1558 * (points for gender)) (3.0997 * LN(age)) (1.7556 * LN(DBP)) (0.3975 * (points for cigarette smoking)) + (0.0297 * (points for cholesterol ratio)) (0.4047 * (points for diabetes)) (0.2506 * (points for diabetes and gender)) (0.2801 * (points for LVH))+ 25.1067

W for cardiovascular disease using diastolic blood pressure =
= (-0.8019 * (points for gender)) (2.1231 * LN(age)) + (0.2584 * (points for LN(age) and gender)) (1.0117* LN(DBP)) (0.3900 * (points for cigarette smoking)) (0.5365 * (points for cholesterol ratio)) (0.3575 * (points for diabetes)) (0.1661 * (points for diabetes and gender)) (0.3847 * (points for LVH)) + 17.5392

W for death from cardiovascular disease using diastolic blood pressure =
= (0.2102 * (points for gender)) + (9.5223 * LN(age)) (1.3999 * (LN(age)^2) (0.5073 * LN(DBP)) (0.1548 * (points for cigarette smoking)) (0.3423 * (points for cholesterol ratio)) (0.1178 * (points for diabetes)) (0.1982 * (points for diabetes and gender)) (0.3181 * (points for LVH)) 9.0211

X = (factor 1) + ((factor 2) * W)

Systolic Equations	**Factor 1**	**Factor 2**
coronary heart disease	0.9145	-0.2784
acute MI	3.4064	-0.8584
death from coronary HD	2.9851	-0.9142
Stroke	-0.4312	0
cardiovascular disease	0.6536	-0.2402
death from CVD	0.8207	-0.4346

Diastolic Equations	Factor 1	Factor 2
coronary heart disease	0.9341	-0.2825
acute MI	3.4587	-0.8647
death from coronary HD	2.1249	-0.6860
Stroke	-0.4212	0
cardiovascular disease	0.6761	-0.2421
death from CVD)	0.9076	-0.4528

Y = EXP(X)

Z = (LN(specified interval in years) W) / Y

probability of outcome in specified years = 1 EXP((-1) * EXP(Z)

Source: Anderson KM, Odell PM, *et al*. Cardiovascular disease risk profiles. Am Heart J. 121: 293-298, 1990.

Appendix C Model for projecting morbidity associated with type 2 diabetes

Parameters:
(1) gender
(2) antihypertensive medication
(3) corticosteroid therapy
(4) age in years
(5) body mass index (BMI)
(6) relatives with diabetes mellitus
(7) smoking history

Parameter	**Finding**	**Point**
Gender	male	0
	female	-0.879
antihypertensive medication	not prescribed	0
	prescribed	1.222
corticosteroid therapy	not prescribed	0
	prescribed	2.191
age in years		(years) * 0.063
body mass index	< 25	0
	>= 25 and < 27.5	0.699
	>= 27.5 and < 30	1.97
	>= 30	2.518
relatives with diabetes mellitus	none	0
	parent or sibling	0.728
	parent and sibling	0.753
smoking history	never smoked	0
	former smoker	-0.218
	current smoker	0.855

from Table 3, page 167

X =SUM(points for the 7 parameters) - 6.322

probability of Type 2 diabetes =1 / (1 + EXP((-1) * X))

Source: Griffin SJ, Little PS, et al. Diabetes risk score: towards earlier detection of Type 2 diabetes in general practice. Diabetes Metabolism Research and Reviews. 16: 164-171, 2002.

Appendix D Calculation tool for cardiovascular disease model

Purpose: To estimate a person's risk for cardiovascular disease within a number of years using the equations of Anderson *et al* based on the Framingham Study (1990)

Conversion	**Enter**			
Total cholesterol in mmol/L		mmol/L equals	0	mg/dL

data	**enter**	
Are you evaluating a person's risk for cardiovascular disease? (Y or N)		enter Y or N
gender of the person (enter M or F)		enter M or F
age of the person in years		years of age
systolic blood pressure reading #1		mm Hg
systolic blood pressure reading #2		mm Hg
diastolic blood pressure reading #1		mm Hg
diastolic blood pressure reading #2		mm Hg
Does the person smoke cigarettes? (Y or N)		enter Y or N
total serum cholesterol in mg/dL		mg/dL
HDL cholesterol in mg/dL		mg/dL
Does the person have diabetes mellitus? (Y or N)		enter Y or N
Does the person have left ventricular hypertrophy on ECG? (Y or N)		enter Y or N
Risk calculated over how many years?		years

calculate	**result**
data complete?	
evaluation appropriate?	
probability of outcome in the next	**years**
coronary heart disease (using SBP)	
coronary heart disease (using DBP)	
AMI (using SBP)	
AMI (using DBP)	
death from CHD (using SBP)	
death from CHD (using DBP)	
stroke (using SBP)	
stroke (using DBP)	
cardiovascular disease (using SBP)	
cardiovascular disease (using DBP)	
death from CVD (using SBP)	
death from CVD (using DBP)	

Appendix E Calculation tool for Type 2 diabetes model

Purpose: To evaluate a person for risk of Type 2 diabetes mellitus using the diabetes risk score of Griffin *et al* (2002)

Data	**enter**		
Gender of the person (enter M or F)		enter M or F	
Age of the person in years		years of age	
Body weight in kilograms		kilograms	
Body height in meters		meters	
Has the person been prescribed anti-hypertensive medications? (Y or N)		enter Y or N	
Is the person being treated with corticosteroids? (Y or N)		enter Y or N	
Does the person have a parent with diabetes mellitus? (Y or N)		enter Y or N	
Does the person have a sibling with diabetes mellitus? (Y or N)		enter Y or N	

enter an "x" in the appropriate column to indicate the person's smoking history (give only 1 answer)			
	never smoked	former smoker	current smoker
Smoking history			

Calculate	**result**	
Data complete?		
Body mass index (BMI)		kilograms per meter squared
Value of X		
Probability that the person has Type 2 diabetes		

Glossary

Benefits. Benefits can be understood in terms of: achievement of a specific short-term or long-term outcome, such as specific reductions in clinical indicators; achievement of outcomes expressed in terms of quality adjusted life years (QALYs) gained; achievement of outcomes expressed in monetary terms; and savings due to expenses avoided due to avoiding negative outcomes.

Cost-effectiveness analysis. The relationship between program costs and a specific short-term or long-term outcome.

Cost-utility analysis. The relationship between costs and outcome expressed in terms of quality adjusted life years (QALYs).

Cost-saving analysis. The measurement of net fiscal savings as a result of a program.

Costs. Costs can be understood in terms of: financial values of the resources used, including money, in-kind support, and time; foregone opportunities in not using these resources for other purposes; and a combination of the resources used and any negative outcomes.

Quality adjusted life year (QALY). QALYs are a metric obtained by multiplying the number of calendar years of life by an index number that reflects the utility or strength of preference for the health state of the person involved.

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