Western Cape Burden of Disease Reduction Project

Volume 6 of 7

Decreasing the Burden of Cardiovascular Disease

Final Report 2007

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Contents

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Executive Summary

Volume 6 of this Report is concerned with interventions to reduce the burden of cardio-vascular disease (CVD) in the Western Cape Province (WC) of South Africa. This is important because CVD is the leading cause of death among both men and women in the Western Cape Province, accounting for one in four deaths (25%); followed by malignant neoplasms (16%); infectious and parasitic diseases (excluding HIV/AIDS) (10%); injuries (9.7%) and HIV/AIDS (8.4%) (Bradshaw et al, 2004). Compared with the rest of the country non-communicable diseases (which CVDs are part of) accounted for a much larger proportion of deaths in the Western Cape (58%) than nationally (38%). It is the third leading cause of premature years of life lost (YLLs) in the Province (Bradshaw et al, 2004), after major infectious diseases (HIV/AIDS and TB) and injury from violence and traffic-related causes.

The transition of CVD and other chronic diseases from being a disease of the wealthy to the one of the poor has been documented in the United Kingdom, South Africa and the USA (Kaplan and Keil, 1993; Bradshaw et al, 2002; Marmot et al, 1991). For example, chronic diseases were relatively rare in the African-American community in the 1960s, but now their incidence equals or exceeds that of the white population of the United States (Reddy, 1993). A similar progression is being seen in South Africa (Bradshaw et al, 2004). It further needs to be kept in mind that — in developing countries, where the epidemiological transition has advanced fairly rapidly — there appears to be a progressive reversal of the social gradient, with the poor becoming the most vulnerable victims of chronic diseases, such as CVD (Reddy and Yusuf, 1998).

Based upon WHO and World Bank data (Walter et al, 2006), it has been predicted that — over the next 30 years — not only will there be an almost doubling of deaths due to CVD in South Africa, but that an increasing proportion of these will be among the working-age group (ages 35-64), compared to other age groups. Furthermore, it is estimated that — by 2030 — 41% of CVD deaths will be occurring in this age group. The economic costs both directly (health care) and indirectly (such as loss of workers and productivity) will be high.

In the last three decades, it has been well documented that the primary causes of the high prevalence of CVD are due not to genetics alone but largely to environmental factors, specifically an unhealthy lifestyle.

The three most important causes of an unhealthy lifestyle are:

(1) lack of regular physical activity;

(2) long-term use of tobacco products; and

(3) the consumption of an unhealthy diet.

An unhealthy diet is one characterised by its high fat (and saturated fat) intake; low fibre intake; low intake of fruit and vegetables; and high intake of salt and sugar. An unhealthy lifestyle in turn may lead to obesity, high blood pressure and diabetes, among other diseases (WHO, 2003).

Data on overall lifestyle patterns indicate that, on average, South Africans are not engaging in practices recommended for good health. In 2002, for example, it was reported that 36.7% of men and 9.4 % of women in South Africa smoke tobacco daily (Demographic & Health Survey — DHS, 2002). The Western Cape Province has the highest prevalence of smoking of all the provinces: 44.7% of men and 27% of women. Of particular concern is the large proportion of pregnant women in the Western Cape who smoke tobacco. The prevalence of overweight and obesity is also high in the Province among women (57.1%) and highest of all provinces among men (38.4%). Although there limited data are available on physical activity, the Youth Risk Behaviour Survey (YRBS) indicated that 41.7% of high school learners participated in insufficient or no physical activity.

Dietary intake data on adults in the City of Cape Town are also cause for concern, since an unhealthy diet predisposes to CVD. Studies have shown that diets are too high in fat and saturated fat (from animal products), too low in fruit and vegetables, and too high in salt, sugar and other refined carbohydrates, or too low in fibre. (Langenhoven et al, 1988; Bourne et al, 1993). Black South Africans who have migrated from rural areas to Cape Town have — with increasing time spent in the city — tended to increase their fat, saturated fat, and sugar intake and decreased their fibre and carbohydrate intakes resulting in very unhealthy diets (Bourne et al, 1993).

As a result, all parts of the Western Cape Government need to take action now to prevent CVD from escalating even further over the next few decades. Members of the Working Group have reviewed the interventions (or programmes) for the prevention of CVD that have been undertaken globally since 1995, in order to make recommendations for interventions in the Western Cape itself.

A review of more than 300 interventions found that very few programmes were located in developing countries and that none of those published were from sub-Saharan Africa. Numerous successful sustainable and cost-effective interventions, however, have the potential to be used in the Western Cape context.

There is a growing evidence base of successful prevention interventions which address more upstream environmental, social and physical issues, as shown in Table below (WHO, 2004; James, 2005). To quote only one example, a recent cost-effectiveness assessment of childhood obesity-prevention interventions in Australia demonstrated that the approach with the biggest impact on the population lay in reducing the amount of TV advertising which promoted high-fat and high-sugar food and drinks to children. (Haby et al, 2006).

Table: Evidence of Workplace or School Environment Policy for Reducing CVD Risk Factors				
Convincing	Combinations of activities & support (i.e. nutrition education Prescriptions for aerobic/strength training Behavioral techniques; providing self-help materials, specific dietary prescriptions, and group or supervised exercise sessions)	Nutrition and physical activity components in combination; Allotting additional time to physical activity during the school day; Non-competitive sports (e.g., dance); and reducing sedentary activities, especially television viewing	Canteen menus Availability of parks and recreational facilities	Subsidises for alternative transport
Probable	Payroll incentives Changes in workplace processes to encourage more activity	Reducing number of soft drink vending machines	Extra railway stations Increasing cycle lanes & pavements	Reducing TV advertising to kids Prices of fruits and vegetables Smaller portion size
Inconclusive	Single interventions alone (i.e. nutrition education) Subsidises for alternative transport to work	Single interventions alone	Reducing concentration of fast food outlets	Tax on sugar drinks Nutrition labelling

The following examples are based on best practice (scientifically valid) studies reviewed.

Multi-component school programmes which included:

- a nutrition-based curriculum taught to learners by trained teachers;
- a physical activity component for learners;

- a healthy school environment, including healthy foods available at the school canteen or shop; and
- parental involvement in the programme

had the most successful outcomes. The best results were attained when the programme ran over three years for children from Grade 4 to Grade 6.

Two excellent examples in this regard are the ***PATHWAYS*** study (Caballero et al, 2003), which was developed for Native Americans and the ***Know Your Body Program*** (Manios et al, 1999) which was offered to primary school children in Crete. Both of these studies were adapted to local culture, values and norms, and showed positive behavioural, clinical and psycho-social outcomes.

A number of ***worksite interventions*** were successful in improving the diet and health status of employees. The successful studies were characterised by the following:

- nutrition and physical activity advice by means of group sessions;
- a physical activity programme instituted at the worksite;
- changes in the food service available to the staff; and
- use of printed materials and multi-media at the worksite to promote health messages.

One of the most important factors in promoting successful outcomes was the involvement of an employee committee in planning and managing a worksite nutrition and exercise intervention programme. A good example of this is the **Treatwell Five-a Day** programme (Sorensen et al, 1999).

Based on an extensive review of evidence, the following recommendations with regard to policy were made by the Working Group:

1. Lifestyle modification methods to improve the diet of the residents in the Western Cape Province

- Ban advertising of foods during children's programmes on radio & TV, or reduce the market pressure on children by regulating advertising and obtaining cooperation from the mass media and Internet providers.
- Introduce advertising and educational campaigns (multi-media) to promote the increased consumption of fruit and vegetables and the decreased consumption of fat, saturated fats, sugar and salt. Include the development of, and building on to, the food-based dietary guidelines of the Department of Health.
- Ensure that communities have access to healthy and safe foods (food security) — such as food gardens, and informal food outlets.
- Develop and implement a policy for schools on those foods which are allowed to be sold or provided free at the schools — including feeding schemes and tuck shops.
- Introduce a nutrition & healthy lifestyle curriculum aimed at schoolchildren for the prevention of Cardio-Vascular Diseases

- Ensure that all State facilities provide healthy foods (high in fruit and vegetables; low in salt, sugar and fats to inmates and patients).
- Develop a system of incentives for companies who introduce healthy canteens and physical activity facilities for their staff.

2. Lifestyle modification methods to improve physical activity

- Ensure that urban development includes access to areas for physical activity.
- Introduce advertising campaigns (multi-media) to promote physical activity.
- Introduce a physical activity curriculum aimed at schoolchildren for the prevention of Cardio-Vascular Diseases.
- Ensure that all schools have adequate space and facilities for physical activity.
- Ensure that all communities have access to safe areas where they can be physically active.

3. Lifestyle modification methods to reduce tobacco use and alcohol

- Increase the price of alcohol and cigarettes.
- Ban all advertising of alcohol.
- Introduce a school policy of a smoke-free environment.

4. Immediate actions to be taken

- Evaluate foods currently sold or provided free at schools in the Western Cape Province.
- Evaluate the current nutrition (& healthy lifestyle) curriculum taught to children at schools in the Western Cape Province.
- Determine whether there have been any “Healthy Lifestyle” interventions in the Western Cape schools, worksites, and communities.
- Pilot a school-based intervention on healthy nutrition, physical activity, and against smoking in the Western Cape.
- Pilot a healthy-nutrition, physical activity and anti-smoking intervention at worksites in the Western Cape.
- Develop a school-based programme for overweight and obese children.

References

Bourne L T, Langenhoven M L, Steyn K, Jooste P L, Laubscher J A, van der Vyver E. “Nutrient intake in the urban African population of the Cape Peninsula, South Africa. The Brisk study”. *Cent Afr J Medical* 1993; 39(12):238-247.

Bradshaw D, Schneider M, Dorrington R, Bourne D, Laubscher R. “South African Cause of Death profile in transition – 1996 and future trends”. *S Afr Med J* 2002; 92:618-623

Bradshaw D, Nannan N, Laubscher R, et al, *South African National Burden of Disease Study 2000. Estimates of provincial mortality.* Cape Town: MRC, 2004

Caballero B, Clay T, Davis S M, Ethelbah B, Rock B H, Lohman T et al, “Pathways: a school-based, randomized controlled trial for the prevention of obesity in American Indian schoolchildren”. *Am J Clin Nutr* 2003; 78(5):1030-1038.

Kaplan G A, Keil J E. “Socioeconomic factor and cardio-vascular diseases: A review of the literature”. *Circulation*, 1993, 88:1973-1998.

Langenhoven M L, Steyn K, van Eck M. ”The food and meal pattern in Cape Peninsula coloured population”. *Ecol Food Nutr*, 1988; 22:107-116.

Manios Y, Kafatos A. “Health and nutrition education in elementary schools: changes in health knowledge, nutrient intakes and physical activity over a six year period”. *Public Health Nutr* 1999; 2(3A):445-448.

Marmot MG, Kogevinas M, Elston MA. “Socioeconomic status and disease”. *WHO Reg Public Eurp Series* 1991, 37:113-146.

MRC/DOH. South African Demographic and Health Survey 1998. Pretoria, 2002

Reddy K S. “Cardio-vascular diseases in India”. *World Health Statistics*. 1993, **46**, 101-107.

Reddy K S, Yusuf S. “Emerging epidemic of cardio-vascular diseases in developing countries”. *Circulation,* 1998, **97:**569-601.

Reddy SP, Panday S, Swart D, Jinabhai CC, Amosun SL, James S, Monyeki KD, Stevens G, Morejele N, Kambaran NS, Omardien RG, Van den Borne HW. 2003. *The 1st South African National Youth Risk Behaviour Survey 2002*. Cape Town: South African Medical Research Council.

Sorensen G, Stoddard A, Peterson K, Cohen N, Hunt MK, Stein E et al, “Increasing fruit and vegetable consumption through worksites and families in the Treatwell 5-a-day study”. *Am J Public Healt*h 1999; 89(1):54-60.

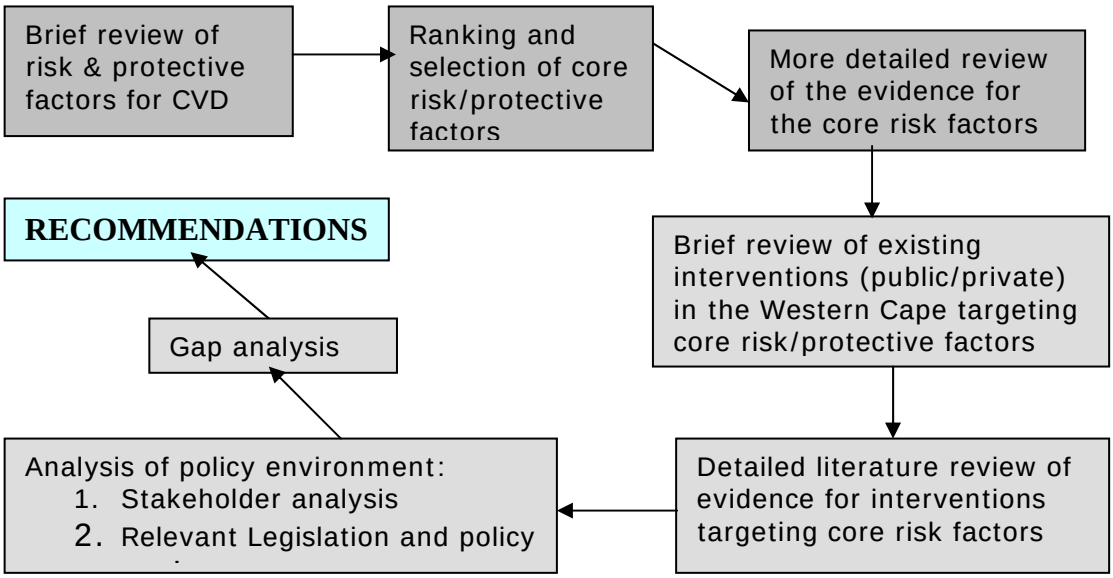
WHO/FAO. *Diet, Nutrition and the Prevention of Chronic Diseases*. Report of a joint WHO/FAO expert consultation. Geneva: World Health Organization, 2003

Introduction

The objective of this workgroup is to devise recommendations for interventions to reduce the burden of cardio-vascular disease (CVD) in the Western Cape Province of South Africa. The CVD Workgroup has conducted a brief review of the data related to CVD mortality in the Province. It has also projected the economic costs of this disease, especially over the next twenty years. The main focus of the workgroup, however, has been on mapping the distribution of risk factors and identifying appropriate interventions to address important risk factors for cardio-vascular disease in the Western Cape. International studies suggest that more than 90% of Type-2 diabetes, 80% of CAD, 70% of stroke, and 70% of colon cancer are potentially preventable by a combination of non-smoking, avoidance of being overweight, moderate physical activity, healthy diet, and moderate alcohol consumption (Walter C. Willett et al, 2006).

Since the Injury Workgroup has covered the evidence base for interventions to reduce alcohol consumption in Volume 5, this workgroup has focused upon risk factors associated with smoking, diet, and a lack of physical activity. For this group of risk factors the workgroup developed a conceptual framework based upon a literature review to identify the causal factors associated with poor diet and lack of physical activity. This was followed by a review of the epidemiological data with regard to the distribution of these risk factors across the province and a systematic review of interventions that have sought to address these risk factors. After identifying the most appropriate and feasible interventions that could be considered in the Province, an analysis of the context of policy-making was undertaken, including a stakeholder analysis. The operational process is summarised in Figure 1 below.

Figure 1: Summary of operational process



Epidemiological data on cardio-vascular disease in the Western Cape Province

The 2000 Burden of Disease Study conducted by the Medical Research Council is probably the most representative source of data concerning the epidemiology of cardio-vascular disease (CVD) in the Western Cape Province (Bradshaw et al, 2004). This study found that CVD was the leading cause of death among both men and women accounting for one in four deaths (25%); followed by malignant neoplasms (16%); infectious and parasitic disease excluding HIV/AIDS (10%); intentional injuries (9.7%); HIV/AIDS (8.4%); and unintentional injuries (7.5%). Intentional and unintentional injuries and respiratory disease were higher in males than in females, while cardio-vascular disease, HIV and diabetes were higher in females than in males.

Since it is mostly the elderly who are presently affected by CVDs, however, the impact on CVDs on years of life lost (YLL) is not as dramatic. Nevertheless, as shown in Figure 2 below, it is still significant.

Figure 2: Burden of Disease components in decreasing order of contribution to premature mortality as Years of Life Lost (YLL)

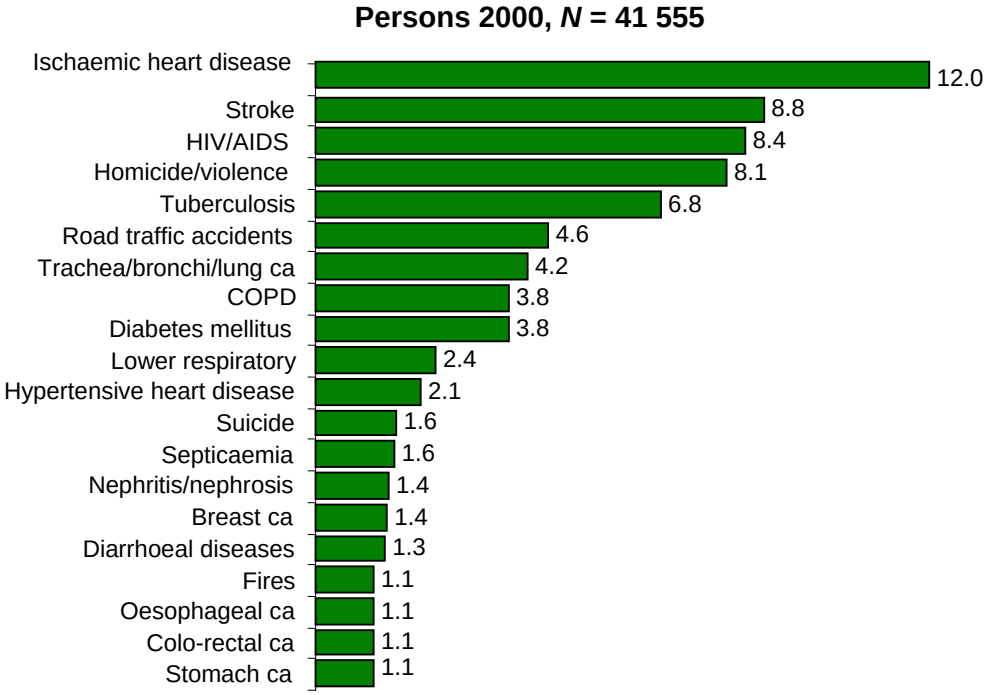
Outcome (disease group)	% YLL	Major risk factor(s) for this outcome
1. Major Infectious diseases	22	Unsafe sex
2. Injury	19.8	Alcohol abuse
3. Mental disorders	---	Early Childhood Development
3. Cardio-vascular disease	10.5	Obesity and Exercise
4. Childhood diseases	>6	Environmental factors

(Scource: Bradshaw et al, 2004)

Ischaemic heart disease and strokes are also the leading single causes of death across the Province, as shown in Figure 3 on page 11**.** Together they account for more than 20% of all deaths during 2000.

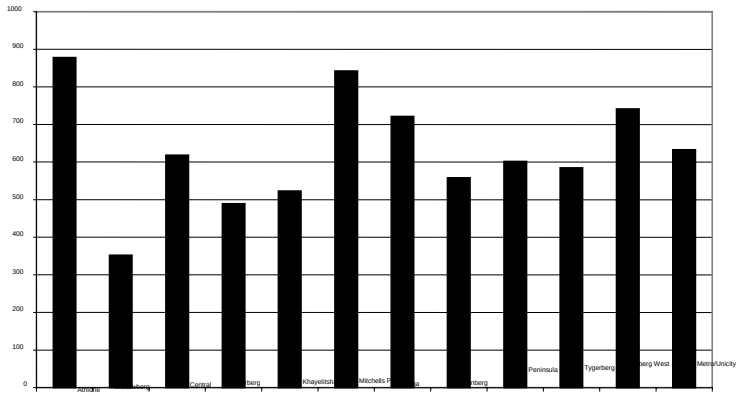
Women in particular are dying more from non-communicable diseases. They have higher numbers of deaths due to stroke, HIV, diabetes and hypertensive heart disease than men. In contrast, men have higher numbers of deaths than women from homicide, ischaemic heart disease, tuberculosis, road traffic accidents, lung cancer, chronic obstructive pulmonary disease, suicide, oesophageal cancer and colorectal cancer.

Figure 3: Twenty leading causes of death across the Western Cape, 2000 (Bradshaw et al, 2004)



Compared with the rest of the country, non-communicable diseases (NCDs) — which are mostly made up of CVDs, diabetes and hypertensive disorders — accounted for a much larger proportion of deaths in the Western Cape (58%) than nationally (38%). This is largely a result of the population in the Western Cape being older than the national population. Cardio-vascular disease and other non-communicable diseases have traditionally been thought of as diseases of increasing affluence in South Africa. However further analysis conducted by the Medical Research Council in collaboration with the School of Public Health, UWC found that rates of death from NCDs were as high in the poorer districts of Cape Town as they are in the better of districts

Figure 4: Age standardised NCD death rate per 100 000 in 2001



(Source: Groenewald et al, 2003).

Future Projections

Although the existing data should provide enough motivation for greater policy attention to be paid to NCDs and CVDs in particular, the nature of the demographic transition across the Province provides compelling reasons for an immediate intervention.

Firstly, there is a significant increase in the working-age population throughout South Africa, including the Western Cape. Secondly, while there will be an increase in the numbers of people aged 65 and over, this will not be to the same degree as is being experienced currently by most developed countries. It is estimated that only 8% to 14% of the population will be aged 65 and over in 2040. In other words, while the population in South Africa, and in the Western Cape Province, will be ageing, this will at first be manifest in increased numbers of young adults and middle-aged people, more than in increased numbers of older people.

This important demographic shift has both positive and negative policy implications. The increase in working-age adults, for example, will improve the dependency ratio, which is the number of working-age adults compared to the number of dependents (both children and older persons). As Leeder et al (2005) point out,

> [this] … demographic window of falling dependency represents a great opportunity for investment, because the employed population will be supporting fewer dependants, and hence it is possible to allocate growth in incomes (personal, family and national) to investment.

They also go on to point out, however, that — if the present trends continue — more people of working age will be affected by the deaths and disability associated with CVDs. This has serious consequences for both health costs and productivity, not just in the next twenty years, but beyond. Based upon WHO and World Bank data, Leeder et al (2005) calculate that, over the next 30 years, not only will there be an almost doubling of deaths due to CVDs in South Africa, but that an increasing proportion of these (over 40%) will be among the working-age group (ages 35-64).

Economic Costs of CVD

This has significant direct health-care and social-benefit cost implications, as well as broader economic costs themselves. Taking the present disability grant to be around $100 per month as an example, the Leeder et al (2005) study calculates that, for South Africa,

> … by 2040, the combination of population aging and rising CVD disability with age, together with a 4% simple compound annual inflation rate, will boost that payment in real terms to about $600 million for the 35-64 aged workforce, eight times its 2000 value.

Studies from the Western Cape and other parts of South Africa indicate that the direct health-care costs of CVDs are much higher than for other conditions. Based upon private insurance claims, it is estimated that the cost per admission for CVD is two to three times the average cost in a tertiary care hospital, and six to seven times the average cost of an admission in a regional or district hospital. Costs per bed day were six times those of the average patient in a tertiary hospital and 10 to 15 times those of an average patient in a district or regional hospital (Department of Health, 2002).

Risk Factors for CVD

A recent review by Willet et al (2006) summarised the large body of evidence concerning risk factors for CVDs, as shown in Table 1 below. The rapid rise in rates of CVDs in the same population over time, and among migrants (both internally from rural to urban settings, as well as to and from other countries), provides compelling evidence that the primary determinants of these diseases are not genetic but environmental factors, including diet and lifestyle. This is supported by a large number of prospective observational and intervention studies.

Table 1: Risk factors and the strength of association for selected chronic diseases (Willet et al, 2006)

Dietary and lifestyle factors	CVD	Type 2 diabetes	Cancer	Dental disease	Fracture	Cataract	Birth defects	Obesity	Metabolic syndrome
Avoid smoking	↓↓	↓↓	↓↓	↓↓	↓	↓↓		↑↑	
Pursue physical activity	↓↓	↓↓	↓↓		↓↓			↓↓	↓↓
Avoid overweight	↓↓	↓↓	↓↓		↑↑	↓↓			↓↓
Diet									
Consume healthy types of fats[a]	↓↓	↓↓							↓
Eat plenty of fruits and vegetables	↓↓		↓		↓	↓	↓	↓	
Replace refined grains with whole grains	↓	↓						↓↓	↓↓
Limit sugar intake[a]	↓	↓		↓				↓	↓↓
Limit excessive calories								↓	↓↓
Limit sodium intake	↓								

Data from South Africa and the Western Cape Province concerning these various risk factors will be examined next.

Tobacco Smoking

South Africa's smoking-related death and disease rates are higher than most other countries in Africa. It is estimated that 25,000 people die each year from tobacco-related illnesses. In sub-Saharan Africa, lung cancer accounts for 6% of all cancers, while in South Africa it accounts for 24% of cancer mortalities in men and 11% in women. In the last twenty years, the incidence of lung cancer has more than doubled among Coloureds and White women, while chronic obstructive lung disease is also on the rise.

Nevertheless, the recent implementation of comprehensive tobacco-control policies (such as increased taxation, restrictions on marketing, and restrictions on smoking in public places) has significantly reduced smoking prevalences across South Africa. The prevalence of smoking among adults fell from 30.2% in 1995 to 24.1% in 2004 (Sitas et al, 2004). An estimated 2.5 million smokers stopped smoking during this period. In 2003, cigarette sales fell for the twelfth consecutive year in South Africa. Annual cigarette consumption fell from 1.8 billion packs in 1993 to 1.2 billion packs in 2003 — a 33% decrease. This decline is also evident among school-aged children. The number of students who had never smoked increased by 20% (from 53.3% in 1999 to 62.4% in 2002) and the number of frequent smokers (smoked on 20 or more days in the past month) declined from 10.1% to 5.8% between 1999 and 2002 (Swart et al, 2003).

Yet this overall decline masks the presence of certain groups who still have very high levels of smoking. Levels of smoking are very high among the Coloured population, for example, with 57% of men and 40% of women smoking. This compares to African male and female rates of 33% and 4% respectively.

Physical Activity

The results of the 2002 National Youth Risk Survey on physical activity are presented below. Overall, this survey suggests that South African youth are not participating in sufficient physical activity with more than one-third of children engaging in insufficient or no activity weekly. Related to this was the finding that more than 25% of the youth surveyed reported watching more than three hours of television per day.

Table 2: Numbers of South African youth not engaging in physical activity

	Males	Females	All
Black	34.4	42.4	37.5
Mixed Ancestry	36.8	56.8	45.6
White	28.2	37	29.4
Indian	40.8	36	38
RSA	34.4	43	37.5

Source: Youth Risk Behaviour Survey, 2002

This pattern of inactivity seems to spread into adulthood. A national WHO survey in 2003 (WHO, 2005) found that less than one third of South Africans met international recommendations for health-enhancing physical activity (that is, an accumulated 30 minutes of moderate activity on most, but preferably all, days of the week), and that nearly half were reportedly inactive (46%). Surveys from the Western Cape report similar findings.

The European WHO office has identified several aspects of the social environment (such as school policies or the media) and the built environment (such as transport and urban design) that influence physical activity choices. Most of these are relevant for South Africa:

- In schools greater emphasis is being placed on academic tasks, often at the expense of time for physical education and other forms of school-based physical activity. In addition, in free time during the day, activities involving exercise are increasingly competing with sedentary activity such as television-watching (in younger classes) or computer use.
- Fewer children cycle and walk to school, mostly because of parents' safety concerns.
- The availability of multiple television channels throughout the day and the high popularity of electronic entertainment make the sedentary use of leisure time almost a default at most ages.
- For adults, the use of private cars has increased in recent decades while physically active means of transport (such as cycling and walking) are at low levels
- Participation in some traditional sports has decreased recently, in part owing to demographic changes and the increase in the variety of sporting codes. Commercial fitness clubs and activities have developed, but their accessibility may be limited in some areas and for some population groups.
- Physical activity during work has decreased along with greater development in the South African and Western Cape economy: increasing numbers of employees now find themselves in sedentary occupations.
- Urban design and the urban physical environment can facilitate or constrain physical activity and active living. Urban design that reduces the spatial separation of living, working, shopping and leisure activities would reduce travel distances, acting as an incentive for cycling and walking, and provide more available time by reducing the need for long-distance travelling. Several European cities have good examples of urban design to encourage cycling and further incentives to promote the use of bicycles instead of, or in addition to, other forms of transport.
- In residential neighbourhoods, not only the physical availability of possibilities for exercise but also the level of maintenance, the

aesthetic quality and the perceived safety and security of public spaces can affect people's willingness to be physically active.

- Socio-economic status is an important factor in these relationships, both through the accessibility of the facilities (as a result of equipment cost, entry cost and location) or people's perceived competence to use them.

Overweight

Overweight (i.e a body mass index (BMI) >25) and obesity (BMI >30) are important risk factors for CVD. At least three quarters of Type-2 diabetes, a third of ischaemic heart disease, one half of hypertensive disease, a third of ischaemic strokes and about a quarter of osteoarthritis can be attributed to excess weight gain (James et al 2004). Obesity reduces life expectancy. The US Framingham study showed that obesity at age 40 years led to a reduction in life expectancy of seven years in women and six years in men. The United Kingdom Department of Health recently projected an average five years' lower life expectancy for men by 2050, if the current obesity trends continue.

The health consequences of young children being overweight are less clear, but a systematic review shows that childhood obesity is strongly associated with risk factors for cardio-vascular disease and diabetes, orthopaedic problems, and mental disorders. A high BMI in adolescence predicts elevated adult mortality rates and cardio-vascular disease, even if the excess body weight is lost. Unfortunately, surveys among South African youth and adults show very high levels of overweight and obesity and indications are that these rates are rising. Paradoxically, and especially in the urban setting, it is among the middle- and low-income groups that the rates of overweight and obesity are the highest.

The 2002 Youth Risk Survey (Reddy et al, 2004) found that 17% of adolescents were overweight, and 4.2% were obese. The 1998 National DHS survey reported an overall prevalence of overweight and obesity of more than 29% for men and 56% of women. The findings for women are particularly disturbing since nearly one in three (30%) were found to be obese (Puoane et al, 2003). Across all studies, women in urban (and especially poor urban) settings have a far higher prevalence of obesity.

A recent survey of Cape Town townships found that 70 percent of women sampled were generally overweight (with 24 percent overweight and 46 percent obese), while only 28 percent fell within the normal weight range. In line with the findings of the DHS survey, only about 20% of women actually perceived themselves to be overweight. More in-depth qualitative work with samples of obese women in the Cape Town townships has uncovered a complex array of factors influencing perceptions of body shape (Mvo et al, 1999). On the one hand, some younger women and those with higher levels of education are aware of, and aspire to, the slim body shape. Yet the majority of African women associate thinness with

illness and now with HIV/AIDS. Being large is a sign of wealth and for men a sign that they can look after their families.

Dietary assessments and observations of the preparation of food show that women in the townships are very adept at accumulating calories at relatively little financial cost. But their environments and situations also mean a sharp reduction in physical activity for some. These points are highlighted in the example given in Box 1 below.

Box 1: The ecology of obesity
(taken from Chopra & Puoane, 2003)

Zanempilo is an NGO providing primary health care and rehabilitation services in the townships of Cape Town. Community Health Workers were residents of Khayelitsha and shared the same socio-cultural and demographic profiles as ordinary members of this community. As part of an initiative to address the problem of overweight and obesity, a participatory approach of assessment, analysis, and action was used to collect baseline data from CHWs on barriers to healthy living, including risk factors, prevention, and treatment of diabetes.

Of 44 CHWs measured, two were normal weight, two were overweight, 25 obese, and 15 extremely obese. Most perceived moderately overweight women as attractive, and associated them with dignity, respect, and confidence. Negative aspects were continuous body aches and tiredness. Photographs showed unhealthy food preparation and large portion sizes. Barriers to physical activity included the fear of losing weight, personal safety, and a lack of exercise.

As one respondent remarked, “I am scared of exercising because I will lose weight and people may think that I have HIV/AIDS”

Others demonstrated a very limited knowledge about nutrition:

“People who boil food are not civilised,” said one. “Fried food is attractive, tasty, such as Kentucky Fried Chicken. If your neighbours boil food, people say that she is still backward because the food does not taste nor look attractive.”

“It’s quick to fry food,” said another, “than to boil it. Fried meat is tastier than boiled meat.”

Yet they also highlighted important environment factors:

“There is a shortage of healthy, low-fat food, and there is little fresh fruit and vegetables available in the townships. The majority of local shops sell cheap, fatty foods. Street-vendor stalls sell fatty meat and sausages.”

“To eat low-fat milk is impractical: it is not available in our shops” stated one of the CHWs after she had tried to cut down on the fat in her diet.

Poor quality diets

There is strong evidence that the diet of people changes dramatically as they move from the rural to urban areas. Two studies from Cape Town have found dramatic changes, especially as regards the substitution of carbohydrates by fats as a source of energy. Currently, WHO recommends that the average human intake of fat as a percentage of overall energy intake should not exceed 25 percent, in order to minimise the risk of CVDs. Notwithstanding this recommendation, Bourne (1996) found that the intake of carbohydrate calculated as a percentage of the total energy intake decreased from 61% to 53% and that the fat intake increased from 24% to 32% as people spent more of their lives in the city.

Fibre intake also decreased significantly — from 20.7 to 16.7 grams — along with the increase of time spent living in the city. Remarkably similar findings have also been reported from the North West Province. The proportion of energy from fat in the diet increased from 22% in rural population to 31% in the settled urban population (MacIntyre et al, 2002). Other studies report fat intakes of 34% (Langenhoven et al, 1988), 35% (Greese, 1991) and 40% (Vorster et al, 1997) among African urban populations.

There has been relatively little work done to ascertain the causes of these dramatic changes in diet associated with urbanisation. The greater availability of fast food and sugar-rich drinks has been associated with obesity epidemics in other countries. The post-Apartheid era has been marked by both the entry and the re-entry of multi-national food companies.

South Africa has always been the most important African market for US-based Coca-Cola and one of their largest markets in the world (Coca-Cola, 2004). After keeping a low profile during the Apartheid era, Coca-Cola ramped up their capital expenditure after 1994 to become a leading investor in the country. Currently, their combined stable of brands have succeeded in capturing around 85% of the carbonated soft-drinks market. This is supported by a $25-million advertising campaign making Coca-Cola one of the top ten advertisers in the country (AdAge, 2004).

South Africa is also the leading sub-Saharan African country for multi-national fast food chains. Even before international brands re-entered the market, South Africa had well-established fast food chains, such as Nando's (spicy chicken) and Steers (burgers). South Africa is the seventh largest international market for Kentucky Fried Chicken with 414 outlets (YUM, 2005). After McDonald's opened its first outlet in 1995 in Johannesburg, their expansion programme was more rapid than any other country with 30 outlets in 26 months. At the time of writing, there were 95 outlets in all parts of the country, nearly always in urban settings (McDonald's, 2005). Though Steers remains more popular, the entry of McDonald's stimulated the fast-food market to become more competitive as a whole. The popularity of such establishments has also spawned cheaper versions in poorer suburbs and, arguably, also changed the culinary culture and tastes of South African residents.

A systematic review of the scientific evidence, conducted for the United Kingdom Food Standards Agency in 2003, concluded that sufficient evidence existed to suggest that advertising increases the overall consumption of food categories, as well as choices between brands. A review by the United States Institute of Medicine in 2006 found strong evidence to suggest that advertising affects overall diet in the short term for children aged 2–11 years, and moderate evidence to suggest long-term effects on children aged 6–11 years. This review also noted strong statistical evidence linking higher exposure to television advertising and obesity among children aged 2–11 years and adolescents aged 12–18 years. Children's exposure to television advertising of energy-dense foods is associated with an elevated prevalence of overweight, and exposure to the advertising of healthier foods is weakly linked to a reduced prevalence of overweight.

Interventions

In summary, the issue of diet, nutrition and physical activity — especially in poor urban settings — is becoming more complex. We are faced by a "paradox of plenty": that is, in the midst of ample food supplies, large sections of the population continue to be malnourished. This no longer means that the poor are necessarily undernourished, since the evidence often shows a double burden of under- and over-nutrition, sometimes even in the same household. Yet even a diet that has too many calories can be found very often to be deficient in crucial micro-nutrients. It is thus more accurate to state that levels of malnutrition remain very high.

The transition from rural diets to "Western" and urban diets both exacerbates and fuels health inequities. A degree of affluence is required to have consistent access to nutritious foods in the cities, and education is required to negotiate the myriad food choices that are aggressively marketed in modern cities. The lack of large fresh-produce markets in poor urban areas, due in part to urban-development pressures and food-safety regulations, further reduces the availability of nutritious foods. For other sub-populations (men without families, for example, who have newly arrived in cities and who work long hours, or families without a kitchen), street vendors are an important group of food retailers.

Increasingly, urban food systems are being shaped by the twin processes of economic and cultural globalisation. Urban food systems around the world are coming to share similar features: a reliance on international supermarket chains and convenience-store chains; the demise of street markets, street vendors and "Mom-and-Pop" stores; around-the-clock availability of nutrient-poor fast and convenience foods; and increasing amounts of cheap imported products, institutionalised by global Free Trade Agreements.

There is a growing evidence base of successful obesity-prevention interventions which address more upstream environmental, social and physical issues, as shown in Table 3 below. (WHO, 2004; James, 2005). To quote only one example, a recent cost-effectiveness assessment of childhood obesity-prevention interventions in Australia demonstrated that the approach with the biggest impact on the population lay in reducing the amount of TV advertising which promoted high-fat and high-sugar food and drinks to children. (Haby et al, 2006).

Table 3: Evidence of Workplace or School Environment Policy				
Convincing	Combinations of activities & support (i.e. nutrition education Prescriptions for aerobic/strength training Behavioral techniques; providing self-help materials, specific dietary prescriptions, and group or supervised exercise sessions)	Nutrition and physical activity components in combination; Allotting additional time to physical activity during the school day; Non-competitive sports (e.g., dance); and reducing sedentary activities, especially television viewing	Canteen menus Availability of parks and recreational facilities	Subsidises for alternative transport
Probable	Payroll incentives Changes in workplace processes to encourage more activity	Reducing number of soft drink vending machines	Extra railway stations Increasing cycle lanes & pavements	Reducing TV advertising to kids Prices of fruits and vegetables Smaller portion size
Inconclusive	Single interventions alone (i.e. nutrition education) Subsidises for alternative transport to work	Single interventions alone	Reducing concentration of fast food outlets	Tax on sugar drinks Nutrition labelling

In order to make effective and feasible recommendations regarding the development and implementation of interventions aimed at the prevention of chronic diseases in South Africa, it was necessary to assess published intervention evaluation research from developed and developing countries world-wide. These interventions have been rated according to their quality in terms of study design and in terms of their outcomes.

For the purposes of this report, the following interventions were considered:

- Systematic approaches designed to increase levels of participation in physical activity;
- Targeting changes in awareness, knowledge and attitudes toward nutrition and physical activity, improving self-efficacy, skill or competency concerning these behaviours; and
- Programmes or strategies targeting changes in social norms, policy and physical environment, health services or consumer behaviour, and so on, which are designed, for example, to promote the increased consumption of fruits and vegetables; reduced dietary fat intake; reduced obesity prevalence; and increased levels of health-enhancing physical activity.

The following outcome measures were considered in the evaluation of the various intervention programs:

- Changes in nutritional knowledge, attitudes, self-efficacy, intentions; stage of change and/or behaviours;
- Changes in physical activity knowledge, attitudes, self-efficacy, intentions; stage of change and/or behaviours;
- Changes in clinical markers such as: body weight or BMI, blood pressure or serum cholesterol concentrations;
- Process and/or policy outcomes.

In addition, factors such as intervention fidelity, sustainability, feasibility, and cost-effectiveness were considered, where measured. Further, programs demonstrated to be effective in a broader context, or specifically under-resourced settings were also highlighted.

Appendix A comprises a summary of interventions published in peer-viewed journals since 1995. This appendix includes studies that were rated as “best practice” in terms of behavioural, or clinical outcomes. In this report “best practice” refers to those interventions which typically have been based on formative assessment, and which have been studied using a generally robust experimental design with sufficient sample size; and with significant and substantive effects on specified outcome variables. They would likely be applicable in a wider variety of settings (developing or under-resourced settings), and have demonstrated feasibility and sustainability in their current setting. These interventions would be considered the “gold standard” or “exemplar” for the setting and specific outcome.

Since interventions have generally been undertaken in specific settings the researchers have classified them according to settings, namely: university; adult education; church; community; population; restaurants; home; government; supermarkets; schools; workplace and primary health care.

Recommendations and outcomes from the best practice studies presented in Appendix A

A review of more than 300 interventions have shown that very few studies are from developing countries and none published were from sub-Saharan Africa. Despite this, there have been numerous successful interventions which have been sustainable and cost-effective and have the potential to be used in the South African context. The following examples are based on best practice studies reviewed by our team.

Multi-component school programmes which include a nutrition-based curriculum offered by trained teachers, a physical activity component; a healthy school environment; and parental involvement. The curriculum should preferably run over three years among Grade 4 to Grade 6 children. Two excellent examples in this regard are the ***PATHWAYS*** study which was developed for American Indians and the ***Know Your Body Program*** offered to primary-school children in Crete. Both of these studies were adapted to local culture, values and norms and showed positive outcomes in behaviour, clinically and in psycho-social aspects.

A number of ***worksite interventions*** were successful in improving the diet and health status of their employees. The successful studies were characterised by the following: nutrition and physical activity advice and group sessions; a physical activity program; changes in the food-service canteens; and the use of printed and multi-media materials to promote health messages. One of the most important factors in promoting successful outcomes was the use of an employee committee which participated in planning and managing a worksite program. A good example of this is the ***Treatwell-5-a Day*** programme.

There were also examples of ***interventions in primary health care and in the community*** with successful outcomes at the lowest level of cost. These include using physicians to endorse healthy programs, dieticians or nurses to do group counselling and the use of self-help materials for patients to use on their own. Brief cholesterol-screening programmes with a minimum time spent on counselling were also effective in some studies. The use of the media as a means of conveying healthy-lifestyle messages was also shown to be effective in many studies.

Based on the evidence provided in Appendix A the following recommendations are made with a view to improving the health of the population in the Western Cape Province:

1. In the short-term, to initiate and fund trials of interventions aimed at promoting a healthy lifestyle in the local urban and rural populations, in order to test the most cost effective and sustainable ways to impact on the health of a large majority of the people living in the Western Cape Province.

2. It is recommended that school-based interventions be evaluated as a first priority, since these have proven to be very successful in numerous populations and can be introduced as a cost-effective strategy to reach children and their parents. Furthermore, children are the adults of the future and promoting a healthy lifestyle from childhood will protect against the development of chronic diseases, such as cardio-vascular diseases, diabetes, and their associated risk factors and determinants.
3. In the long term, it is recommended that trials are undertaken to test interventions in primary health care at worksites and in the community, since there have been numerous trials which have been effective in these settings. These may also prove to be the most cost-effective in terms of using existing resources and expertise.
4. Equally in the long term, it may be possible to introduce interventions with successful outcomes at a provincial level.

Policy Implications

From the above systematic review of intervention studies one message should be clear: **To improve dietary habits and increase physical activity, measures should primarily be directed at the level in society where conditions for healthy dietary habits and physical activity are created, thus making adopting a healthy lifestyle easy**.

This approach has been identified in the WHO Global Strategy on Diet, Physical Activity and Health (adopted in 2002 in World Health Assembly resolution WHA55.23) and in regional initiatives, such as the NEPAD Nutrition, Food and Diet Strategy. The achievement of this strategy requires a range of actions, many of which fall outside the scope of the Department of Health (DoH). But the DoH has the important responsibility of leadership and stewardship in the development and implementation of a comprehensive strategy.

Much can also be learned from the ***Framework Convention on Tobacco Control***, which focused on legislation, labelling, finance and education. (Chopra and Darnton-Hill, 2004). This combination has succeeded in reducing tobacco consumption in South Africa as detailed above. The ***WHO Global Strategy on Diet, Physical Activity & Health*** (WHO, 2004) focuses on the provision of information, development of national food, and agricultural policies, which are consistent with the protection and promotion of public health, and multi-sectoral policies that promote physical activity.

There are examples which show that, when a broader combination of more upstream population-level price manipulation and clear nutrition labelling, and individual-focused public education are employed, then adverse trends in diet can be reversed. Both Norway and Finland are examples of countries that have successfully reversed high-fat, energy-dense diets in their populations. In the case of Norway, this was based upon a wide range of measures that included:

- The setting of consumer and producer price and income subsidies jointly in nutritionally justifiable ways;
- The adjustment of absolute and relative consumer food price subsidies;
- Ensuring low prices for food grain, skimmed and low fat milk, vegetables and potatoes;
- The avoidance of low prices for sugar, butter and margarine;
- The creation of regulations to promote the provision of healthy foods by retail stores, street vendors, and institutions;
- The regulation of food processing and labelling; and
- Public and professional education and information.

(Norum KR 1997)

While relatively few evaluated interventions exist in developing countries, Mauritius provides an example of a successful comprehensive programme that reduced mean serum cholesterol levels, as well as achieving declines in hypertension, smoking, and heavy alcohol use. The use of mass media, price policy, widespread educational activity in the community, workplace and schools and other legislative and fiscal measures were key planks in the prevention strategy.(Dowse GK et al, 1995) In Sao Paulo, Brazil, the population-wide Agita Sao Paulo physical-activity programme, held over the course of four years, successfully reduced the level of physical inactivity in the general population, using a multi-level, multi-strategy approach, including educational interventions in the community and financial discount incentives for individuals to be more active. (Matsudo et al, 2006).

In summary, actions to promote the demand for and supply of healthier food include:

- developing and improving food-based dietary guidelines;
- implementing measures to regulate prices, to impose food standards and to support socially disadvantaged groups in accessing healthy foods;
- reducing the market pressure on children by regulating advertising and obtaining cooperation from the mass media and Internet providers;
- conducting nutrition education and improving labelling schemes;
- promoting breastfeeding;
- improving nutrition profiles of food by reducing their content of sugar, salt and saturated fat;
- avoiding production incentives for fat, sugar and alcohol and promoting the cultivation and marketing of fruit and vegetables;
- providing healthy food in schools; and improving catering, including in workplaces.

Action to promote physical activity in the population includes:

- enhancing the affordability and access to places and facilities for physical activity;
- promoting safe physically active transport, especially for commuting to schools and workplaces;
- adapting workplaces to improve the motivation for being physically active;
- stimulating changes in the urban environment to promote physical activity;
- communicating to the public; improving school physical activity programmes;
- promoting physically active recreation and promoting individual counselling via health professionals.

Bibliography

Ad Age Global (2004) Hey, Big Spenders. (November 1, 2004); accessed at: http://www.adageglobal.com

Bourne LT, Langenhoven ML, Steyn K, Jooste PL, Laubscher JA, van der Vyver E. Nutrient intake in the urban African population of the Cape Peninsula, South Africa. The Brisk study. *Cent Afr J Medical* 1993; 39(12): 238-247.

Bradshaw D, Schneider M, Dorrington R, Bourne D, Laubscher R. South African Cause of Death profile in transition – 1996 and future trends. *S Afr Med J* 2002; 92: 618-623

Bradshaw D, Nannan N, Laubscher R, et al, South African National Burden of Disease Study 2000. Estimates of provincial mortality. Cape Town: MRC, 2004

Caballero B, Clay T, Davis SM, Ethelbah B, Rock BH, Lohman T et al, Pathways: a school-based, randomized controlled trial for the prevention of obesity in American Indian schoolchildren. Am J Clin Nutr 2003; 78(5):1030-1038.

Chopra M & Puoane T (2003) Determinants of Obesity Diabetes Digest, Brussels

Chopra, M & Darnton-Hill, I 2004 Tobacco and obesity epidemics: not so different after all? BMJ, 328, 1558-1560.http://bmj.bmjjournals.com

Coca-Cola Company Annual Report 2002

Dowse GK, Gareeboo H, Alberti KG, Zimmet P, Tuomilehto J, Purran A, Fareed D, Chitson P & VR., C 1995 Changes in population cholesterol concentrations and other cardio-vascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius. British Medical Journal, 311, 1255-1259

Groenewald P, Bradshaw D,Nojilana B, et al, Cape Town Mortality, 2001, Part I, Cause of death and premature mortality. South African Medical Research Council, Cape Town, South

Africa.Haby, MM, Vos, T, Carter, R, Moodie, M, Markwick, A, Magnus, A, Tay-Teo, KS & Swinburn, B 2006 A new approach to assessing the health benefit from obesity interventions in children and adolescents: the assessing cost-effectiveness in obesity project. Int J Obes, 30, 1463-1475.http://dx.doi.org/10.1038/sj.ijo.0803469

James WPT et al, Overweight and obesity (high body mass index). In: Ezzati M et al,, eds. Comparative quantification of health risks: global and regional burden of disease attribution to selected major risk factors. Vol. 1. Geneva, World Health Organization, 2004:497–596 (http://www.who.int/publications/cra/en, accessed 15 May 2006

James, WPT 2005 The policy challenge of coexisting undernutrition and nutrition-related chronic diseases. Maternal and Child Nutrition, 1, 197-203.http://www.blackwell-synergy.com/doi/abs/10.1111/j.1740-8709.2005.00031.x

Kaplan GA, Keil JE. Socioeconomic factor and cardio-vascular diseases: A review of the literature. *Circulation*, 1993, 88:1973-1998.

Langenhoven ML, Steyn K, van Eck M. The food and meal pattern in Cape Peninsula coloured population. *Ecol Food Nutr*, 1988; 22: 107-116.

Leeder S, Raymond S, Greenburg H et al, 2005 Race against time: the challenge of cardio-vascular disease for developing economies. Columbia University, New York

MacDonalds (2004) Annual Report www.macdonalds.com

Manios Y, Kafatos A. Health and nutrition education in elementary schools: changes in health knowledge, nutrient intakes and physical activity over a six year period. Public Health Nutr 1999; 2(3A):445-448.

Matsudo, SM, Matsudo, VKR, Andrade, DR, Araujo, TL & Pratt, M 2006 Evaluation of a physical activity promotion program: The example of Agita Sao Paulo. Evaluation and Program Planning, In Press, Corrected Proof.http://www.sciencedirect.com/science/article/B6V7V-4KPFKMJ-1/2/632941463e20fe73d94fd09285f10ebf

Mvo Z, Dick J, Steyn K. 1999 Perceptions of overweight African women about acceptable body size of women and children. Curationis Jun;22(2):27-31.

Norum KR 1997 Some aspects of Norwegian nutrition and food policy IN SHETTY P & MCPHERSON K (Eds.) Diet, Nutrition and Chronic Disease: Lessons from contrasting worlds. London, John Wiley & Sons Ltd.

Puoane T, Steyn K, Bradshaw D, Laubscher R, Fourie J, Lambert V, Mbananga N. .2002 Obesity in South Africa: the South African demographic and health survey Obes ResOct;10(10):1038-48.

Reddy SP, Panday S, Swart D, Jinabhai CC, Amosun SL, James S, Monyeki KD, Stevens G, Morejele N, Kambaran NS, Omardien RG, Van den Borne HW. 2003. *The 1st South African National Youth Risk Behaviour Survey 2002*. Cape Town: South African Medical Research Council.

Sitas F, Urban M, Bradshaw D, Kielkowski D, Bah S, Peto R. Tobacco attributable deaths in South Africa. Tob Control 2004;13:396-399.

Sorensen G, Stoddard A, Peterson K, Cohen N, Hunt MK, Stein E et al, Increasing fruit and vegetable consumption through worksites and families in the Treatwell 5-a-day study. Am J Public Health 1999; 89(1):54-60.

Swart D, Reddy P, Ruiter RA, de Vries H. Cigarette use among male and female grade 8-10 students of different ethnicity in South African schools. Tob Control 2003;12:e1.

Willett WC, Koplan JP, Nugent R, Courtenay Dusenbury, Pekka Puska & Thomas A. Gaziano 2006 Prevention of Chronic Disease by Means of Diet and Lifestyle Changes IN JAMISON, D. T., WORLD BANK. & DISEASE CONTROL PRIORITIES PROJECT. (Eds.) Disease control priorities in developing countries 2nd ed. New York, NY Oxford University Press ; World Bank.

WHO 2004 Global strategy on diet, physical activity and health, Geneva, World Health Organisation.

WHO 2005 . Preliminary results of the World Health Survey, 2002-2003; International Physical Activity Data, South African results. Geneva: WHO, 2005.

APPENDIX A

A summary of studies published between 1995 and July 2006 which had best practice outcomes in behavior or clinically

SETTINGS EVALUATED	POLICY IMPLICATIONS	*References*	*Key Success Factors*
1. University: 5 studies were evaluated			
Vending Machine Pricing Strategy -Prices of low-fat snacks were reduced by 50% over 3 weeks. -Price of purchase messages re fat content (3g fat or less) below each low fat item in bright orange.	Reducing relative prices may be effective in promoting lower fat food choices in the population.	*French et al,1997(1)*	All of these interventions show promise in terms of cost-effectiveness. However there is insufficient evidence in terms of duration of the intervention and repeated trials to know if they could be implemented elsewhere. There is insufficient evidence, however decreasing prices of healthier foods in vending machines does appear to be effective in the short term.
2. Adult Classes: 2 studies evaluated			
SNAP: Stanford Nutrition Action Program -Low literacy, low income adults, -6 Week classroom intervention & 12 week maintenance program	A curriculum tailored to the cultural, economic and learning needs of low literacy, low income adults was modestly more effective in achieving fat-related nutritional changes than a general nutrition curriculum.	*Howard et al, 1997(2)*	Insufficient evidence, however it appears that longer periods may be necessary to change behaviour.
3. Church Settings: 6studies were evaluated			
Black Churches United for Better Health Project -50 African American churches -20 Month intervention -Multi-component intervention: Group education, supermarket	Targeted multiple levels of change & culturally sensitive designed programs Nutrition Action Team comprised of church members organised and implemented many of the	*Campbell et al, 1999(3) for intervention outcomes*	Overall the church setting was one which proved to be very successful in the African American

visits, literature, demonstrations, pastor support, lay advisers	activities. Lay health advisors from the church also used.		communities studied. In communities where the church plays an important role in people's lives, this type of intervention will be likely to succeed. It may also prove to be cost-effective and feasible since the church and community members shoulder most of the responsibility in terms of staff support. The following were key factors: -The use of church members to plan and participate in the intervention is important for successful outcomes. -The pastor/minister should support and participate in the intervention. -It is necessary for the intervention to be culturally
Project Joy -African American churches & women aged 40+ years -One year intervention -Multi-component intervention: Group education, PA, self-help strategies, spiritual support, health & lay educators	Community involvement in design of intervention which assists with community ownership of program and dissemination of results.	*Yanek et al 2001(4)*	
Eat for Life Trial -African American churches -One year intervention -Self-help intervention: Phone calls using MI & self-help materials: video, cookbook, literature, newsletters	Culturally sensitive intervention. Motivational interviewing & this intervention also made use of a local advisory board.	*Resnicow et al 2001(5)*	
Body and Soul Intervention -African American churches -6 month intervention -Church wide nutrition activities presented by trained lay workers -Self help materials	Intervention delivered collaboratively by community volunteers and a health related volunteer agency under real world conditions.	*Resnicow et al 2004(6)*	

Healthy Body Healthy Spirit Trial -African American churches -One year intervention -Self-help intervention: Phone calls using MI, self-help materials: nutrition video, cookbook, exercise video and guide	MI intervention delivered by psychologists which makes the program expensive.	*Resnicow et al 2005(7)*	sensitive in order to be effective. -The use of spiritual strategies to change behaviour should be an integral part of church interventions. -The intervention needs to be based on a relevant theory of behaviour such as social cognitive theory or the trans-theoretical model. -The intervention needs to be undertaken over a period of at least 12 months; ideally a longer period.
5. <u>Community Setting:</u> 27 studies were evaluated			
WHLP: Womens Healthy Lifestyle Project -Healthy pre-menopausal women -Intervention 5 years -20 week group session intensive phase and 20 week group session maintenance phase (diet & PA) -Thereafter group, mail or phone contact every 2-3 months	The program was led by trained nutritional and behavioural interventionists. The groups were taught behavioural strategies and self-monitored their diet and PA programs. Cost and labour expensive. May be difficult to implement in a developing context	*Simken-Silverman et al, 1995 (8)* *Simken-Silverman et al, 2003 (9)*	-Interventions based on behavioural theories such as social cognitive theory and trans-theoretical theory were among those with best practice outcomes. -Interventions where participants were required to undertake self-monitoring of their diet and physical activity had best practice or moderately effective outcomes. -Most of the successful interventions included follow-up on initial visits (by telephone, mail or personally). -Teaching participants behavioural strategies such as motivational interviewing
Callers to the CIS: Cancer Information Service Studies -Adults calling the Centre -Callers to the CIS received a brief proactive educational intervention at the end of the usual service & 2 follow up mail outs.	May be replicated by organisations that provide services to low income or low literacy populations who rely on phone contact as part of service.	*Marcus et al, 1998 (10)* *Marcus et al, 2001 (11)*	
Take Five: Nutrition Education Intervention -Adults -8 Week intervention -1 lecture & literature,motivational approaches & behavioural methods such as a self monitoring diary	This intervention showed very positive outcomes with relatively low manpower. Only 1 educational lecture was held.	*Cox et al, 1998 (12)*	
The Women's Health Trial Feasibility Study in Minority Populations	Nutritionists delivered the program and provided individualised attention to those who had	*Coates et al, 1999 (13)*	

-Postmenopausal women 50+years -2 year intervention -Group sessions: weekly for 6 weeks, biweekly for 6 weeks, monthly for 9 months, then quarterly; individual sessions for those with difficulties	difficulties in making changes		had best practice or moderately effective outcomes.
Weight Loss Program Using Computer & Staff consultations -Adults with BMI>25 plus 1 CVD risk factor -12 month intervention : -IG1=Workbook alone; -IG2= Workbook & computer -IG3= Workbook & computer & staff consults with dieticians (6 group & personal or phone)	Interventions that correlated best with weight loss were: more computer log-ons; more self-monitoring; achieving computer goals; increased walking; decreased energy & fat intake. Cost per participant over 12 months was USD 12.33; 41.99 & 133.74 from IG1 to IG3. It may be most cost effective to use the moderate intervention which has positive outcomes at lower cost	*Wylie-Rosett et al, (2001)(14)*	
Dietary Intervention in an Aboriginal Community -Adults -Intervention over 4 years -Store policy changes; PA program; nutrition education to high risk persons by diabetes nurse educator	This community based dietary intervention reduced the prevalence of coronary heart disease risk factors related to diet	*Rowley et al, 2001(15)*	
Dietary Intervention to Decrease Consumption of Fat and Increase Consumption of Fruits and Vegetables. -Adult women aged 40-70 years -6-9 Week 2 x 45 Minutes counselling sessions including a 20minutes interactive computer based intervention & 2 phone calls	Sessions conducted by health counsellors having a masters degree. Moderate intensity intervention using motivated subjects.	*Stevens et al, 2002)(16)* *Stevens et al, 2003 (17)*	
Physical activity & nutrition program -Couples living together <2 years -4 Month intervention Six modules: 1) IG1=low level group- modules were mailed 2) IG2= high level group ½ modules mailed and ½ delivered in interactive group sessions.	Strategies that encourage goal setting, and overcoming perceived barriers to change were better predictors of behaviour change than increasing knowledge. IG2 estimated cost was only $0.03 per participant per month more than the group receiving the program mainly by mail.	*Burke et al, 2003 (18)* *Burke et al, 2004 (19)*	
Diet and Physical Activity Modification Program -4 Week intervention- 4 x a week for 2 hours. -Home assignments, lectures, supermarket tours -Weekly lectures by dieticians & other health professionals	Large beneficial changes were observed in health behaviour and risk factor levels. However this is large cost implications since many resources are required.	*Aldana et al, 2005 (20)*	
5. <u>Campaigns & Awards:</u> 10 studies were evaluated			
Changing Fatty Acid Composition of Cooking Oil -Mauritius	A cost-effective and sustainable way of reducing saturated fat intake	*Uusitalo et al, 1996(21)*	-There should be intensive use of mass media over a

-Government reduced the content of palm oil & increased soy oil in vegetable oil nationally			sufficiently long duration. -The use of a logo can be effective when used by a recognised health authority. -The use of a food-based program by government can be cost effective and reach the majority of the population.
1% or Less Campaign: Mass Media to Promote Healthy Eating -6 week intervention in cities -Mass media: paid advertising on TV, radio and newspapers and/or community-based programs	Media only approach was enough for a significant proportion of people to alter the dietary habit targeted by the intervention. Use of simple message targeting one behaviour rather than multiple or complex behaviours.	*Reger et al, 1998(22)*	
6. <u>Restaurant settings:</u> 2 studies were evaluated	No best practice		
7. <u>Home setting:</u> 4 studies were evaluated			
The Seattle Senior Farmers' Market Nutrition Pilot Program -Low-income elderly -Market baskets were delivered to the homes of seniors every 2 weeks by Meals on Wheels	This system could work well in other areas having an established Meals on Wheels (or similar) infrastructure.	*Johnson et al,1994(23)*	There is insufficient evidence to make conclusions in this regard. However it does imply that the delivery of market baskets results in increased consumption of fruit and vegetables in the elderly.
Metroville Health Study -Pakistan -Lower middle class urban households -6 Household visits & 8 maintenance visits by social workers	Using social workers is an expensive way of doing health promotion. It would have been more cost effective to use health educators.	*Aziz et al, 2003 (24)*	
8. <u>Government programs:</u> 5 studies evaluated	No best practice		
9. <u>Supermarket setting:</u> 5 studies evaluated	No best practice		
10. <u>School settings:</u> More than 80 evaluated			
PATHWAYS -American Indian (8-11 years) children in 41 schools -Three-year intervention -Classroom curriculum to promote healthy eating behaviors and PA (2 x 45 minutes over 12 weeks/year for 3rd and 4th grades and for 8 weeks during 5th grade); Physical activity program; Changes in canteen meals; Parental involvement	The program was very comprehensive and also focused on cultural identity. Trained teachers were used to do the intervention. Several indigenous learning modes ie, story telling were used. Sustainable feature are the fact that teachers do the intervention which also makes it cost-effective. Of the family-based components giving children family packs & family events at school were most successful. Process evaluation found that the interventions were successfully implemented with good reach, high extent & fidelity.	*Caballero et al, 2003(25)* *Davis et al, 2003 (26)* *Teufel et al, 1999 (27)* *Stevens et al, 2003 (28)* *Steckler et al, 2003 (29)*	There were numerous school interventions which had best practice behavioural and psycho-social outcomes, although only a few had best practice clinical outcomes. Key success factors appeared to be: A nutrition-based curriculum offered at school by trained

CATCH (Child & Adolescent Trial for Cardio-vascular Health) - Children (8-11 yrs) at 96 schools -3 year intervention Interventions comprised: -One intervention arm with school only component (curriculum & PA & food service component) -One arm with school component (curriculum & PA & food service component) plus family involvement.	Trained teachers provided the intervention. Dose effects were found for knowledge and attitudes according to parental involvement suggesting the importance of a family component. Similarly many positive dietary and PA effects continued up to grade 8. General nutrition intervention wasn't sufficient to change F & V intake. Food based targeted messages may be required. Staff training an important factor in achieving institutionalization of these programs. Also health education programs need to be compatible with school policy and priorities to be adequately institutionalized.	*Webber et al, 1996 (30)* *Edmundson et al,1996 (31)* *Lytle et al, 1996 (32)* *Nader et al, 1996 (33)* *Nader et al, 1999(34)* *Hoelscher et al, 2004(35)*	teachers' generally improved behavioural outcomes. A physical activity program/component was associated with most of the best practice clinical and behavioural outcomes. All the best practice studies included a parental/family component. All the best practice studies were grounded on a firm theory of behaviour, such as social cognitive; social marketing or stages of change. Most of the interventions which included a food service component had best practice behavioural outcomes.
CATCH (Child & Adolescent Trial for Cardio-vascular Health) Eat Smart Food Service Intervention -96 schools - 2 ½ year intervention -Trained food service staff and administrators of the - National School Lunch Program (NSLP) & School Breakfast Program - Training sessions, educational materials, newsletter and ongoing support visits.	School meals remained healthier at 5 years after completion of the intervention. CATCH Eat Smart Program assisted school cafeterias in meeting USDA guidelines (<30% E fat and <10%E sat fat) 5 years post intervention. Introduced guidelines & standards for meals	*Osganian et al, 1996 (36)* *Dwyer et al, 1996 (37)* *Hoelscher et al, 2004 (38)* ***Hoelscher et al, 2003 (39)***	
High-5 Project **(One of 9 community projects within NCI 5-a-Day for Better Health Initiative)** -Children (8-9 yrs) in 28 schools -One year intervention - Curriculum (14 lessons to 4th grade plus three short sessions in 5th grade); cafeteria changes & training; parental involvement	Project coordinators helped by teachers implemented the intervention. They also trained food service staff and coordinated parent activities. Very effective program in most sub samples suggesting program is generalizable to different groups. High implementation rates were found in the classrooms. Moderate rates in family participation.	*Reynolds et al, 2000 (40)* *Reynolds et al, 2000 (41)*	
TEENS (Teens Eating for Nutrition & Energy at School) - Grade 7-8 low income at 16 schools -2 year intervention -School environment (food service component) only -School environment plus curriculum (& parental component) -School environment plus curriculum plus peer leaders	Trained teachers and peer leaders presented the intervention to grade 7 children. Peer group training proved most successful in improving F&V intake and lower fat intake. Use of peers may be an effective and sustainable way of running programs.	*Birnbaum et al,(42)*	
Know your Body (adapted) School Health Promotion Programme -Primary school children at 16 schools -6 year intervention from grade 1to 6	Trained teachers provided the nutrition component of the intervention. PE teachers provided PA. 45-50hrs of intervention activities annually. High parental participation attributed to good	*Manios et al, 1999 (43)* ***Manios & Kafatos***	

- Curriculum- health and nutrition (13 to 17 classroom hours/year; PA program (2x45min sessions/week; parental involvement	outcomes as did the long duration of the intervention and teacher compliance in delivering the program.	***1999(44)*** *Manios et al, 2002 (45)*	
Eat Well & Keep Moving - Grade 4-5 mainly African American children at 16 schools -2 year intervention - Classroom curricula (13 lessons/year); PA program; parental involvement; food service/cafeteria	Program was integrated into existing school curricula using classroom teachers. Materials integrated into maths, science, language arts and social studies classes. Makes program replicable and sustainable. Teachers attended 1 day training and 2 meetings /year. Another outcome is marginally reduced TV viewing which has greater implications for snacking and weight gain. Classroom based materials were developed to be low cost and sustainable.	*Gortmaker et al, 1999 (46)*	
Healthy Start -Children majority low income African American & Hispanic. (2-5yr) in 9 Head Start centres -Two-year intervention Intervention done with 2 arms: -Food service only -Food service plus nutrition education Parental involvement	Chefs received one day training from dieticians. Teachers trained to deliver educational curriculum. The food service intervention was successful in decreasing dietary fat and blood cholesterol values. Limited time was allocated to the education program which may have accounted for not providing any further benefit over and above the food service intervention. Food service intervention was modelled after CATCH.	*Williams et al, 2002 (47)* *Williams et al, 2004 (48)*	
Squires Quest -26 primary schools , children 8-12 yrs -5 week intervention -Intervention: 10 session interactive multimedia game called Squires Quest. Goals related to F&V intake are set at end of every session.	A psycho-educational game for children in a multiethnic environment. The development of such games is very expensive and sufficient resources are required to use this as an educational tool which may not be appropriate in developing countries.	*Cullen et al, 2005 (49)* *Baranowski et al, 2003* (50) Cullen et al, 2004 (51)	
Evaluation of a low fat milk program -In 6 elementary schools mainly Latino). -7 to 10 day intervention -Aimed at increasing consumption of 1% milk rather than full cream milk -Based on social marketing techniques including product positioning, celebrity endorsement, taste tests, advertising, point of purchase incentives, a slogan and entertainment activities.	Focus on one specific eating behaviour. Latinos used as culturally appropriate role models. Food service staff made displays and encouraged consumption of 1% milk. Product packaging may affect product choice. Intervention does not interfere with classroom time. This is a quick and effective way to decrease sat fat intake in a large group of children.	*Wechsler et al, 1998 (52)*	
The CHIPS Study: Changing Individuals Purchase of Snacks -55 Vending machines in 12 secondary schools and 12	Average profits per machine were not affected by the interventions. Pricing and promotion had similar effects for adolescent and adult populations.	*French et al, 2001 (53)* *Reference also*	

worksites - 12 month intervention which tested: -Four pricing levels (equal price, 10%, 25% & 50% reduction) and 3 promotional conditions of low fat labels	Another possibility is to increase pricing on high fat snacks. Need to make healthy food choices available at attractive prices while maintaining overall profitability	*under workplace*	
11. <u>Workplace:</u> 30 studies were evaluated			
Worksite Cholesterol Screening with Nutrition Education -40 Worksites -One month intervention following cholesterol screening -Screening plus 5 minute education plus brochure plus group sessions and a 30minute video	The cost per person for the program works out to about 50 USD. This study also showed that longer periods may be necessary to measure changes in cholesterol.	*Byers et al, 1995 (54)*	All in all a large number of diverse types of interventions were successful in changing outcomes positively in the interventions described -: -Outcomes were generally effective when dieticians were involved in nutrition education. -Changes in the cafeteria/canteen which increased the availability of healthy food options and advertised them accordingly generally resulted in effective outcomes. -Tailored feedback on diet (and blood) values generally showed effective outcomes. -Employee involvement in planning and managing worksite programs is crucial for effective outcomes. - It appears that reducing prices (of healthy food items) in vending machines induces employees to buy healthier options. -The stages of change theory was most commonly associated with best practice outcomes.
Low Fat Worksite Intervention on Blood Lipids -15 Worksites -Intervention 8 weeks -8x 30 Minute sessions by dieticians , literature, media	This intervention would be costly in terms of using a health professional. However it may be worth while for a company to employ a health profession if long term results indicated significant improvement.	*Hartman et al, 1995 (55)*	
The Treatwell 5-a-Day Study -Adult workers (mainly low income) at 22 health centres -Intervention over 20 months with -Worksite & worksite plus family -Using employee advisory boards (worker participation); group & individual sessions; environmental changes, media, literature	One of the benefits of this program is that it is largely organized and managed by the employees. This can make it more cost effective and allow for better support by staff.	Sorensen et al, 1999 (56)	
Low-Intensity Nutrition Intervention -At 4 worksites in men -Intervention 3 months - Personal & group counselling by dieticians , mass media, literature, -Environmental changes	This intervention was successful in obtaining some self-reported dietary changes and decreased cholesterol levels in high risk men.	Braeckman et al, 1999 (57)	
Minimal Intervention to Reduce Fat Intake -Hospital workers mostly females -Intervention once off feedback on baseline survey -Personalized feedback informing them of their current diet fat intake & literature	Personalized feedback is relatively quick and inexpensive and could be administered by someone with training.	*Armitage & Conner 2001 (58)*	
Changing Risk Factors for Chronic Diseases -Men at 2 manufacturing worksites -Intervention 6 months -Key workers consulted in planning the program -Group counselling -Caféteria/food service changes and point of purchase advertising	A low level intervention can significantly improve certain risk behaviours including diet and knowledge. A longer duration may be necessary for some physical improvements.	Cook et al, 2001 (59)	

The CHIPS Study: Changing Individuals Purchase of Snacks -55 vending machines in 12 secondary schools & 12 worksites - 12 month intervention. -Four pricing levels (equal price, 10%, 25% & 50% reduction) - Low fat labelling	Average profits per machine were not affected by the interventions. Need to make healthy food choices available at attractive prices while maintaining overall profitability	*French et al, 2001(53)*	
Heart at Work Program (American Heart Association) -2 Manufacturing sites -Intervention over 1 year Multi-component intervention using a nurse co-ordinator: -4 Modules (2x PA, low fat diet & knowledge on CVD risk), mass media, cafeteria changes, PA, screening, personal diet feedback	Onsite health care coordinator-a nurse responsible for program implementation and provide feedback for those at CVD risk. Ability to influence behavior and clinical measures may require a more intensive intervention.	*Pegus et al, 2002 (60)*	
Danish 6-a-day Worksite Canteen Model Study -In 5 worksites with canteens) -Intervention of 1 year -Cafeteria/food services changes -8 Hours training of canteen staff -Environmental & structural strategies used in canteens	One of the advantages of this program is that it can be cost effective since it involves initial 8 hour training for staff, followed by goal setting and 3-4 interim support visits. The canteen managers and staff themselves have a lot of freedom	Lassen et al, 2003 (61)	
Interactive Multimedia Program (IMP) -2 Worksites) mainly female, -30 day intervention -Comprised a computer program tailored to the user by gender, interests, race & age combining audio, video, graphics and printouts	The IMP approach may be effective for persons with poor reading skills. Easy user friendly program not requiring computer skills. Valuable tool to use by companies who have workers with low reading skills since it is cost effective and can be used by large numbers.	Irvine et al, 2004 (62)	
CHIP: Coronary Health Improvement Project -Medical care provider employees -Intervention over 4 weeks -Lecture educational course over 4 weeks (4x 2hrs /week) by health professionals at a local college, literature, shopping tours, cooking demonstrations by dieticians	This intensive program was offered by a local college offsite in conjunction with dieticians and medical professionals which makes it a costly intervention.	Aldana et al, 2005 (63)	
12. Primary Health Care: 32 studies evaluated			
WATCH-Worcester Area Trial for Counselling in Hyperlipidemia -Adults in upper 25th percentile cholesterol at first meeting -Intervention 1 year (4 visits) -45 Primary care physicians trained 3 hours to do nutrition counselling	Overall the study showed that brief supported physician nutrition counselling can produce beneficial effects in diet, weight and blood lipids. However training of physicians alone was not sufficient to bring about significant changes	*Ockene et al, 1996 (64)* *Ockene et al, 1999(65)*	-Physician endorsed advice to patients was generally associated with best practice outcomes. -Consultations by a dietician with follow up were generally found to have best practice behavioural
WATCH-Worcester Area Trial for Counselling in Hyperlipidemia -Massachusetts, USA	This intervention shows the effectiveness of a dietician-delivered intervention in the care of patients with hyperlipidaemia. These effects were	*Herbert et al 1999(66)*	

-Adults in upper 25th percentile cholesterol -4 Sessions over 1 year -2 Group & 2 Individual sessions conducted over 6 weeks by a dietician.	additive to those of the physician-delivered intervention		outcomes. -A few studies had best practice outcomes when consultations were done by a trained nurse with follow up. -The majority of best practice studies relied on the stages of change model of behaviour change. -The use of motivational or negotiation methods of interviewing appeared to be effective in the studies which used them as tools.
Behavioural Counselling on Fruit and Vegetable Consumption - Adults; low income -Intervention over 2 weeks -2-3 x 20 Minute behavioural counselling consultations over 2 weeks by active nurses	Consultations by nurses who were trained over 3 days by psychologists. This may be feasible in any PHC centre where nurses work except that it would increase their workload. Behavioural intervention for fat reduction was particularly effective for patients in pre-contemplation and contemplation stages at baseline.	*Steptoe et al 1999 (67)* *Steptoe et al, 2003.(68)* *Steptoe et al, 200l(69)*	
Health Lifestyle Pattern –Secondary Data Analysis of The Eating Patterns Study -See Beresford et al,1997 -Participants were grouped into 6 lifestyle patterns according to diet, alcohol, PA & smoking status		*O'Halloran et al, 2001 (70)*	
Fruit and Vegetable Trial -Healthy 25-64 year olds at 2 general practices -Intervention 6 months -Comprised of 2 sessions -Individual counselling by a nurse with leaflets. -Phone follow up at 2 weeks & mail at 3mths	Nurses conducted the trial and were trained in the brief negotiation method. Overall this intervention can be regarded as being reasonably cost-effective since the clients only have 2 visits and individual counselling is at a minimum.	*John et al, 2002 (71)* *John et al, 2003. (72)*	
Women's Health Initiative Dietary Modification Trial (WHIDM) plus Motivational Interviewing - Post menopausal women participating in the WHI Dietary Modification Intervention -5 Month intervention -Three individual motivational interviewing contacts in person or by phone from a dietician plus the usual WHI dietary intervention.	Difficult to implement outside of a research setting, especially in developing country settings. Very labour intensive with trained dieticians. Study can't really be generalised to ethnically diverse or impoverished groups.	*Bowen et al, 2002(73)*	
Women's Health Initiative Dietary Modification Trial (WHIDM) -Menopausal women aged 50-79 years from 40 clinical centres across USA - 8 Year intervention-2 year results -18 Group sessions in first year followed by group maintenance sessions once every three months by nutritionists	Trained nutritionists run intervention sessions which make it costly. Race and ethnicity differences observed in food selections which highlights the importance of designing culturally appropriate interventions. See also comments below	*Patterson et al, 2003 (74)*	
Women's Health Initiative Dietary Modification Trial -Menopausal women aged 50-79 from 40 clinical centers	Used a Special Populations Advisory Committee to make intervention culturally appropriate. Group	*Patterson et al,2003(75)*	

-5 Years of 8 year intervention	sessions attendance was strongly associated with poorer adherence as were low income, being African American or Hispanic, being older and being obese.	*Patterson et al, 2004 (76)*	
Women's Health Initiative Dietary Modification Trial -Menopausal women aged 50-79 from 40 clinical centers - 8 Year intervention results	It needs to be recognised that this was a very comprehensive and extensive study which required large capital and human resources. This may not be an option in developing countries	*Beresford et al, 2006 (77)* *Prentice et al, 2006 (78)* *Howard et al,2006 (79)* *Howard et al, 2006 (80)*	
Oxford Fruit & Vegetable Study -Healthy adults aged 25 to 64 years. -2 Consultations 6 months apart - Nutrition education by a brief negotiation model done by a trained research nurse	Interviews done by trained nurses. The outcomes need to be measured in the long term	*Huxley et al, 2004.(81)*	

References for Systematic Review

1. French SA, Jeffery RW, Story M, Hannan P, Snyder MP. 1997. "A pricing strategy to promote low-fat snack choices through vending machines." *Am J Public Health* 87:849-851.

2. Howard PB, Winkleby MA, Albright CL, Bruce B, Fortmann SP. 1997. "The Stanford Nutrition Action Program: a dietary fat intervention for low-literacy adults." *Am J Public Health* 87(12):1971-1976.

3. Campbell MK, Demark-Wahnefried W, Symons M, Kalsbeek WD, Dodds J, Cowan A et al. 1999. "Fruit and vegetable consumption and prevention of cancer: the Black Churches United for Better Health project." *Am J Public Health* 89(9):1390-139

4. Yanek LR, Becker DM, Moy TF, Gittelsohn J, Koffman DM. 2001. "Project Joy: faith based cardio-vascular health promotion for African American women." *Public Health Rep* 116 Suppl 1:68-81.

5. Resnicow K, Jackson A, Wang T, De AK, McCarty F, Dudley WN et al, 1999. "A motivational interviewing intervention to increase fruit and vegetable intake through Black churches: results of the Eat for Life trial." *Am J Public Health* 91(10):1686-1693.

6. Resnicow K, Campbell MK, Carr C, McCarty F, Wang T, Periasamy S et al, 2004. "Body and soul. A dietary intervention conducted through African-American churches." *Am J Prev Med* 27(2):97-105.

7. Resnicow K, Jackson A, Blissett D, Wang T, McCarty F, Rahotep S et al, 2005. "Results of the healthy body healthy spirit trial." *Health Psychol* 24(4):339-348.

8. Simkin SL, Wing RR, Hansen DH, Klem ML, Pasagian-Macaulay AP, Meilahn EN et al, 1995 "Prevention of cardio-vascular risk factor elevations in healthy premenopausal women." *Preventive Medicine* 24(5):509-517.

9. Simkin-Silverman LR, Wing RR, Boraz MA, Kuller LH. 2003. "Lifestyle intervention can prevent weight gain during menopause: results from a 5-year randomized clinical trial." *Ann Behav Med* 26(3):212-220.

10. Marcus AC, Heimendinger J, Wolfe P, Rimer BK, Morra M, Cox D et al, 1998. "Increasing fruit and vegetable consumption among callers to the CIS: results from a randomized trial." *Preventive Medicine* 27(5 Pt 2):S16-S28.

11. Marcus AC, Heimendinger J, Wolfe P, Fairclough D, Rimer BK, Morra M et al, A randomized trial of a brief intervention to increase fruit and vegetable intake: a replication study among callers to the CIS. Preventive Medicine 2001; 33(3):204-216.

12. Cox DN, Anderson AS, Reynolds J, McKellar S, Lean MEJ, Mela DJ. Take Five, a nutrition education intervention to increase fruit and vegetable intakes: Impact on consumer choice and nutrient intakes. Br J Nutr 1998; 80(2):123-131.

13. Coates RJ, Bowen DJ, Kristal AR, Feng Z, Oberman A, Hall WD et al, The Women's Health Trial Feasibility Study in Minority Populations: Changes in dietary intakes. *Am J Epidemiol* 1999; 149(12):1104-1112.

14. Wylie-Rosett J, Swencionis C, Gindberg M, Cimino C, Wassertheil-Smoller S, Caban A, Segal-Isaacson CJ, Martin T, Lewis J. Computerized weight loss intervention optimizes staff time: the clinical and cost results of a controlled clinical trial conducted in a managed care setting. *J Am Diet Assoc* 2001; 101:1155-62.

15. Rowley KG, Su Q, Cincotta M, Skinner M, Skinner K, Pindan B et al, Improvements in circulating cholesterol, antioxidants, and homocysteine after dietary intervention in an Australian Aboriginal community. Am J Clin Nutr 2001; 74(4):442-448.

16. Stevens VJ, Glasgow RE, Toobert DJ, Karanja N, Smith KS. Randomized trial of a brief dietary intervention to decrease consumption of fat and increase consumption of fruits and vegetables. Am J Health Promot 2002; 16(3):129-134.

17. Stevens VJ, Glasgow RE, Toobert DJ, Karanja N, Smith KS. One-year results from a brief, computer-assisted intervention to decrease consumption of fat and icnrease consumption of fruits and vegetables. Preventive Medicine 2003; 36(5):594-600.

18. Burke V, Giangiulio N, Gillam HF, Beilin LJ, Houghton S. Physical activity and nutrition programs for couples: a randomized controlled trial. J Clin Epidemiol 2003; 56(5):421-432.

19. Burke V, Giangiulio N, Gillam HF, Beilin LJ, Houghton S. Changes in cognitive measures in a randomized controlled trial of a health promotion program for couples targeting diet and physical activity. Am J Health Promot 2006; 18(4):300-311.

20. Aldana SG, Greenlaw RL, Diehl HA, Salberg A, Merrill RM, Ohmine S et al, Effects of an intensive diet and physical activity modification program on the health risks of adults. J Am Diet Assoc 2005; 105(3):371-381.

21.Uusitalo U, Feskens EJM, Tuomilehto J, Dowse G, Haw U, Fareed D et al, Fall in total cholesterol concentration over five years in association with changes in fatty acid composition of cooking oil in Mauritius: Cross sectional survey. Br Med J 1996; 313(7064):1044-1046.

22.Reger B, Wootan MG, Booth-Butterfield S, Smith H. 1% or less: a community-based nutrition campaign. Public Health Rep 1998; 113(5):410-419.

23.Johnson DB, Beaudoin S, Smith LT, Beresford SA, LoGerfo JP. Increasing Fruit and Vegetable Intake in Homebound Elders: The Seattle Seniors Farmers' Market Nutrition Pilot Program. Preventing Chronic Disease Public Health Research, Practice, and Policy 2004; 1(1):1-9.

24.Aziz KU, Dennis B, Davis CE, Sun K, Burke G, Manolio T et al, Efficacy of CVD risk factor modification in a lower-middle class community in Pakistan: the Metroville Health Study. Asia Pac J Public Health 2003; 15(1):30-36.

25.Caballero B, Clay T, Davis SM, Ethelbah B, Rock BH, Lohman T et al, Pathways: a school-based, randomized controlled trial for the prevention of obesity in American Indian schoolchildren. Am J Clin Nutr 2003; 78(5):1030-1038.

26.Davis SM, Clay T, Smyth M, Gittelsohn J, Arviso V, Flint-Wagner H et al, Pathways curriculum and family interventions to promote healthful eating and physical activity in American Indian schoolchildren. Preventive Medicine 2003; 37: S24-S34.

27.Teufel NI, Perry CL, Story M, Flint-Wagner H, Levin S, Clay TE et al, Pathways family intervention for third-grade American Indian children. Am J Clin Nutr 1999;69(suppl): 803S-809S.

28.Stevens J, Story M, Ring K, Murray DM, Cornell CE, Juhaeri et al, The impact of the Pathways intervention on psychosocial variables related to diet and physical activity in American Indian schoolchildren. Preventive Medicine 2003; 37(6 Pt 2):S70-S79.

29.Steckler A, Ethelbah B, Martin CJ, Stewart D, Pardilla M, Gittelsohn J et al, Pathways process evaluation results: a school-based prevention trial to promote healthful diet and physical activity in American Indian third, fourth and fifth grade students. Preventive Medicine 2003; 37(6 Pt 2):S80-S90.

30.Webber LS, Osganian SK, Feldman HA, Wu M, McKenzie TL, Nichaman M et al, Cardio-vascular Risk Factors among Children after a 2 1/2- Year Intervention - The CATCH Study. Preventive Medicine 1996; 25:432-441.

31.Edmundson E, Parcel GS, Feldman HA, Elder J, Perry CL, Johnson CC et al, The effects of the Child and Adolescent Trial for Cardio-vascular Health upon

psychosocial determinants of diet and physical activity behavior. Preventive Medicine 1996; 25(4):442-454.

32.Lytle LA, Stone EJ, Nichaman MZ, Perry CL, Montgomery DH, Nicklas TA et al, Changes in nutrient intakes of elementary school children following a school-based intervention: results from the CATCH Study. Preventive Medicine 1996; 25(4):465-477.

33.Nader PR, Sellers DE, Johnson CC, Perry CL, Stone EJ, Cook KC et al, The effect of adult participation in a school-based family intervention to improve Children's diet and physical activity: the Child and Adolescent Trial for Cardio-vascular Health. Preventive Medicine 1996; 25(4):455-464.

34.Nader PR, Stone EJ, Lytle LA, Perry CL, Osganian SK, Kelder S et al, Three-year maintenance of improved diet and physical activity: The CATCH cohort. Arch Pediatr Adolesc Med 1999; 153(7):695-704.

35.Hoelscher DM, Feldman HA, Johnson CC, Lytle LA, Osganian SK, Parcel GS et al, School-based health education programs can be maintained over time: results from CATCH Institutionalization study. Preventive Medicine 2004; 38(5):594-606.

36.Osganian SK, Ebzery MK, Montgomery DH, Nicklas TA, Evans MA, Mitchell PD et al, Changes in the nutrient content of school lunches: results from the CATCH Eat Smart Food service Intervention. Preventive Medicine 1996; 25(4):400-412.

37.Dwyer JT, Hewes LV, Mitchell PD, Nicklas TA, Montgomery DH, Lytle LA et al, Improving school breakfasts: effects of the CATCH Eat Smart Program on the nutrient content of school breakfasts. Preventive Medicine 1996; 25(4):413-422.

38.Hoelscher DM, Mitchell P, Dwyer J, Elder J, Clesi A, Snyder P. How the CATCH eat smart program helps implement the USDA regulations in school cafeterias. Health Educ Behav 2003; 30(4):434-446.

39.Hoelscher DM, Feldman HA, Johnson CC, Lytle LA, Osganian SK, Parcel GS et al, School-based health education programs can be maintained over time: results from CATCH Institutionalization study. Preventive Medicine 2004; 38(5):594-606.

40.Reynolds KD, Franklin FA, Binkley D, Raczynski JM, Harrington KF, Kirk KA et al, Increasing the fruit and vegetable consumption of fourth-graders: results from the high 5 project. Preventive Medicine 2000; 30(4):309-319.

41. Reynolds KD, Franklin FA, Leviton LC, Maloy J, Harrington KF, Yaroch AL et al, Methods, results, and lessons learned from process evaluation of the high 5 school-based nutrition intervention. SO: Health Educ Behav 2000; 27(2):177-186

42. Birnbaum AS, Lytle LA, Story M, Perry CL, Murray DM. Are differences in exposure to a multicomponent school-based intervention associated with varying dietary outcomes in adolescents? Health Educ Behav 2002; 29(4):427-443.

43. Manios Y, Moschandreas J, Hatzis C, Kafatos A. Evaluation of a health and nutrition education program in primary school children of Crete over a three-year period. Preventive Medicine 1999; 28(2):149-159.

44. Manios Y, Kafatos A. Health and nutrition education in elementary schools: changes in health knowledge, nutrient intakes and physical activity over a six year period. Public Health Nutr 1999; 2(3A):445-448.

45. Manios Y, Moschandreas J, Hatzis C, Kafatos A. Health and nutrition education in primary schools of Crete: changes in chronic disease risk factors following a 6-year intervention programme. Br J Nutr 2002; 88(3):315-324.

46. Gortmaker SL, Cheung LW, Peterson KE, Chomitz G, Cradle JH, Dart H et al, Impact of a school-based interdisciplinary intervention on diet and physical activity among urban primary school children: eat well and keep moving. Arch Pediatr Adolesc Med 1999; 153(9):975-983.

47. Williams CL, Bollella MC, Strobino BA, Spark A, Nicklas TA, Tolosi LB et al, "Healthy-start": outcome of an intervention to promote a heart healthy diet in preschool children. J Am Coll Nutr 2002; 21(1):62-71.

48. Williams CL, Strobino BA, Bollella C, Brotanek J. Cardio-vascular Risk Reduction in Preschool Children: The "Healthy Start" Project. J Am Coll Nutr 2004; 23(2): 117-123.

49. Cullen KW, Watson K, Baranowski T, Baranowski JH, Zakeri I. Squire's Quest: intervention changes occurred at lunch and snack meals. Appetite 2005; 45(2):148-151.

50. Baranowski T, Baranowski J, Cullen KW, Marsh T, et al, Squire's Quest! Dietary outcome evaluation of a multimedia game. Am J Prev Med 2003; 24(1):108-109.

51. Cullen KW, Zakeri I, Pryor EW, Baranowski T, Baranowski J, Watson K. Goal setting is differentially related to change in fruit, juice, and vegetable consumption among fourth-grade children. Health Educ Behav 2004; 31(2):258-269.

52. Wechsler H, Basch CE, Zybert P, Shea S. Promoting the selection of low-fat milk in elementary school cafeterias in an inner-city Latino community: Evaluation of an intervention. Am J Public Health 1998; 88(3):427-433.

53.French SA, Jeffery RW, Story M, et al, 2001. “Pricing and promotion effects on low-fat vending snack purchases: the CHIPS Study.” *Am J Public Health* 91(112):117

54.Byers T, Mullis R, Anderson J, Dusenbury L, Gorsky R, Kimber C et al, 1995. “The costs and effects of a nutritional education program following work-site cholesterol screening.” *Am J Public Health* 85(5):650-655.

55.Hartman TJ, Himes JH, McCarthy PR, Kushi LH. 1995. “Effects of a low-fat, worksite intervention on blood lipids and lipoproteins.” *J Occup Environ Med* 37(6):690-696.

56.Sorensen G, Stoddard A, Peterson K, Cohen N, Hunt MK, Stein E et al, 1999. “Increasing fruit and vegetable consumption through worksites and families in the Treatwell 5-a-day study.” *Am J Public Health* 89(1):54-60.

57.Braeckman L, De Bacquer D, Maes L, De Backer G. 1999. “Effects of a low-intensity worksite-based nutrition intervention.” *Occup Med (Lond)* 49(8):549-555.

58. Armitage CJ, Conner M. 2001. Efficacy of a minimal intervention to reduce fat intake. *Social Sci Med* 52(10):1517-1524.

59.Cook C, Simmons G, Swinburn B, Stewart J. 2001. “Changing risk behaviours for non-communicable disease in New Zealand working men - is workplace intervention effective?” *N Z Med J* 114(1130):175-178.

60.Pegus C, Bazzarre TL, Brown JS, Menzin J. 2002. “Effect of the Heart At Work program on awareness of risk factors, self-efficacy, and health behaviors.” *J Occup Environ Med* 44(3):228-236.

61.Lassen A, Thorsen AV, Trolle E, Elsig M, Ovesen L. 2004. “Successful strategies to increase the consumption of fruits and vegetables: results from the Danish '6 a day' Work-site Canteen Model Study. *Public Health Nutr* 7(2):263-270.

62.Irvine AB, Ary DV, Grove DA, Gilfillan-Morton L. The effectiveness of an interactive mulitmedia program to influence eating habits. *Health Educ Res* 2004; 19(3): 290-305.

63.Aldana SG, Greenlaw RL, Diehl HA, Salberg A, Merrill RM, Ohmine S. The effects of a worksite chronic disease prevention program. *Journal of occupational and environmental medicine / Am Coll Occupational Environ Med* 2005; 47(6):558-564.

64.Ockene IS, Hebert JR, Ockene JK, Merriam PA, Hurley TG, Saperia GM. 1996. “Effect of training and a structured office practice on physician-delivered nutrition counseling: the Worcester-Area Trial for Counseling in Hyperlipidemia (WATCH).” *Am J Prev Med* 12(4):252-258.

65. Ockene IS, Herbert JR, Ockene JK, Merriam PA, Hurley TG, Saperia GM. 1996. “Effect of training and a structured office practice on physician-delivered nutrition counselling: the Worcester-Area Trial for Counselling in Hyperlipidaemia (WATCH).” *Am J Prev Med* 1996; 12 (4): 252-8.

66. Herbert JR, Ebbeling CB, Ockene IS, Ma Y, Rider L, Merriam PA, Ockene JK, Saperia GM. 1999. “A dietitian-delivered group nutrition program leads to reductions in dietary fat, serum cholesterol, and body weight: the Worcester-Area Trial for Counselling in Hyperlipidaemia (WATCH).” *J Am Diet Assoc* 99(5):544-52.

67. Steptoe A, Doherty S, Rink E, Kerry S, Kendrick T, Hilton S. 1999. “Behavioural counselling in general practice for the promotion of healthy behaviour among adults at increased risk of coronary heart disease: randomised trial.” *BMJ* 319(7215):943-947.

68. Steptoe A, Perkins-Porras L, McKay C, Rink E, Hilton S, Cappuccio FP. 2003. “Behavioural counselling to increase consumption of fruit and vegetables in low income adults: randomized trial. *BMJ* 326(7394):855.

69. Steptoe A, Kerry S, Rink E, Hilton S. 2001. “The impact of behavioral counseling on stage of change in fat intake, physical activity, and cigarette smoking in adults at increased risk of coronary heart disease.” *Am J Public Health* 91(2):265-269.

70. O'Halloran P, Lazovich D, Patterson RE, Harnack L, French S, Curry SJ et al, 2001. “Effect of health lifestyle pattern on dietary change.” *Am J Health Promot* 16(1):27-33.

71. John JH, Ziebland S, Yudkin PL, Roe L, Neil HA. 2002. “Effects of fruit and vegetable consumption on plasma antioxidant concentrations and blood pressure: a randomised controlled trial.” *The Lancet* 359:1969-1974.

72. John JH, Yudkin PL, Neil HAW, Ziebland S. 2003. “Does stage of change predict outcome in a primary-care intervention to encourage an increase in fruit and vegetable consumption?” *Health Educ Res* 18(4):429-438.

73. Bowen DB, Ehret C, Pedersen M, Snetselaar L, Johnson M, Tinker L et al, 2002. “Results of an adjunct dietary intervention program in the Women's Health Initiative. *J Am Diet Assoc* 102(11):1631-1637.

74. Patterson RE, Kristal A, Rodabough R, Caan B, Lillington L, Mossavar-Rahmani Y et al, 2003. “Changes in food sources of dietary fat in response to an intensive low-fat dietary intervention: early results from the Women's Health Initiative.” *J Am Diet Assoc* 103(4):454-460.

75. Patterson RE, Kristal A, Rodabough R, Caan B, Lillington L, Mossavar-Rahmani Y, Micheals S, Snetselaar L, Van Horn L. 2003. “Changes in food sources of dietary fat in response to an intensive low-fat dietary intervention: Early results from the Women’s Health Initiative.” *J Am Diet Assoc* 103:454-60.

76. Patterson RE. 2004. “Dietary adherence in the women's health initiative dietary modification trial.” *J Am Diet Assoc* 104(4):654-658.

77. Beresford SA, Johnson KC, Ritenbaugh C, Lasser NL, Snetselaar LG, Black HR, et al, 2006. “Low-fat dietary pattern and risk of colorectal cancer: the Women’s Health Initiative Randomised Controlled Dietary Modification Trial.” *JAMA* 295 (6):643-54.

78. Prentice RL, Caan B, Chlebowski RT, Patterson R, Kuller LH, Ockene JK et al, 2006. “Low-fat dietary pattern and risk of invasive cancer: the Women’s Health Initiative Randomised Controlled Dietary Modification Trial.” *JAMA* 295 (6):629-42.

79. Howard BV, Van Horn L, Hsia J, Manson JE, Stefanick ML, Wassertheil-Smoller S et al, 2006, “Low-fat dietary pattern and risk of cardio-vascular disease: the Women’s Health Initiative Randomised Controlled Dietary Modification Trial.” *JAMA* 295 (6):655-66

80. Howard BV, Manson JE, Stefanick ML, Beresford SA, Frank G, Jones B et al, 2006. “Low-fat dietary pattern and risk of colorectal cancer: the Women’s Health Initiative Randomised Controlled Dietary Modification Trial.” *JAMA* 295 (6):639-49.

81. Huxley RR, Lean M, Crozier A, John JH, Neil HA. 2004. “Effect of dietary advice to increase fruit and vegetable consumption on plasma flavonol concentrations: results from a randomised controlled intervention trial.” *J Epidemiol Community Health* 58(4):288-289.