The social drift phenomenon: Associations between the socio-economic status and cardiovascular disease risk in an African population undergoing a health transition

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ABSTRACT

Background:

The global burden of cardiovascular diseases (CVDs) is escalating as part of the rapid health transition that developing countries are experiencing. This increase is associated with shifts in demographics and economics, two of the major factors that affect diet and activity. The term *social drift phenomenon* (SDP) is used to describe the observations that: in the early stages of the epidemiological and nutrition transitions, it is usually the more affluent, higher socio-economic groups that are affected; in the later stages, it is the poor, lower socio-economic groups that display the consequences of these transitions. Therefore, in developing countries at the beginning of the transition, affluent people have higher prevalence of obesity and increased CVD risk. In developed countries, at much later stages of the transition, obesity and increased CVD risk is more prevalent in the lower socio-economic groups.

In South Africa, the Transition and Health during Urbanisation of South Africans (THUSA) study which was done in 1996/1998 indicated that at that time, most of the risk factors for CVD were observed in the more urbanised (richer) subjects. It is not known if this pattern changed in any way due to the present rapid urbanisation of South African blacks. Therefore, in this study we explored the associations between socio-economic status (SES) (measured by level of urbanisation, education and employment) and CVD risk factors in an African population undergoing transition in the North-West Province of South Africa, that were prevalent in 2005 when the baseline data for in the Prospective Urban and Rural Epidemiology (PURE) study were collected.

Objectives:

The main objective of this dissertation was to examine the SDP in an African population in a nutrition and health transition, by: (i) Reviewing the literature on associations between socio-economic variables and biological health outcomes focusing on CVD risk factors in developed and developing countries; (ii) Analysing the baseline data from the 2005 PURE study to examine the relationships between components of SES, namely level of
urbanisation, education and occupation, and nutrition-related CVD risk factors in men and women participating in the PURE study; and (iii) Comparing results on these associations between CVD risk factors and SES from the PURE study with those found in the THUSA study, which was conducted almost 10 years earlier, to examine if social drift in these associations has taken place.

**Study design:**

The dissertation is based on a comparison of the CVD risk factors and socio-economic status of the THUSA and PURE studies. Secondary analysis of the baseline cross-sectional epidemiological data from the PURE study was executed. The South African PURE study is part of a 12-year Prospective Urban and Rural Epidemiology study which investigates the health transition in urban and rural subjects in 22 different countries. The main selection criterion was that there should be migration stability within the chosen rural and urban communities. The rural community (A) was identified 450 km west of Potchefstroom on the highway to Botswana. A deep rural community (B), 35 km east from A and only accessible by gravel road, was also included. Both communities are still under tribal law. The urban communities (C and D) were chosen near the University in Potchefstroom. Community C was selected from Ikageng, the established part of the township next to Potchefstroom, and D from the informal settlements surrounding community C. The baseline data for PURE were collected from October to December 2005. A total of 2010 apparently healthy African volunteers (35 years and older), with no reported chronic diseases of lifestyle, tuberculosis (TB) or known human immunodeficiency virus (HIV) were recruited from a sample of 6000 randomly selected households.

**Methods:**

A variety of quantitative and qualitative research techniques was used by multidisciplinary teams to collect, measure and interpret data generated from biological samples and validated questionnaires. For this study, the statistical package for social sciences (SPSS) package (version 17.0, SPSS Inc) was used to analyze the data. Means and 95%
confidence intervals (CI) of CVD risk and dietary factors were calculated. Participants of both genders were divided into different groups (according to urbanisation, education and employment levels) and compared. Estimated significant differences between rural and urban participants were determined with analysis of variance using the general linear model (GLM), multivariate procedure. Univariate analysis was used to explore further the influence of education on CVD risk factors and dietary intakes. Employment was used as a proxy for income, and pairwise comparisons using GLM, multivariate procedure were done for comparing the three groups (Not answered, employed and not employed). Tests were considered significant at P<0.05.

**Results:**

Comparison of urban with rural subjects participating in the PURE study showed that urban men had significantly higher systolic and diastolic blood pressures and lower fibrinogen levels than rural men. In women, systolic and diastolic blood pressure, fasting blood glucose and serum triglycerides were significantly higher in urban subjects whereas fibrinogen levels were significantly lower among urban subjects. After examining the relationship between the level of education and CVD risk factors, we observed that men with higher education levels had significantly higher BMI. In women, serum triglycerides and blood pressure were lower and BMI was significantly higher in the educated subjects. Because it was difficult to distinguish between reported household and individual income levels, we compared CVD risk factors of employed and unemployed subjects. Employed men had significantly higher BMI whereas the unemployed men had significantly higher fasting glucose and fibrinogen levels. Although mean blood pressure of employed men was higher than that of unemployed men, the difference did not reach significance. In women, the only significant difference seen was that employed women had lower high density lipoprotein (HDL) cholesterol, fasting glucose, triglycerides and fibrinogen levels, but they had a significantly higher BMI. Employed women had significantly higher BMI than unemployed women (27.9 [26.3-29.4] versus 26.5 [26.0-27.0] kg/m²). It seems that most of the nutrition related CVD risk factors were still higher in the higher socio-economic group, a situation similar to that reported in the THUSA study.
Conclusion:

The results of this study showed little evidence of a major social drift in CVD risk factors from subjects participating in the 1996/1998 THUSA study to those in the 2005 PURE study. Most cardiovascular disease risk factors are still higher in the higher SES groups. However, there were some indications (increased fibrinogen in both men and women living in rural areas; higher triglyceride and fasting glucose levels in unemployed women; no significant differences in blood pressure and total cholesterol across different SES groups which existed in the THUSA study) that a social drift in CVD risk factors in our African population is on the way. This means that promotion of healthy, prudent diets and lifestyles should be targeted to Africans from all socio-economic levels for the prevention of CVD.

KEYWORDS

Cardiovascular disease risk factors; Socio-economic status; Africans; Developing/developed country; Nutrition transition; Education level; Rural; Urban; Employment/unemployment; North West Province of South Africa; PURE study; THUSA study.
ABSTRAK

Agtergrond:

Die globale lading van kardiovaskulêre siekte (KVS) is besig om toe te neem, veral as gevolg van ’n toename in lande wat tans die vinnige gesondheidsoorgang beleef. Hierdie toename hou verband met demografiese en ekonomiese veranderinge, twee faktore wat dieet en aktiwiteit beïnvloed. Die term, sosiale verskuiwings-fenomeen (SVF) word gebruik om aan te toon dat in die vroeë stadium van die epidemiologiese en voedingstransisie dit gewoonlik die meer welvarende, hoër sosio-ekonomiese groepe is wat geaffekteer word; in latere stadiums van die transisie, is dit die laer sosio-ekonomiese groepe wat die gevolge van die transisie toon. In ontwikkelende lande is dit dus die welvarende deel van die bevolking wat ’n groter voorkoms van vetsugtigheid en KVS risiko het. In ontwikkelde lande is die risiko vir KVS groter in die laer sosio-ekonomiese groepe.

In Suid-Afrika het die THUSA-studie wat van 1996 tot 1998 gedoen is, bevind dat die meeste risikofaktore vir KVS in die verstedelike, ryker proefpersone voorgekom het. Dit is nie bekend of hierdie patroon enigsins in die afgelope tyd as gevolg van die vinnige verstedeliking van swart Suid-Afrikaners verander het nie. Daarom is die verwantskappe tussen sosio-ekonomiese status (SES) soos gemeet aan verstedeliking, opvoedingspeil en indiensneming/werkloosheid, en KVS risikofaktore in die swart bevolking van die Noord-Wes provinsie in hierdie studie ondersoek deur die basislyn data van die PURE-studie ("Prospective Urban and Rural Epidemiology") wat in 2005 ingesamel is te ontleed.

Doelwitte:

Die hoofdoelwit van hierdie verhandeling was om die SVF in ’n swart Suid-Afrikaanse populasie te ondersoek deur: (i) die literatuur oor die verwantskappe tussen sosio-ekonomiese veranderlikes en biologiese gesondheidsuitkomstes te bestudeer, met ’n fokus op KVS risikofaktore in ontwikkelde en ontwikkelende lande; (ii) om die basislyndata van die PURE-studie te analiseer om die verwantskap tussen SES (vlak van verstedeliking, opvoeding en beroep) en die voedingsverwante KVS risikofaktore van manlike en vroulike
deelnemers aan die studie te ondersoek; en (iii) om die verwantskappe tussen SES en KVS risiko wat in die PURE studie verkry word, te vergelyk met die wat bykans 10 jaar vroeër in die THUSA-studie bevind is, om vas te stel of daar wel ’n verskuiwing van die risiko van die hoër na die laer sosio-economiese groepe plaasgevind het.

**Studie-ontwerp:**

Die verhandeling is gebaseer op ’n vergelyking van SES en KVS risikofaktore in die THUSA en PURE-studies. Sekondêre analise van die dwarsdeursnit epidemiologiese data van die PURE-studie is gedoen. Die Suid-Afrikaanse PURE-studie is deel van die 12-jaar “Prospective Urban and Rural Epidemiological” studie wat die gesondheidsoorgang in 22 ontwikkelende lande se verskillende gebiede ondersoek. Die verhandeling is gebaseer op ’n vergelyking van SES en KVS risikofaktore in die THUSA en PURE-studies. Sekondêre analise van die dwarsdeursnit epidemiologiese data van die PURE-studie is gedoen. Die Suid-Afrikaanse PURE-studie is deel van die 12-jaar “Prospective Urban and Rural Epidemiological” studie wat die gesondheidsoorgang in 22 ontwikkelende lande se verskillende gebiede ondersoek. Die vernaamste seleksie kriteria was dat daar stabiliteit in migrasie in die ondersoekgebiede moes wees. Die platelandse gemeenskap (A) is gekies, 450 km wes van Potchefstroom op die hoofweg na Botswana. ’n Gebied B, 35 Km Wes van A wat met ’n grondpad bereik kon word, is ook gekies. Beide A en B is onder stambestuur. Die verstedelikte gemeenskappe C en D was Ikageng, deel van die groter Potchefstroom en plakkerskampe rondom Ikageng. Die PURE-basislyn data is in Oktober-Desember 2005 ingesamel. ’n Totaal van 2010 klaarblyklike gesonde vrywilligers, 35 jaar en ouer, met geen gerapporteerde chroniese siektes soos tuberkulose of MIV nie, is uit 6000 ewekansig geselekteerde huishoudings gewerf om aan die PURE-studie deel te neem.

**Metodes:**

Multidissiplinêre navorsingspanne het ’n verskeidenheid kwantitatiewe en kwalitatiewe tegnieke gebruik om biologiese data en inligting in te samel, te ontleed en te interpreteer. Vir hierdie verhandeling is statistiese analises met die SPSS-pakket (uitgawe 17.0, SPSS geïnkorporeer) gedoen. Gemiddeldes en 95% vertroulikheidsintervalle (VI) van die KVS risikofaktore is bereken. Manlike en vroulike deelnemers is in verskillende groepe ingedeel op grond van vlakte van verstedeliking, opvoeding en indiensneming/werkloosheid en met mekaar vergelyk. Betekenisvolle verskille tussen
groep is met meervoudige en enkelvoudige variansie-analises bereken (GLM prosedure). ’n P-waarde van minder as 0.05 is as betekenisvol aanvaar.

**Resultate:**

Die vergelyking van verstedelikte en plattelandse groepe in die PURE-studie het aangetoon dat verstedelikte mans betekenisvolle hoër sistoliese en diastoliese bloeddrukke en laer plasmafibrinogeenvlakke as plattelandse mans gehad het. In vroue was die sistoliese en diastoliese bloeddrukke, vastende bloedglukose, en serumtrigliseriede hoër in verstedelikte groepe terwyl hulle ook laer fibrinogeen as plattelandse groepe gehad het. Die ontleiding van die verwantskap tussen vlakke van opvoeding en KVS risikofaktore het getoon dat mans met die hoogste opvoedingspeil, betekenisvolle groter liggaamsmassa indekse (LMI) gehad het. Omdat dit moeilik was om tussen huishoudelike en persoonlike inkomste te onderskei, is die KVS risikofaktore van mans en vroue wat ’n werk gehad het, vergelyk met die wat werkloos was. Mans met ’n werk het betekenisvolle hoër LMI gehad, terwyl werkloze mans betekenisvolle hoër vastende glukose en fibrinogeen gehad het. Mans wat ’n werk gehad het, het ook hoër bloeddrukke gehad, maar die verskille was nie betekenisvol nie. In vroue was die betekenisvolle verskil dat vroue met ’n werk laer HDL-cholesterol, vastende bloedglukose, trigliseriede en fibrinogeen gehad het, maar ook ’n hoër LMI (26.5 [26.0-27.0] versus 27.9 [26.3-29.4] kg/m²) onderskeidelik in werklose en vroue wat ’n werk gehad het. Dit blyk dat die meeste van die KVS risikofaktore nog steeds hoër was in die hoër sosio-ekonomiese groepe was, wat ooreenstem met die resultate wat in die THUSA-studie gerapporteer is.

**Gevolgtrekking:**

Die resultate van hierdie studie het nie bewyse gelewer dat wanneer die THUSA en PURE-studies vergelyk word, daar ’n grootskaalse verskuwing van KVS risikofaktore van die hoër na die laer sosio-ekonomiese groepe in die tydperk vanaf 1996/8 tot 2005 was nie. Die meeste KVS risikofaktore was nog steeds hoër in die hoër sosio-ekonomiese groepe. Maar daar was tog aanduidings dat van die risikofaktore in beide mans en vroue van die
laer sosio-ekonomiese groepe begin verskyn soos hoër fibrinogeen, vastende glukose, triglyceriede in plattelandse en werklose groepe. Verder suggereer die gebrek aan verskille in totale cholesterol tussen alle groepe en bloeddrukke in sommige groepe dat daar wel 'n verskuiwing van die risiko vir KVS in aantog is. Dit beteken dat die voeding-intervensies wat gemik is op die voorkoming van KVS, Afrikane van alle sosio-ekonomiese vlakke moet teik. 
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LIST OF ABBREVIATIONS

µg/L: Micro grams per litre
AIDS: Acquired Immune Deficiency Syndrome
ANOVA: Analysis of variance
AUTHeR: Africa Unit for Transdisciplinary Health Research
BMI: Body mass index
BP: Blood pressure
CEN: Centre of Excellence for Nutrition
CHD: Coronary heart disease
CI: Confidence interval
CRP: C-reactive protein
CVD: Cardiovascular disease
DBP: Diastolic blood pressure
Dr: Doctor
EDTA: Ethylenediamine tetra acetic acid
FBG: Fasting blood glucose
FBDGs: Food based dietary guidelines
g/ml: Grams per milliliter
g/L: 
g: Gram
g/day: 
GDP: Gross domestic product
GLM: General linear model
HbA1C: glycated haemoglobin
HDI: Human Development Index
HDL: High density lipoprotein
HDLC: High density lipoprotein cholesterol
HIV: Human immunodeficiency virus
kg/m²: Kilogram per metre squared
Km: Kilometer
LDL: Low density lipoprotein
ml: Milliliter
mm: Millimeter
mmHg: millimeters of mercury
mmol/l: Millimols per litre
n: Sample size (number)
NCD: Non-communicable chronic diseases
NHANES: National Health and Nutrition Examination Survey
NIDDM: Non-insulin dependent diabetes mellitus
NRF: National Research Foundation
NS: Not significant
PURE: Prospective Urban and Rural Epidemiology study
QFFQ: Quantitative food frequency questionnaire
RB: Ronia Behanan
SBP: Systolic blood pressure
SC: Serum cholesterol
SDP: Socio-economic drift phenomenon
SES: Socio-economic status
SPSS: Statistical Package for Social Sciences
SMAC: Sequential Multiple Analyser Computer
Suppl: Supplement
TB: Tuberculosis
TC: Total cholesterol
TE: Total Energy
TG: Triglyceride
THUSA: Transition and Health during Urbanisation of South Africans study
UK: United Kingdom
USA: United States of America
WC: Waist circumference
LIST OF SYMBOLS

%; Percentage
<: Less than
=: Equal
>: Greater than
≤: Smaller than or equal to
≥: Greater than or equal to
µ: Micro
° C: Degree Celsius
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CHAPTER 1

INTRODUCTION
CHAPTER 1: INTRODUCTION

1.1 Background and motivation

South Africa, a developing country with an emerging economy, is currently undergoing a health transition characterised by the triple burden of disease (Vorster, 2002) consisting of a high prevalence of under nutrition-related infectious diseases, the emergence of risk factors of non-communicable chronic diseases (NCDs), including cardiovascular disease (CVD), and the human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) pandemic. In addition to changes in food patterns and other lifestyle behaviours, Pisa (2009) reported that high alcohol intakes and binge drinking, especially in men, contribute to this disease burden.

The nutrition transition, defined as the changes in dietary patterns association with urbanisation and modernisation, has been observed to be both a consequence and cause of changes in patterns of agriculture, health and socio-economic factors (Popkin, 2002). This kind of transition usually occurs gradually and differs greatly between various geographic and socio-economic subpopulations (Popkin, 2002). The transition usually affects many factors including food supply which relates to agricultural systems and agricultural technology, economic resources, demographic patterns, various cultural and knowledge factors associated with food choice, disease patterns, and sociological considerations such as the role of women and the family structure (Popkin, 2002). Vorster et al. (2005) illustrated that in the North West Province of South Africa, the nutrition transition was accompanied by an improvement in micronutrient intakes and status, as well as increases in overweight and obesity. Additionally, several risk factors for NCDs were observed (Vorster et al., 2005). It is recommended that intervention programmes designed to promote nutritional health, should aim at improving micronutrient intake and status without leading to obesity (Vorster et al., 2005). Due to rapid urbanisation and cultural changes, dietary patterns have drastically evolved from consisting of unrefined traditional foods to refined fast foods. This change in the food consumption pattern could be one of
the many factors that may explain the emergence of NCDs in recent years among African people.

The term “social drift phenomenon” (SDP) is used to describe the observations that: in the early stages of the epidemiological and nutrition transitions, it is usually the more affluent, higher socio-economic groups that are affected; in the later stages, it is the poor, lower socio-economic groups that display the consequences of these transitions. Therefore, in developing countries at the beginning of the transition, affluent people have higher prevalence of obesity and increased CVD risk, while in developed countries, obesity and increased CVD risk are more prevalent in the low socio-economic groups, indicating a drift from the higher to the lower socio-economic groups in a population.

Socio-economic status (SES) is the primary function of the SDP, and can be seen as a predictor used to investigate association between the SDP and CVD risk factors. Socio-economic status is usually measured by level of education, income, occupation, or a combination of these factors (Winkleby et al., 1992).

Education has become a popular single indicator of social class mostly because of its association with many lifestyle characteristics (Liberatos et al., 1988). A disadvantage of using education as a measure of social class is that educational attainment varies by age cohort. However, Jacobsen and Thelle (1988) found in the Tromso Heart Study that education was the best predictor of CVD, illustrating that it could be a useful variable to use in the present study.

Income is used as a quantitative variable, grouped into categories. The categories are often determined on the basis of the income range of respondents within the sample being studied and, therefore, comparability across studies is somewhat limited (Liberatos et al., 1988). Another disadvantage is that in the context of the extended family structures in Africa, several sources of income and complex households, it may be difficult to distinguish between personal (individual) and household income.
Of the three indicators (education, income and occupation) occupational data may be the most complex to obtain. Approximately seven questions are required to obtain sufficient information to code occupations appropriately (Liberatos et al., 1988). In the African context, it could be useful to gather information on whether people are employed or unemployed and, therefore, have a steady income or not.

Several studies in both developing and developed countries have shown associations between SES and CVD risk factors (Bobak et al., 1999; Ishizaki et al., 2000; Reddy et al., 2002; Schroder et al., 2004; Roohafza et al., 2005). In developing countries higher SES was shown to be associated with higher CVD risk (Gilberts et al., 1994; Reddy et al., 2002), whereas discrepancies were found in a few studies conducted in developing countries which showed that higher SES was associated with lower CVD risk (Gupta et al., 1994; Bobak et al., 1999; Roohafza et al., 2005; Reddy et al., 2007). Numerous studies were also conducted in developed countries where it was shown that higher SES is associated with lower CVD risk factors (Irribarren et al., 1997; Ishizaki et al., 2000; Nishi et al., 2004; Schroder et al., 2004; Panagiotakos et al., 2008;), whereas few studies conducted in developed countries showed different results i.e. higher SES is associated with higher CVD risk factors (Yu et al., 2002; Yarnell et al., 2005).

Vorster et al. (2007) reported on a study in the North West Province of South Africa done in 1996/1998 which determined the association between CVD risk factors and SES in an African population. The results of the study showed that higher SES groups had significantly lower CVD risk factors such as serum glucose levels, systolic blood pressures (BP), higher micro-nutrient intakes and fewer smokers. However, sustained increases in total fat and saturated fat intakes and higher serum total and low density lipoprotein (LDL) cholesterol levels, as well as increased body mass indices (BMI) in men in more affluent urban subjects, suggested that at that point in time, the burden of CVD is carried by those Africans with higher socio-economic status.

The objective of the current study was, therefore, to determine if the SDP is affecting CVD risk factors in the same population group of South Africa 10 years later.
1.2 Nutritional cause of the social drift phenomenon (SDP)

As mentioned above, the SDP can be defined as the drift in NCDs, and particularly in CVD risk, from high to lower socio-economic classes in a population coupled to economic development in the population. A major change in economic structure associated with the nutrition transition is the shift away from a pre-industrial agrarian economy towards one with increasing industrialisation (Popkin, 1997). Socio-economic changes important in the nutrition transition are (i) changes in the role of women (especially with respect to patterns of time allocation); (ii) changes in income patterns and, therefore, possibly also on expenditure patterns; (iii) changes in household food preparation technology; (iv) changes in food production and processing technology; and (v) changes in family and household composition (Popkin, 1997). Income seems to play an important role in the nutrition transition since it determines the flow of goods and services. Increased income allows people to purchase goods or services that can affect diet, activity and nutritional status. According to Popkin (1997) the three key ways that income affects nutrition are:

(i) The effect of increased income on dietary choices.

(ii) The effect of increased income on the amount of energy, protein and fat consumed.

(iii) The effect of increased income on the structure of the economy, particularly the change to commercial agriculture.

As soon as people urbanise and have more money to spend on foods, the food industry will ensure that good-tasting, fast, convenience, take-away, ready-to-eat and ready-to heat, highly processed foods are available. These foods are often high in energy and low in micronutrients, and have profound influences on dietary and nutrient intakes, and eventually on the development of CVD risk factors. In the beginning of economic development, these foods will be available to urban, educated, employed people with sufficient income to buy them. As economic development proceeds, these foods also become available and affordable in more rural areas.
It is conceivable that as health promotion messages regarding prevention of NCDs through healthy eating and other lifestyles reach the more educated in a population, improved eating behaviour may result in the shift of NCD and CVD risk factors away from the more informed, higher socio-economic classes. Evidence for this phenomenon by comparing the relationships between socio-economic class and CVD risk factors is briefly discussed in the next section and analysed in more depth in Chapter 2.

1.3 Association between cardiovascular disease (CVD) risk factors and socio-economic status (SES)

1.3.1 Association between CVD risk factors and SES in developed countries

The term *developed country* is used to describe countries that have a high level of development according to some criteria. One such criterion is income *per capita*; countries with a high gross domestic product (GDP) *per capita* would thus be described as developed countries. Another economic criterion is industrialisation; countries in which the tertiary and quaternary sectors of industry dominate would thus be described as developed. More recently another measure, the Human Development Index (HDI), which combines an economic measure, national income, with other measures, indices for life expectancy and education, has become prominent. All these criteria would include Japan in Asia, Canada and the United States in North America, most European countries, as well as Australia and New Zealand in Oceania in the list of *developed countries*.

The term *developing country* is generally used to describe a nation with a low level of material well-being. Developing countries are in general countries which have not achieved a significant degree of industrialisation relative to their populations, and which have, in most cases a medium to low standard of living. There is a strong correlation between low income and high population growth. South American countries such as Brazil and Argentina, countries in Sub-Saharan Africa, and India, are examples of *developing countries*. 
As mentioned before, studies done in developed countries have generally shown that a higher SES is associated with lower risk for developing CVD (Winkleby et al., 1992; Wong & Donnan, 1992; Connolly & Kesson, 1996; Hoeymans et al., 1996; Iribarren et al., 1997; Chaturvedi et al., 1998; Benetou et al., 2000; Choiniere et al., 2000; Ishizaki et al., 2000; Jonnalagadda et al., 2000; Nishi et al., 2004; Schroder et al., 2004; Larrañaga et al., 2005; Ezeamama et al., 2006; Metcalf et al., 2007; Osler et al., 2000; Pangiotakos et al., 2008).

Two studies with similar results are those of Panagiotakos et al. (2008) and Choiniere et al. (2000):

The first study was conducted in Greece with the aim of investigating if dietary habits were associated with SES, and if dietary habits modify the relationships between SES and CVD risk factors in a sample of apparently healthy men and women. SES variables included in this study were education and income. The results indicated that hypertension, diabetes mellitus and hypercholesterolaemia were more prevalent in the low education groups, across all income classes (Panagiotakos et al., 2008). The second study by Choiniere et al. (2000) in Canada, measured the distribution of risk factors for CVD by SES in adult men and women across Canada. Education and income were the SES variables used in this study. The results of this study also showed that CVD risk factors were more prevalent among the lower SES groups.

A study in the Netherlands examined the association between socio-economic status and CVD risk. Education was used as an SES measure. This study showed an inverse association between educational level and the prevalence of physical inactivity during leisure time, obesity, hypercholesterolemia, high density lipoprotein (HDL)-cholesterol levels and hypertension. Cardiovascular disease risk factors were more prevalent in the groups with lower education levels (Hoeymans et al., 1996).

According to Metcalf et al. (2007), a New Zealand study compared the CVD risk factor levels of men and women in a local workforce with measures of SES such as income and education. It was shown that lower leisure time physical activity levels were observed in the lower SES strata compared to the highest. Raised blood pressure and blood lipids were
highest in people with no tertiary education compared to those with tertiary education. Lower income groups had higher diabetes rates compared to those with a higher income. In this study, low SES was associated with higher body mass index and obesity.

A study in Japan investigated the association between SES and CVD risk factors and all three SES variables were measured in this study. The results showed that people with lower SES had higher levels of CVD risk factors. Men with lower incomes had a higher mean diastolic blood pressure. In women, education and occupation were inversely associated with mean values of both systolic and diastolic blood pressure and body mass index (Yu et al., 2000).

These studies all provide evidence that in developed countries, the risk factors for CVD are more prevalent in the lower socio-economic classes than in those with higher SES. There are, however, exceptions, as will be discussed below.

1.3.2 Discrepancies between the association between CVD risk factors and SES in developed countries

A study in France and Northern Ireland examined the contribution of socio-economic factors to CVD risk factors. This study, in contrast to findings in other developed countries, showed that higher CVD risk factors were associated with higher SES groups (Yarnell et al., 2005).

A study by Jonnalagadda et al. (2000) in an African-American population, examined dietary intakes and socio-economic factors that contribute to CVD. The results suggested that income, education, and occupation were associated with CVD risk. A significant correlation between annual income and education was observed in this study. This small group of African-American women showed opposite results from those found in the Canadian and Greek studies. Therefore, these results may suggest that the epidemiological transition amongst different ethnic groups in the same country may differ.

1.3.3 Associations between CVD risk factors and SES in developing countries
As discussed before, studies done in developing countries have shown that higher SES leads to increased risk of CVD (Reddy et al., 2002; Gilberts et al., 1994; Yu et al., 2002).

Education and occupation were used to measure SES in a study conducted on a semi-urban population in the Indian state of Andhra Pradesh, where the prevalence of CVD risk factors was assessed. The results showed that higher SES groups had greater prevalence of CVD risk factors than lower SES groups. Increases in hypercholesterolaemia and hypertriglyceridaemia in both men and women were associated with a higher SES. Among men, systolic blood pressure and body mass index were positively associated with SES levels (Reddy et al., 2002).

Gilberts et al. (1994) observed determinants of blood pressure with special reference to SES in a rural South Indian community. Occupation was the only SES variable used in this study. It was concluded that there was a significantly higher level of hypertension in individuals within the higher SES group.

Yu et al. (2002) evaluated the association between SES and serum lipids in an urban Chinese population where education, occupation and income were used as SES variables. It was shown in this study that higher socio-economic groups had more unfavourable serum lipid profiles compared with those in lower socio-economic groups.

The THUSA study conducted among a black South African population used education and income as the two SES measures. It showed that although the group with the highest SES position had lower serum glucose levels, systolic blood pressure, higher micronutrient intakes and fewer smokers, their sustained increases in total and saturated fat intakes and higher serum total and LDL cholesterol levels, as well as increased body mass index in men suggested that the burden of CVD will be higher in those Africans in higher SES positions (Vorster et al., 2007).
Although fewer studies are available from developing countries, it seems as if the burden of CVD risk is higher in those with higher SES. However, there are exceptions, possibly indicating the dynamics of social drift in these populations.

1.3.4 Discrepancies between the association between CVD risk factors and SES in developing countries

The studies from the developing world that reported higher CVD risk factors in lower socioeconomic groups, are those of (Gupta et al., 1994; Bobak et al., 1999; Yu, et al., 2000; Roohafza et al., 2005; Reddy et al., 2007).

A study conducted in Iran (Roohafza et al., 2005) investigated the distribution of CVD risk factors according to educational levels. All CVD risk factors showed an inverse relationship with educational level. High serum total and LDL-cholesterol were inversely related to educational level. According to Bobak et al. (1999), who examined whether CVD risk factors are determined by SES in the Czech Republic, results indicated that there was a strong inverse association between education and serum cholesterol in both genders. Body mass index in both genders decreased with education levels. In men, there was a significant decrease in cholesterol with higher education, in females there was a significant decrease in hypertension with higher education.

Another study carried out in India (Reddy et al., 2007) examined whether CVD risk factors are predicted by level of education and influenced by the level of urbanisation in an industrial population. Education was the only variable used to measure SES. Cardiovascular disease risk was higher in less educated and low-income groups in the rural population. In urbanised areas, a reversal of social gradients for high blood pressure, diabetes, and being overweight was found. Hypertension was significantly more prevalent in the group that was less educated as compared to the more educated groups. Dyslipidaemia prevalence was significantly higher in high-education groups. These findings are similar to those in the THUSA study (Vorster et al., 2007), which indicated
that some CVD risk factors are higher in subjects with low SES, while others, notably hyperlipidaemia, were still higher in those with the higher SES.

The pattern, that in developed countries it is the lower SES groups and in developing countries the higher the SES groups that have the greater risk for CVD is, therefore, not always consistent. In developed countries it seems that studies that include population groups from different ethnic groups deviate from general findings. It is of course also possible that some developed countries are experiencing the SDP. In developing countries, the controversial findings are probably related to a dynamic social drift regarding the CVD risk factors.

1.4 Cardiovascular disease risk factors to be explored in this study

The black South African population has had an increase of NCDs, and particularly of CVD which may be attributed to the observed nutrition transition and its influence on CVD risk factors (Vorster, 2002). The CVD risk factors that are incorporated in this study are discussed briefly below:

1.4.1 Lipid profile

Total serum cholesterol (TC), and particularly elevated low-density lipoprotein cholesterol (LDLC) is accepted as the major risk factor for CVD. Low-density lipoprotein is the main carrier of cholesterol and delivers cholesterol to various cells and tissues. High-density lipoprotein cholesterol (HDLC) is regarded as protective against CVD, because it serves as an acceptor for cholesterol from various tissues and hence promotes the removal of cholesterol from the cell, and its secretion into bile by the liver. To explain the terms to the general public, LDLC is consequently designated “bad” cholesterol, as high levels are associated with increased deposition of cholesterol in arterial walls and an increased incidence of CVD. High-density lipoprotein, on the other hand, has been designated as “good” cholesterol. It should be noted that the best single indicator for the development of atherosclerotic heart disease is, therefore, not TC but the ratio of LDLC to HDLC: the lower the ratio, the lower the risk (Pisa, 2009).
Controversy exists concerning whether triglyceride (TG) concentration is a risk factor for CVD, regardless of its association with cholesterol (Castelli et al., 1977). According to Castelli et al. (1977), a direct relationship was found between fasting TG concentration and prevalence of CVD, but only when other lipids are considered equivocally significant. Strong associations between elevated TG level and the risk of CVD in the presence of lower levels of HDLC and LDLC were reported in a study by Criqui et al. (1993). Other studies have indicated that there is an excess risk of CVD in the presence of TG levels of ≥204 mg per decilitre (2.3 mmol per litre) when the ratio of LDLC to HDLC exceeds 5 (Assmann & Schulte, 1992; Manninen et al., 1992).

1.4.2 Obesity and anthropometric variables

Obesity is a global health problem (Kuczmarski et al., 1994; Deurenberg & Yap, 1999). It is associated with CVD risk factors including hypertension, dyslipidaemia, diabetes mellitus and insulin resistance, which increases the risk of cardiovascular morbidity and mortality (Isomaa et al., 2001; Expert Panel on Detection Evaluation and Treatment of High Blood Cholesterol in Adults, 2001). Body mass Index (BMI) and waist circumference (WC) are clinical measures for obesity in adults (Kuczmarski et al., 1994). Body mass index is also used as an independent predictor for CVD risk. The adult BMI cut off points are different for different racial groups (Lin et al., 2002). The BMI and WC as recommended by the USA National Institute of Health are as follows, in Kg/m²: underweight (BMI < 18.5), normal weight (18.5 – 24.9), overweight (25.0-29.0), class I obesity (30.0 – 34.9), class II and III obesity (BMI ≥ 35.0). Men and women with WC values of no greater than 102 and 88 cm, respectively, were considered to have a normal WC, whereas men and women with WC values of greater than 102 and 88 cm, respectively, were considered to have a high WC. People with high WC values were more likely to develop the CVD risk factors such as hypertension, diabetes, dyslipidaemia, and the metabolic syndrome compared with those with normal WC values (Janssen et al., 2002).
1.4.3 Haemostatic variables

A wide range of factors have been identified in prospective epidemiological studies affecting blood thrombogenicity. There is increasing evidence of the relationship between the traditional cardiovascular diseases such as diabetes mellitus, hypertension, hyperlipidaemia and increased thrombogenicity, which in turn is characterised by hypercoagulability, hypofibrinolysis or increased platelet reactivity (Markis et al., 1997). For this reason, much interest has recently been given to elevated blood coagulation in acute and chronic cardiovascular disturbances. Additionally, high fibrinogen concentrations have been implicated as a significant and independent risk factor for CVD (Fuller et al., 1979; Collaboration fibrinogen studies., 2005).

1.4.4 Blood pressure

Several epidemiological studies conducted in over 400 000 adults aged between 25–70 years have demonstrated that high BP (hypertension) is associated with an increased CVD risk (MacMahon et al., 1990; Whelton, 1994). Hypertension usually co-exists with other CVD risk factors such as with dyslipidaemia, insulin resistance, glucose intolerance and obesity (Kannel, 1996).

1.4.5 Dietary patterns and nutrient intake profiles

There is convincing scientific evidence that dietary patterns, specific foods and nutrient intakes influence CVD risk, which has led to global recommendations for the prevention of CVD and other NCDs (WHO, 2003). Diets with too much macronutrients (total fat, protein and carbohydrate) leading to overweight and obesity, and not enough dietary fibre from whole grains, fruit and vegetables, are associated with an increased risk of CVD. These diets are also known as “imprudent” diets. There is also evidence that some micronutrients and other chemical substances in plant foods have protective effects. The mechanisms through which these dietary substances influence CVD are complex and often interrelated. The THUSA study has shown varying degrees of “imprudent” macronutrient intakes in urban and rural Africans (Vorster et al., 2005). The same study also showed that
although micronutrient intakes of urban Africans were better than those of their rural counterparts, all groups had suboptimal intakes. Therefore, it was decided to include dietary intakes as a risk factor for CVD in the present study.

1.5 Study hypothesis

The hypothesis of this study is that the burden of CVD risk in the African population of the North West Province will still be higher in the higher socio-economic group, despite the rapid transition process. However, based on the results from the THUSA study, it is also hypothesised that the SDP regarding some of these risk factors will be observed.

To test this hypothesis, secondary analysis of the 2005 PURE study baseline data will be conducted. The PURE study is a 12-year Prospective Urban and Rural Epidemiological study which investigates the health transition in urban and rural Africans. The 2005 baseline PURE study represents cross-sectional epidemiological data approximately 10 years after the THUSA data was collected.

1.6 Aims and objectives

To examine the SDP in the African population in the North West Province of South Africa, the following objectives were formulated:

1. To conduct an extensive literature survey on associations between SES and biological health outcomes, focusing on CVD risk factors, in developed and developing countries.

2. To analyse data from the 2005 PURE study in order to examine the relationships between components of the SES (income, education and occupation) and CVD risk factors in an African population undergoing a health transition. To examine the relationship of dietary intakes, being rural or urban, education level and employment status with CVD risk factors (BP, HDL, TC, TG, fasting glucose and BMI).
3. To compare results on the associations between CVD risk factors and SES from the PURE study to those found in the THUSA study which was conducted 10 years earlier.

1.7 Methods

This cross-sectional epidemiological survey was part of the North West Province South African leg of the 12-year Prospective Urban and Rural Epidemiology (PURE) study which investigates the health transition in urban and rural Africans. The main selection criterion was that there should be migration stability within chosen rural and urban communities. The rural community (A) was identified 450km west of Potchefstroom on the highway to Botswana. A deep rural community (B), 35km east from A only accessible by gravel road, was also included. Both communities are still under tribal law. The urban communities (C and D) were chosen near the North-West University (Potchefstroom Campus). Community C was selected from the established part of Ikageng township next to Potchefstroom and D from informal settlements surrounding community C. The baseline data were collected from October to December 2005 by a multidisciplinary research team under leadership of Prof. Annamarie Kruger. A total of 2010 apparently healthy African volunteer (35 years and older), with no reported chronic disease of lifestyle, tuberculosis (TB) or known HIV were recruited from a sample of 6000 randomly selected households.

1.8 Structure of the dissertation

This dissertation is presented in article format and is structured as follows:

Chapter 1, this introductory chapter motivates the study by defining the SDP, and giving a brief overview of the relationships between SES and CVD risk factors in both developing and developed countries.

Chapter 2 is a more detailed literature study which gives the background and literature necessary for the interpretation of the data in this dissertation.
Chapter 3 is an original article which examines the association between SES and CVD risk factors in this African population undergoing a health transition.

Chapter 4 comprises a general discussion, conclusions and recommendations.

A conceptual framework that illustrates the areas examined in this dissertation is given in Figure 1. The figure portrays how SDP is associated with the development of CVD.
Urbanisation:
- Nutrient intake
  Dietary changes e.g. high fat intake, low fibre intake, decreased intake of staple food
- Media
- Smoking
- Health care facility
- Lifestyle changes
- Physical activity

Socio-economic status:
- Income
- Education
- Housing
- Occupation

Risk factors/risk markers:
- Serum lipids
  - HDL-C*
  - LDL-C*
  - Triglycerides
  - Total cholesterol
- Serum glucose

Morbidity:
- Obesity
- Diabetes
- Hypertension
- CVD*

*HDL-C = High density lipoprotein, LDL-C = Low density lipoprotein, CVD = Cardio-vascular disease, CHD = Coronary heart disease

Figure 1. Conceptual framework for areas examined in this dissertation.
1.9 Ethical considerations

This study forms part of the PURE study and the collection of information and relevant biological samples from informed volunteers had the necessary ethical clearance from the Ethics Committee of the North-West University and North West Department of Health: ethics number 04M10.

1.10 Contributions of the candidate

The study reported in this dissertation was planned and executed by a team of researchers and the contributions of each as well as that of the candidate (RB) are listed in Table 1.

Table 1. LIST OF RESEARCH TEAM AND THEIR CONTRIBUTIONS TO THIS STUDY

<table>
<thead>
<tr>
<th>NAME</th>
<th>ROLE IN THE STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ronia Behanan (RB) (MSc. Candidate)</td>
<td>Statistical analysis of the relevant PURE data, writing and compilation of this dissertation, interpretation of results, and first author of the paper (Chapter 3).</td>
</tr>
<tr>
<td>Dr. Pedro Pisa Supervisor</td>
<td>Supervised this dissertation, statistical analyses and interpretation of results, co-authored the paper in Chapter 3.</td>
</tr>
<tr>
<td>Prof. HH Vorster Co-supervisor</td>
<td>Co-supervised and edited the dissertation, co-authored the paper in Chapter 3.</td>
</tr>
<tr>
<td>Prof. A Kruger</td>
<td>Planning and coordinating the PURE study.</td>
</tr>
<tr>
<td>Prof Edelweiss Wentzel-Viljoen</td>
<td>Was responsible for dietary intake measurements and analyses.</td>
</tr>
<tr>
<td>Team from the Centre of Excellence for Nutrition (CEN)</td>
<td>Were responsible for blood collections and analyses.</td>
</tr>
<tr>
<td>Team from the Africa Unit for Transdisciplinary Health Research (AUTHeR)</td>
<td>Were responsible for the blood pressure and anthropometry measurements.</td>
</tr>
</tbody>
</table>
1.11 References


CHAPTER 2

LITERATURE BACKGROUND: THE ASSOCIATION BETWEEN CARDIOVASCULAR DISEASE RISK FACTORS AND SOCIOECONOMIC STATUS.
CHAPTER 2: LITERATURE BACKGROUND

Preface
In this chapter, the effects of socio-economic status (SES) on cardiovascular disease (CVD) risk factors in different parts of the world are examined using available literature. Although the study was not a true systematic review, a systematic approach was followed to include as many studies as possible which met the defined criteria.
CHAPTER 2: LITERATURE BACKGROUND ON THE RELATIONSHIP BETWEEN CARDIOVASCULAR DISEASE AND SOCIO-ECONOMIC STATUS

2.1 Introduction

Cardiovascular diseases (CVDs) are increasingly becoming the leading cause of death worldwide (Reddy, 2004). Socio-economic status (SES) has been shown to be an independent risk factor for CVD (Mancia, 1988; Kraus et al., 1980). Additionally, socio-economic status indicators including education, income, and occupation are associated with CVD risk (Luepker et al., 1993). The relationship between SES and risk for developing CVDs varies among different populations (Chang et al., 2002). In studies conducted in developed countries it has been shown that CVD risk is lower in the higher SES groups (Gupta et al., 1994; Bobak et al., 1999; Roohafza et al., 2005; Reddy et al., 2007) whilst in developing countries, CVD risk is higher in the higher SES groups (Gilberts et al, 1994; Reddy et al., 2002). In many developing countries undergoing health transition, there are strong economic and demographic forces propelling previously once isolated rural groups into the peri-urban and urban areas. These changes seem to increase CVD risk relatively in these former rural groups (Yusuf et al., 2001). In view of this, the aim of this review was to examine extensively the associations between SES and CVD risk in both developing and developed countries.

2.2 Methods

A comprehensive literature search was conducted to retrieve publications on the association of SES with CVD risk in adults among different populations. The search was done in different databases (Pub Med, Ebscohost, Science direct, Google scholar, Academic Search Premier, and ISI web of science). From the above search the final number of articles that met the defined inclusion criteria was 35.

2.3 Keywords used for the search

The keywords used to select possible studies were: cardiovascular disease risk factors, lipid profile, blood pressure, coronary heart disease, socio-economic status, income, education, occupation, adults, developing and developed country.
2.4 Criteria based analysis

Inclusion criteria

- Age: subjects had to be adults, no studies reporting on children or teenagers were used;
- Type of study: studies used for this literature study were observational;
- At least one of the cardiovascular disease risk factors should have been measured: diabetes, hypertension, lipid levels (high density lipoprotein (HDL), low density lipoprotein (LDL), triglycerides (TG) and total cholesterol (TC) and fibrinogen);
- SES: One of the three variables occupation, income or education should have been used to indicate SES;
- Dates: Studies from 1990 – 2010 were included in the analysis.

Exclusion criteria

- Studies where SES status and CVD risk factors were not measured;
- Studies done on children and adolescents.

2.5 Results

Table 2.1 consists of all summarised findings (relating to the association between CVD risk and SES) of various studies which were conducted in both developed and developing countries. ADDENDUM 1 consists of an in depth description of these studies and main findings.
<table>
<thead>
<tr>
<th>Developing</th>
<th>Developed</th>
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<tbody>
<tr>
<td>Study 3 (Bobak <em>et al.</em>, 1999)</td>
<td>Study 1 (Benetou <em>et al.</em>, 2000)</td>
</tr>
<tr>
<td>- There was a strong inverse association between education and cholesterol in both genders.</td>
<td>- The TC values are inversely associated with educational level in both genders, a pattern contrasting with that found 20 years ago. The association is more prominent among women.</td>
</tr>
<tr>
<td>- Ratio of HDL-cholesterol to TC increased with education in women but not in men.</td>
<td>- The HDL-cholesterol values are inversely associated with educational level in men, whereas the association is less consistent in women.</td>
</tr>
<tr>
<td>- The body mass index (BMI) in both genders decreased with education.</td>
<td>- In comparison with women, men have lower levels of TC and HDL-cholesterol, but higher TC/HDL-cholesterol ratio.</td>
</tr>
<tr>
<td>- In men there was a significant decrease in cholesterol with higher education P&lt; 0.001.</td>
<td>- Mean TC decreases as educational level increases, in both genders. In men, HDL-cholesterol is higher in the lower educational level compared with the medium level. Women in the high educational level, however, have somewhat higher mean HDL-cholesterol compared with those in the medium and low levels.</td>
</tr>
<tr>
<td>- In women there was a significant decrease in systolic blood pressure (BP) with higher education P&lt; 0.001.</td>
<td>- In both genders, TC is inversely associated with educational level.</td>
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<tr>
<td>- In women there was a significant decrease in BMI P&lt; 0.001.</td>
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<tr>
<td>- In women there was a significant decrease in hypertension with education P&lt; 0.001.</td>
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<td>Study 7 (Ezeamama <em>et al.</em>, 2006)</td>
<td>Study 2 (Bennett S, 1995)</td>
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<tr>
<td>American Samoans have more years of education, higher material life styles and are more involved in the wage economy than their age and sex counterparts in Samoa.</td>
<td>The LDL-cholesterol levels decreased significantly among older women with low or medium education.</td>
</tr>
<tr>
<td>At baseline all CVD risk factors had higher proportions in American Samoa relative to Samoa. Incident hypertension and obesity were also higher in American Samoa relative to Samoa. Incident type 2 diabetes and hypertension were also higher for American Samoa than Samoa among both men and women.</td>
<td>The BMI was greatest among women of low educational attainment</td>
</tr>
<tr>
<td>Women from American Samoa had approximately a twofold higher odds of hypertension and obesity, respectively, than employed or high material lifestyle American Samoan women.</td>
<td>Mean BP tended to be higher among those with lower educational attainment but the difference was not statistically significant at all point in time.</td>
</tr>
<tr>
<td>Samoan men in subsistence work or unemployed had twofold lower odds of hypertension relative to their employed counterparts.</td>
<td>The BP was highly correlated with BMI and to a lesser extent with smoking status.</td>
</tr>
<tr>
<td>Among Samoan men obesity was highest in high SES groups and the predicted probability of obesity increased with SES in Samoa regardless of sex. In American Samoan women on the other hand, low material life style was associated with higher obesity</td>
<td>An inverse association between average TC and the level of education among women but not among men.</td>
</tr>
<tr>
<td>The overall lipid picture in this study favours women of high educational attainment, who in addition to lower TC concentrations, also had higher average concentrations of HDL-cholesterol, lower TG, lower LDL-cholesterol, and lower TC/HDL-cholesterol.</td>
<td>The overall lipid picture in this study favours women of high educational attainment, who in addition to lower TC concentrations, also had higher average concentrations of HDL-cholesterol, lower TG, lower LDL-cholesterol, and lower TC/HDL-cholesterol.</td>
</tr>
<tr>
<td>The inverse relationship between BMI and educational attainment was also repeated at each survey.</td>
<td>Women with higher education had lower TC and higher HDL-cholesterol, lower TG, lower LDL-cholesterol and lower TC/HDL-cholesterol; younger women experienced no change</td>
</tr>
</tbody>
</table>
in average TC at any level of educational attainment.

- Average TC concentration decreased in older women, especially those of low educational attainment. The most notable change in the lipid profile among men was the increase in TC/HDL-cholesterol ratios among men of low educational attainment.
- In this study correlation between education and occupation was highly significant i.e. men of lower educational attainment were more likely to be in manual occupations.

<table>
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<tr>
<td>▪ Greater educational attainment was significantly associated with higher BMI and a greater prevalence of overweight.</td>
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<tr>
<td>▪ The positive associations between SES and BMI in this low-income, rural population are likely to be related to the changing patterns of food availability.</td>
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<tr>
<td>▪ Greater educational attainment was significantly associated with higher BMI and a greater prevalence of overweight and obesity in men and women.</td>
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<tr>
<td>▪ The BMI and household income were significantly correlated in women and not in men</td>
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<tr>
<td>▪ Mortality was twice as high in diabetic people in the lowest socio-economic groups as in those in the highest groups.</td>
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<tr>
<td>▪ The difference was largely due to higher rates of smoking and high BP in the lowest social groups, while blood glucose concentration had little impact on the relation.</td>
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<tr>
<td>▪ These results emphasise the importance of improving conventional CVD risk factors and reducing social inequality for reducing mortality in diabetic people.</td>
<td></td>
</tr>
<tr>
<td>Study 9 (Gilberts et al., 1994)</td>
<td>Study 5 (Choiniere et al., 2000)</td>
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<tr>
<td>▪ The prevalence of hypertension in the highest SES group (22-5%) was more than twice than that in the lowest SES group (8-8%).</td>
<td></td>
</tr>
<tr>
<td>▪ The prevalence of hypertension was significantly (p&lt;0.001) higher in rich people (22-5%) than poor (8-8%).</td>
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<tr>
<td>▪ For most of the risk factors examined, the prevalence of the risk factors was inversely related to SES, but the relationship was stronger and more consistent for education than for income.</td>
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<tr>
<td>▪ Men and women with a university degree were less likely to have elevated cholesterol than those with no university degree, but no difference was found among income levels.</td>
<td></td>
</tr>
<tr>
<td>▪ The relationship between education and CVD risk factors was stronger for women than for men.</td>
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</table>

<table>
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<tr>
<th>Study 10 (Gupta et al., 1994)</th>
<th>Study 6 (Connolly &amp; Kesson, 1996)</th>
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<tbody>
<tr>
<td>▪ Among uneducated and less educated people there was higher prevalence of coronary risk factors and hypertension.</td>
<td></td>
</tr>
<tr>
<td>▪ Educational level showed an inverse relation with systolic and diastolic BP.</td>
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<tr>
<td>▪ Physical activity was higher among uneducated people.</td>
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</tr>
<tr>
<td>▪ Men with more education were heavier and had a higher BMI.</td>
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<tr>
<td>▪ Hypertension was more prevalent among uneducated people.</td>
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<tr>
<td>▪ Physical activity was greater among uneducated people, and</td>
<td></td>
</tr>
<tr>
<td>▪ This study compared patients with non-insulin dependent diabetes (NIDDM) from the seven categories of SES, it was found that those from deprived categories experienced a higher prevalence of obesity. In the most affluent groups, 30% had a BMI &gt; 30kg/m² compared with 47% in the most deprived categories.</td>
<td></td>
</tr>
<tr>
<td>▪ Analysis of serum cholesterol levels in subjects younger than 70 years of age by deprivation category indicated higher cholesterol levels in the deprived categories.</td>
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</tr>
<tr>
<td>▪ When analysed for all patients, systolic and diastolic BP</td>
<td></td>
</tr>
</tbody>
</table>
men with more education had a higher BMI.
- Less educated and illiterate people had higher CHD.

levels were higher in the deprived groups.
- Using an area based index of SES and a diabetic clinic population, it was demonstrated that obesity and hypertension are higher among diabetic subjects of low SES.

<table>
<thead>
<tr>
<th>Study 18 (Mendez et al., 2003)</th>
<th>Study 11 (Hoeymans et al., 1996)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- In both men and women, the income distributions of BP and hypertension were non-linear, indicating elevated levels in low as well as in high-income groups.</td>
<td>- The age adjusted prevalence of physical inactivity in men was significantly higher in men with lowest education than in all other educational groups. In women a decrease in inactivity was observed with an increase in educational level.</td>
</tr>
<tr>
<td>- In contrast to the negative relationships typical for industrialized countries, multivariate-adjusted BP and hypertension were highest in the wealthiest women.</td>
<td>- The age-adjusted prevalence of obesity decreased with increasing level of education.</td>
</tr>
<tr>
<td>- In men with some high school education, income was positively associated with BP, while there were negative associations in men with lesser education.</td>
<td>- The BMI was strongly related to cholesterol levels and BP.</td>
</tr>
<tr>
<td>- Unlike women, mean BP was highest in poor men with limited education.</td>
<td>- The age adjusted prevalence of hypercholesterolemia and low HDL-cholesterol decreased with increasing educational level, but not in all age groups.</td>
</tr>
</tbody>
</table>

- Socio-economic differences in hypertension were relatively small. In women the association was stronger than in men. Only men with the highest educational level had a significantly lower prevalence of hypertension than men in the other educational groups.
- This study showed an inverse association between educational
level and the prevalence of physical inactivity during leisure
time, obesity, hypercholesterolemia, low HDL-cholesterol
levels and hypertension.
- Concurrence of CVD risk factors occurred more frequently in
  the lower educated than in the higher educated groups.

<table>
<thead>
<tr>
<th>Study 24 (Reddy et al., 2007)</th>
<th>Study 12 (Iribarren et al., 1997)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- The CHD risk becomes higher in the less-educated, less-income groups and even in the rural population.</td>
<td>- Education and income were found to be inversely associated with CVD risk factors during the decade of the 1980s.</td>
</tr>
<tr>
<td>- In urbanised areas reversal of social gradients for hypertension, diabetes, and overweight.</td>
<td>- However, there were some inconsistencies between education and income for serum cholesterol level and for BP and BMI in men.</td>
</tr>
<tr>
<td>- In less urbanised location such reversal was only for hypertension.</td>
<td>- Taken together these data from a random sample of a</td>
</tr>
<tr>
<td>- Hypertension was significantly more prevalent in the low compared with the high education group (P&lt;0.001).</td>
<td>Midwestern US population do not support a widening of CVD</td>
</tr>
<tr>
<td>- Dyslipidaemia prevalence was significantly higher in high-education group (P&lt; 0.01).</td>
<td>risk across SES groups.</td>
</tr>
<tr>
<td>- Higher education group had lower prevalence for hypertension, diabetes, and overweight.</td>
<td></td>
</tr>
<tr>
<td>- This study indicates the growing vulnerability of lower SES groups to CHD.</td>
<td></td>
</tr>
<tr>
<td>- Prevalence of diabetes and obesity was directly associated</td>
<td></td>
</tr>
</tbody>
</table>


with educational status in the less-urbanised locations.

|---------------------------------|-----------------------------------|
| • In men a significant positive rank correlation was observed between SES and serum cholesterol, TG, systolic and diastolic BP, and BMI. In women the same trend was found only with serum cholesterol, and TG.  
  ▪ Higher the SES groups have greater prevalence of CHD risk factors than lower SES groups.  
  ▪ Increases in hypercholesterolaemia, hypertriglyceridaemia and leisure time physical activity in both men and women were positively associated with SES.  
  ▪ In women low HDL-cholesterol was more common among the lower SES groups, whereas in men the prevalence of obesity and hypertension increased with higher social class.  
  ▪ SES levels were positively associated with mean levels of cholesterol and TG.  
  ▪ Among men systolic BP and BMI were positively associated with SES levels.  
  ▪ Negative relationship between HDL-cholesterol and SES levels among women. | Employment grade and educational background were inversely and significantly associated with plasma fibrinogen level in the study of Japanese males. |
<table>
<thead>
<tr>
<th>Study 26 (Roohafza et al., 2005)</th>
<th>Study 14 (Jonnalagadda et al., 2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ All CVD risk factors showed an inverse relationship with educational level in all subjects except HDL-cholesterol level in women.</td>
<td>▪ Both current annual income and educational attainment were significantly correlated (p&lt; 0.05) with a number of CVD risk factors, educational attainment having the strongest relationship.</td>
</tr>
<tr>
<td>▪ High TC, HDL-cholesterol and LDL-cholesterol were inversely related to educational level (P&lt;0.05). However, this relationship was not significant with Mantel Haenszel test in men.</td>
<td>▪ The results of the study further suggest that income, education, and occupation can impact risk factors, such as BMI, hypertension, hypercholesterolaemia, diabetes, diet quality, all of which can significantly influence CVD morbidity and mortality in this African-American population.</td>
</tr>
<tr>
<td>▪ Results from this study show an inverse association between educational attainment and the prevalence of dyslipidaemia, hypertension, and being overweight. However, there was no significant relationship between low HDL-cholesterol in Iranian women and their educational attainment.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study 29 (Vorster et al., 2007)</th>
<th>Study 15 (Kanjilal et al., 2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Increased total serum and LDL-cholesterol levels in men and women with urbanisation (higher income and education).</td>
<td>▪ Between 1971 and 2002, the prevalence of all CVD risk factors, except diabetes, decreased in all income and education groups, but there has been little reduction in income and education-related disparities in CVD risk factors and few improvements during these 10 years.</td>
</tr>
<tr>
<td>▪ Increased BMI levels in men.</td>
<td>▪ The prevalence of high BP declined by about half in all income and education groups, ranging from 30.3% to 40.6%.</td>
</tr>
</tbody>
</table>
in 1971-1974 and 16.4% in 1999-2002, with the greatest reduction among those in the lowest income quartile and those with less than a high school education (18.0 and 15.9 percentage points, respectively).

- The prevalence of high BP declined for all income groups from National Health and Nutrition Examination Survey (NHANES I to NHANES III) and was followed by no change between the last 2 surveys. Trends by education were similar to those for relative income. People with less than a high school education had a decrease in prevalence from NHANES I to NHANES 1999-2002 of 15.9 percentage points, compared with a decrease of 13.4 percentage points for those with more than a high school education.

- High cholesterol prevalence also declined in all groups and ranged from 28.8% to 32.4% in 1971-1974 and 15.3% to 22.0% in 1999-2002, with the largest decline (15.9 percentage points) among people with the highest income.

- Diabetes prevalence increased most among persons with low incomes and education. All surveys found that the prevalence of diagnosed diabetes was higher for people in the lowest income quartiles. The prevalence increased from 1971 to 1974 to 1999 to 2002 for all groups except those with the highest
<table>
<thead>
<tr>
<th>Study 31 (Winkleby et al., 1998)</th>
<th>Study 16 (Larrañaga et al., 2005)</th>
</tr>
</thead>
</table>
| ▪ Women with lower SES from each of the 3 ethnic groups had significantly higher levels of BMI and non HDL-cholesterol and higher prevalence of physical inactivity than women with higher SES (P<0.001).  
▪ There were higher levels of CVD risk factors among black and Mexican American women than among white women of comparable age and SES. | ▪ The prevalence of known Type 2 diabetes was higher in patients of lower SES, especially among women.  
▪ In Type 2 diabetes patients, obesity, sedentary lifestyle, and abnormal levels of LDL-cholesterol and HbA1c were more prevalent among those from lower SES.  
▪ Among Type 2 diabetic patients, obesity and sedentary lifestyle were inversely related to SES in both sexes, after adjusting by age and duration of the diabetes. These risk factors were highly prevalent among diabetic patients, particularly among women living in areas of lower SES.  
▪ In this study, the higher prevalence of diabetes in deprived areas was apparent in both sexes, but increased risk of diabetes as SES drops is more marked in women than in men.  
▪ Abnormal LDL-cholesterol levels ($\geq 2.58$ mmol/l) were more frequent among patients of lower SES. |
| Study 33 (Yu et al., 2000) | Study 17 (Luepker et al., 1993) |
| ▪ People with lower SES had higher levels of CVD risk factors. The association between SES and CVD risk factors | ▪ Education was significantly and inversely related to BP, cigarette smoking, and BMI. |
was more consistent among women than men.
- Men with lower incomes had significantly higher mean diastolic BP.
- For women, educational attainment and occupation were consistently and inversely associated with mean values of systolic and diastolic BP, BMI.
- Occupation was inversely associated with BMI.
- Serum cholesterol was inversely related to education in women but not in men.
- Education was positively associated with physical activity.
- The most educated men and women had the lowest BMI levels and the least educated had the highest.
- For men increasing household income was associated with higher BMI.
- Income was positively related to blood cholesterol and to BMI in men. In women, BMI was negatively associated with income.
- In women, BMI was negatively associated and cholesterol not associated with income. In general relations of risk factors with income were weaker than for educations.
- For men, income was positively associated with serum cholesterol level, with higher income groups having higher blood cholesterol levels.
- Low education groups continue to have the highest expected CHD rates.

<table>
<thead>
<tr>
<th>Study 34 (Yu et al., 2000)</th>
<th>Study 19 (Metcalf et al., 2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>People in higher SES groups had a more unfavourable</td>
<td>Both income and education showed 5 year CVD risks and</td>
</tr>
<tr>
<td>Serum lipid profile compared with those in lower SES groups.</td>
<td>Lower leisure time physical activity levels in the lower SES strata compared to the highest.</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>In this study, people with high SES had more unfavourable serum lipids compared with those individuals with low SES. However, the significant association of SES and serum lipids was more evident in men than in women.</td>
<td>Raised blood pressure was highest in people with no tertiary education compared to those with a university education.</td>
</tr>
<tr>
<td></td>
<td>Lower income had &gt; diabetes compared to higher income group.</td>
</tr>
<tr>
<td></td>
<td>High cholesterol and TG in people with no tertiary education compared to a university education.</td>
</tr>
<tr>
<td></td>
<td>Diabetes was higher in low income groups compared to highest income group.</td>
</tr>
<tr>
<td></td>
<td>Low income and low education were associated with higher risk of CVD compared to the highest income and education groups respectively. Low SES is associated with higher BMI and obesity.</td>
</tr>
</tbody>
</table>

**Study 20 (Nishi et al., 2004)**

<table>
<thead>
<tr>
<th>An inverse relationship between hypercholesterolemia and SES was only found by education level in women.</th>
<th><strong>An inverse relationship between hypercholesterolemia and SES was only found by education level in women.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>In men, manual workers had a significantly higher risk of developing hypertension than did higher-level non-manual workers.</td>
<td><strong>In men, manual workers had a significantly higher risk of developing hypertension than did higher-level non-manual workers.</strong></td>
</tr>
<tr>
<td>Women with a lower level of education were more likely to</td>
<td><strong>Women with a lower level of education were more likely to</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Women with a lower level of education were more likely to</strong></td>
</tr>
<tr>
<td>Study 21 (Osler et al., 2000)</td>
<td><strong>Men with a low level of education were more likely to be diabetic.</strong></td>
</tr>
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</tr>
<tr>
<td></td>
<td><strong>In Denmark the increased socio-economic difference in CVD mortality during the 1980s only seems to be accompanied by growing social differences in the prevalence of smoking.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>The analyses of time trends from 1982 to 1992 in biological risk factors in each educational group showed that HDL-cholesterol concentrations declined in women in all educational groups, and in the highest educated men.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Increases in height, and diastolic BP were significant in men and in women with less than 10 years of schooling, while an increase in weight and BMI was significant for men with 10-11 years of schooling and in women with 8-9 years.</strong></td>
</tr>
<tr>
<td>Study 22 (Panagiotakos et al., 2008)</td>
<td><strong>Low SES groups exhibited higher prevalence of CVD risk factors, such as obesity, hypertension, diabetes mellitus and hypercholesterolemia (all P&lt;0.001).</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Higher SES index was associated with lower likelihood of having hypercholesterolemia (95% CI 0.83, 1.00) and</strong></td>
</tr>
</tbody>
</table>
diabetes (95% CI 0.72, 0.95), after adjusting for various potential confounders.

- Comparisons between SES groups showed that the low and medium education groups had a higher prevalence of CVD risk factors than the high education groups.

<table>
<thead>
<tr>
<th>Study 23 (Panagiotakos et al., 2008)</th>
</tr>
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<tbody>
<tr>
<td>- Multiple logistic regression analysis revealed that people in the lowest SES group, compared to highest were 2.14-times (95% CI 1.24–3.71) more likely to have four or more of the common CVD risk factors, i.e. smoking, physical inactivity, obesity, hypertension, diabetes and hypercholesterolaemia, irrespective of age, sex, dietary habits and depression status.</td>
</tr>
<tr>
<td>- Studying elderly people living in Mediterranean islands it was found that participants in the upper SES group had a lower prevalence of hypercholesterolaemia and hypertension.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study 27 (Stelmach et al., 2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Generally, higher education level decreased and higher income increased the number of CVD risk factors in all participants.</td>
</tr>
<tr>
<td>- A higher risk of diabetes and obesity associated with lower</td>
</tr>
</tbody>
</table>
levels of education.
- Older age and university education decreased the risk of obesity in females.
- In males, university education increased the risk of hypercholesterolaemia.
- Higher education (high school or university) decreased the risk of diabetes in females; less-educated respectively; males were more likely to smoke and have hypercholesterolaemia than females.

<table>
<thead>
<tr>
<th>Study 28 (Schroder et al., 2004)</th>
</tr>
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<tbody>
<tr>
<td>▪ Age adjusted linear regression analysis revealed a direct association of educational status with LDL-cholesterol in men, and with BMI, and systolic and diastolic BP in women.</td>
</tr>
<tr>
<td>▪ The relationships between SES and LDL-cholesterol in men, and BMI in women remained significant after adjusting for several confounders including lifestyle variables.</td>
</tr>
<tr>
<td>▪ Only LDL-cholesterol in men and BMI in women were independently related to lower levels of SES in this population.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study 30 (Winkleby et al., 1992)</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Higher CVD risk factor was associated with lower levels of</td>
</tr>
<tr>
<td>Study 32 (Wong and Donnan, 1992)</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td>Higher levels of SES were associated with higher mortality from ischemic heart disease in men.</td>
</tr>
<tr>
<td>Lower SES was associated with higher risks of men from cerebrovascular disease and hypertensive disease.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study 35 (Yarnell et al., 2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among men who were initially free of CHD there were clear SES differentials (years of full time education, unemployment, and educational level) in the distribution of several CHD risk factors for CHD, notable smoking habit, systolic blood pressure, BMI and fibrinogen.</td>
</tr>
</tbody>
</table>
In this cohort of men free of CHD at baseline few SES indicators showed relationships with risk of CHD by 5 years of follow up.

All 842 men showed some evidence of CHD at screening examination and these men were more likely to be living in poorer material circumstances, be unemployed, or have less full-time education than men without CHD at screening in both France and Northern Ireland. These relationships persisted following adjustment for all known risk factors for CHD.

Among men who were initially free of CHD there were clear SES differentials (years of full-time education, unemployment, and educational level) in the distribution of several risk factors for CHD like systolic BP, BMI and fibrinogen. TC in contrast showed no SES differentials.
2.6 Discussion

The main aim of this review was to examine the relationship between SES and CVD risk in both developing and developed countries. Table 2.1 shows a summary of the association between SES and CVD risk in both developing and developed countries. The associations of SES with CVD risk has been suspected for ages. In the initial phases of the CVD epidemic the urban, affluent, and educated population groups due to risk-prone behaviours including smoking, poor dietary eating habits, and low rates of exercise seemed at greater risk of developing CVDs. As the mediators of the CVD risk became more available, more social classes seemed affected. In the later phases of the CVD epidemic, the urban, educated, and affluent population groups began to acquire health information, adopt healthy behaviours, and access health care more efficiently. Apparently as the decline of CVD risk in the more affluent groups was occurring, the burden of CVD (shifted) became higher in the less-educated and low-income groups (Reddy et al., 2007). It is this social drift of the CVD epidemic that formed the focus of this study.

This review was done to gain a deep understanding of the association between SES and CVD risk factors in developed and developing countries. From these studies, twenty five studies proved the hypothesis to be true, which means that in developing countries higher SES was associated with increased risk for CVD (Gilberts et al., 1994; Reddy et al., 2002), and higher SES was associated with lower CVD risk in developed countries (Irríbarren et al., 1997; Ishizaki et al., 2000; Nishi et al., 2004; Schroder et al., 2004; Panagiotakos et al., 2008). However six studies showed opposite associations to our hypothesis between CVD risk and SES (Gupta et al., 1994; Bobak et al., 1999; Yu, et al., 2000; Roohafza et al., 2005; Yarnell et al., 2005; Reddy et al., 2007). There were four studies that reported both positive and negative associations between SES and CVD risk (Luepker et al., 1993; Mendez et al., 2003; Stelmach et al., 2004; Kanjilal et al., 2006).

Three variables that are usually used as a proxy for SES are income, education and occupation. Income, when used in developing countries as a SES variable to determine its association with CVD risk, results portrayed that higher income is associated with an increased risk for developing CVDs (Vorster et al., 2007), whereas a study conducted by Yu et al. (2002) showed opposite findings in that lower income
was associated with higher CVD risk. In developed countries when income was used as a variable it was seen that higher SES was associated with lower CVD risk (Winkelby et al., 1992; Wong & Donnan, 1992; Iribarren et al., 1997; Choiniere et al., 2000; Jonnalagadda et al., 2000; Metcalf et al., 2007; Panagiotakos et al., 2008a; Panagiotakos et al., 2008b). A limitation for using income as a SES variable is that it is more susceptible to change. Stable measures of household income are more difficult to obtain. Income is sensitive to change in job status, including retirement, family circumstances, economic trends, and is more susceptible to misreporting (Luepker et al., 1993). Also it may be difficult to measure household versus individual income in certain cultures.

When education was used as a SES variable, studies conducted in developing countries showed that as one becomes more educated the risk for CVD increased (Fernald, 2007; Yu et al., 2002; Vorster et al., 2007). On the contrary some studies conducted in developing countries also showed that higher education was associated with lower CVD risk (Gupta et al., 1994; Bobak et al., 1999; Yu et al., 2000; Reddy et al., 2002; Roohafza et al., 2005; Reddy et al., 2007). Studies conducted in developed countries showed that higher education was associated with lower CVD risk (Winkleby et al., 1992; Wong & Donnan, 1992; Luepker et al., 1993; Bennet, 1995; Hoeymans et al., 1996; Iribarren et al., 1997; Benetou et al., 2000; Choiniere et al., 2000; Ishizaki et al., 2000; Jonnalagadda et al., 2000; Osler et al., 2000; Nishi et al., 2004; Schroder et al., 2004; Larranaga et al., 2005; Metcalf et al., 2007; Panagiotakos et al., 2008). Education may be the best SES indicator to use in epidemiological studies. The positive attributes of using education as a SES indicator are that data on education are usually available to all individuals regardless of employment status; educational data usually have high reliability and validity; are generally stable after early adulthood; are easily reported; and can be collected as a continuous variable (Liberatos et al., 1988). There are potential limitations of using education as a sole indicator of SES; its stability can mask important changes in individuals’ circumstances, regional differences in education, the question of whether degrees or certification are better measurement parameters than years of schooling (Liberatos et al., 1988).

Occupation, when used as a SES variable in developing countries to determine its association with CVD risk factors, results indicated that, higher occupation was
associated with increased risk for CVD (Fernald, 2007; Gilberts et al., 1994; Reddy et al., 2002; Yu et al., 2002). One study showed an opposite finding in that higher occupation was associated with lower CVD risk (Yu et al., 2000). In developed countries, when occupation was used as a SES variable, studies showed that the higher the occupation level the lower the risk for CVD (Winkleby et al., 1992; Connolly & Kesson, 1996; Chaturvedi et al., 1998; Ishizaki, et al., 2000; Jonnalagadda et al., 2000; Nishi et al., 2004; Larranaga et al., 2005). A major limitation for using occupation as a SES is that it is susceptible to change (Luepker et al., 1993). Occupation is the most difficult factor to measure because so many different types of occupations exist, and there are so many competing scales. Many scales rank occupations based on the level of skill involved, from unskilled to skilled manual labour to professional, or use a combined measure using the education level needed and income involved.

In general studies conducted in developed countries showed that a higher SES was associated with lower risk for developing CVDs. The reasons for this could be partly explained by the fact that people in the higher SES groups seem to follow a healthy diet compared to the lower SES groups (Jonnalagadda et al., 2000; Schröder et al., 2004; Panagiotakos et al., 2008). Additionally, poor diet quality not only influences macronutrient intake, but can also result in poor intake of protective components, such as antioxidants, phytochemicals, fibre, and other related compounds. For example, the high sodium intake and the poor intake of fruit, milk and milk products could be one of several potential explanations for the higher rates of hypertension commonly encountered in the African-American populations (Jonnalagadda et al., 2000). It was also observed that in some countries people only consume food that they are familiar with i.e. food that is culturally acceptable not taking into account the nutritional quality the foods have (Schröder et al., 2004). Another reason for this observation (increased CVD risk in lower SES groups) could be that of low physical activity levels in those falling within the lower education and low income groups (Hoeymans et al., 1996; Choiniére et al., 2000; Schröder et al., 2004). Schröder et al. (2004) observed that the lower SES groups spent less time in leisure physical activity than higher SES groups. Additionally the lower SES groups who are not educated seem to have higher CVD risk factors, and this could be attributed to that education may give awareness and influence life-style behaviours including eating healthy, exercising, not smoking and management of weight. Moreover, education may facilitate the
acquisition of positive social, psychological, and economic skills. Such skills and assets that may accompany higher educational attainment include positive attitudes about health, access to preventative health service, memberships in peer groups that promote the adoption or continuation of positive health behaviours, higher self-esteem and self-efficacy (Winkleby et al., 1992). Higher levels of smoking (Choiniére et al., 2000; Metcalf et al., 2007) and alcohol consumption (Shröder et al., 2004) found in the lower SES groups could also increase the risk of developing CVDs.

The prevalence of hypertensive diseases found in the lower SES groups in developed regions could be attributed to the poor regular medical care that the less wealthy groups receive (Wong & Donnan, 1992). Additionally the high levels of fibrinogen found in the lower SES groups in Japan could partly be associated with the higher levels of smoking among the lower SES groups. In the same study, higher levels of glycated haemoglobin (HbA1C) were also positively associated with fibrinogen levels. Another possible reason for the higher fibrinogen levels in the lower SES groups could be due to the increased stress they are constantly under pertaining to employment and income. Psychological stress releases hormones such as catecolamines and cortisol which increases blood glucose, which in turn becomes glycated to fibrinogen, thus the positive association between HbA1C and fibrinogen. Therefore, psychological stress seems to be associated with increased fibrinogen levels (Ishizaki et al., 2000). Furthermore, lower SES groups are associated with a higher prevalence of depression and other psychological disorders (Panagiotakos et al., 2008).

The majority of studies conducted in developing countries has shown that the higher the SES the higher the risk for developing CVDs. These observations could be attributed to the fact that rapid industrialisation and urbanisation has led to a health and epidemiological transition that is characterised by changes in dietary patterns, eating habits and a reduction in physical activity levels (Reddy et al., 2002). The higher SES groups were overweight and hypertensive as compared to the lower SES groups (Gilberts et al., 1994). In the Chinese population there was a higher concentration of the serum lipid profile in higher SES groups (Yu et al., 2002). China currently seems to be having an accelerated pace of transition thus increased adoption of the so called westernised diet which is characterised by increased fat, free sugar, salt and alcohol intakes. Increased weight gain and risk for being obese are associated
with increased consumption of alcoholic beverages, carbonated drinks and low cost snacks in higher SES groups. Increased economic resources may allow people to purchase and consume a larger number of high calorie beverages, and high calorie snacks which then contribute to weight gain (Fernald, 2007). In the African populations, higher SES was associated with increased CVD risk in a study conducted between 1996-1998, the possible reason for this could be that Africans then were at a stage in their transition where the burden of CVD and other NCDs still lay with those with higher SES position (Vorster et al., 2007), but in time there seems to be a slight shift in the burden as the rural poor seem to be catching up in that they have an increased concentration of different types of risk factors for CVD as this study will indicate in Chapter 3.

With many studies illustrating that in developing countries CVD risk was higher in those having a higher SES (Gilberts et al, 1994; Reddy et al, 2002), we observed within this literature review few discrepancies with this hypothesis. For example a study done in India (developing country) showed that there was an increased risk in developing CVDs for those in the lower SES groups. This observation could be attributed to the increased use of tobacco and tobacco products, intake of diets high in salt, and low intakes of fruits and vegetables. Indians have been reported to have a high propensity to developing metabolic abnormalities (Gupta et al., 1994; Reddy et al., 2007). A study done in an Iranian population also showed an adverse CVD risk profile in the least educated adults (Roohafza et al., 2005). Education plays as an indicator of the link between SES and CVD risk via two broad pathways found in lower SES groups:

- Less favourable patterns of established major lifestyles and biomedical risk factors such as smoking, sedentary lifestyle, adverse diets, high serum cholesterol, high blood pressure, obesity and diabetes and
- Less favourable patterns of psychosocial factors such as hostility, depression, low social support, social isolation, job instability (Roohafza et al., 2005).
2.7 Conclusion

From this literature review we conclude that in developed countries it is shown that CVD risk is lower in the higher SES groups whilst in developing countries, CVD risk was more in the higher SES groups. Few discrepancies have been observed with the findings in Iran and India. Thus in developing countries undergoing health transition, there are strong economic and demographic forces propelling previously once isolated rural (low SES groups) groups into the peri-urban and urban areas, thus stimulating changes in dietary patterns, eating habits and a reduction in physical activity levels, which ultimately might lead to the shift of CVD burden from those in higher SES to those that have a lower SES.
2.8 References


• METCALF, P., SCRAGG, R. & DAVIS, P. 2007. Relationship of different measures of socioeconomic status with cardiovascular disease risk factors and


CHAPTER 3: SOCIAL DRIFT OF CARDIOVASCULAR DISEASE RISK FACTORS IN AFRICANS FROM THE NORTH WEST PROVINCE OF SOUTH AFRICA: THE PURE STUDY

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CHAPTER 3: SOCIAL DRIFT OF CARDIOVASCULAR DISEASE RISK FACTORS IN AFRICANS FROM THE NORTH WEST PROVINCE OF SOUTH AFRICA: THE PURE STUDY

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Running title: Social drift of CVD risk factors in Africans

Keywords: CVD risk factors, social drift phenomenon, socio-economic status, dietary intakes, PURE baseline study, NorthWest Province, South Africa, serum lipids.
Summary

The objective of this paper was to examine whether the associations between socio-economic status (SES) and cardiovascular disease (CVD) risk factors in black South Africans from the North West Province shifted from the more affluent groups with higher SES to the less affluent, lower SES groups over a period of nine years. Cross-sectional baseline data of 2010 urban and rural subjects (35 years and older) participating in the Prospective Urban and Rural (PURE) study and collected in 2005, were analyzed to examine the relationships of level of education, employment and being urban or rural with dietary intakes and other CVD risk factors. These relationships were compared to those found nine years earlier in the THUSA study conducted in the same area. The results showed that urban women had higher body mass index (BMI), serum triglyceride and fasting glucose compared to rural women and that both urban men and women had higher blood pressures and followed a more “Westernized” diet. However, rural men and women had higher plasma fibrinogen levels. The higher educated subjects (which included both urban and rural subjects) were younger than those with no or only primary school education. Few of the risk factors differed significantly between education groups, except that highly educated men and women had lower BMIs, and women lower blood pressure and triglycerides. These women also followed a more “prudent” diet than those with only primary school education. Employed men and women had higher BMIs, higher energy intakes but lower plasma fibrinogen, and employed women lower triglycerides. No significant differences in total serum cholesterol were observed. These results suggest a drift of CVD risk factors from groups with higher SES to groups with a lower SES from 1996 to 2005, indicating that interventions to prevent CVD should also be targeted to Africans living in rural areas, to those with low education levels, and to the unemployed.
Introduction

The escalating global burden of cardiovascular disease (CVD) is related to the rapid health transition that developing countries are experiencing. Adoption of high-energy, high-fat, “Westernized” diets and diminished physical activity contribute to the acceleration in CVD epidemics. South Africa, an emerging economy, is currently undergoing a health transition characterised by a triple burden of disease consisting of a high prevalence of under nutrition-related infectious diseases, the emergence of non-communicable chronic diseases (NCDs), and the human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) pandemic.

The THUSA study conducted in 1996/8 in the North West Province of South Africa indicated that Africans with a higher socio-economic status (SES) had higher risk factors of CVD, than those with a lower SES. Many studies have showed that in developing countries, during the early phases of the health transition, the NCD/CVD burden is usually higher in the higher SES class. In developed countries, the burden has shifted to the poor. This shift of the burden of CVD from the rich to the poor in a population can be seen as a social drift in CVD risk.

However, there are studies which found that the usual pattern is not always followed. In some developing countries, higher CVD risk factors were seen in lower SES groups. A study from a developed country showed that higher CVD risk factors were found in higher SES groups. These studies illustrate a dynamic drift of the burden of CVD risk factors between groups of different SES within countries.

As mentioned earlier, the health transition in developing countries is closely related to the transition from “prudent”, low-energy, low-fat diets traditionally followed in rural areas to more “Westernized” high-energy, high-fat diets followed in urban areas. There is convincing evidence that this “Westernised” dietary pattern increases the risk of CVD and other NCDs through a variety of mechanisms. Diet can, therefore, be seen as a risk factor for CVD and dietary recommendations create the cornerstone in prevention of CVD. To be effective and successful, any dietary intervention programme should be focused, using diet messages, education material and nutrition advice targeted to specific groups. It is, therefore, important for prevention of CVD
to know which groups within a population have a high risk for CVD and which risk factors should be targeted with dietary interventions.

In this study we explored the associations between SES (measured by level of urbanisation, education and employment) and CVD risk factors (including diet and nutrient intakes) in an African population undergoing a nutrition transition in the North West Province of South Africa that were prevalent in 2005, when the baseline PURE data were collected. PURE is an acronym for the 12 year Prospective Urban and Rural Epidemiological study which investigates the health transition in urban and rural Africans (from 2005 to 2017). The objective was to assess if social drift in CVD risk has taken place over a period of nine years in Africans of the North West Province by comparing the findings of the baseline PURE study data to those reported for the THUSA study, which was collected in 1996/8.

**Methods**

*Study design, subject selection and organizational procedures*

This analysis is based on cross-sectional data collected at baseline in 2005 as part of North West Province, South Africa leg of the international 12-year PURE study. The PURE study investigates the effects of the health and nutrition transitions, and specifically of the NCDs or chronic diseases of lifestyle, in urban and rural subjects. Migration stability was the main selection criterion within the chosen rural and urban communities. Four different areas of residence were used in the subject recruitment for the PURE study. Community A was located 450 km west of Potchefstroom on the highway to Botswana. Community B, a deep rural community, 35 km east from A, was only accessible with a gravel road. A and B were the rural communities of the PURE study. Communities C and D were the urban communities. C was the established Ikageng Township, part of the greater Potchefstroom. Community D was the informal settlements surrounding community C. A random household census regarding number of people, their ages and health profile was done in 6000 houses (1500 in each community).

Every head of a household gave signed consent to fill out the census questionnaire. If a person refused or was not at home, the next house was taken and a non-complier questionnaire was filled out. From the data obtained a paper selection of possible subjects with no reported NCDs, tuberculosis or diagnosed HIV was made. A total of
2010 apparently healthy African volunteers, 35 years and older were then recruited. Participants were fasted (10-12 hours) for the baseline blood sampling and other measurements. Trained field workers assisted in providing information to the participants in their language of choice. Participants received feedback regarding their blood pressure, fasting glucose concentrations and HIV status, and were referred to the nearest clinic or hospital where necessary. Travelling expenses of participants were covered.

Ethical approval was obtained from the Ethics Committee of the North-West University, Potchefstroom, South Africa (ethics number: 04M10) and signed informed consent forms were received from all participants. Participants were provided with background information about the study and its purpose, and they were informed that participation was voluntary and that they could withdraw at any time. Permission to conduct the study was also obtained from North West Department of Health, tribal chiefs, and the local government authorities of each selected site.

**Questionnaires**

Structured, validated demographic, socio-economic and lifestyle questionnaires were administered by trained field workers during home visits in the language preferred by the participants. The questionnaires used were adapted from those used by all countries participating in the PURE study. A quantitative food frequency questionnaire (QFFQ) validated for this population was administered by trained field workers using food models and food photographs of different portion sizes to assess habitual dietary intakes. The food data were converted to nutrient intakes using the South African Food Composition Tables and computer programme of the South African Medical Research Council.

**Anthropometric measurements**

Anthropometric measurements were done by trained Biokinetisits. Height was measured to the nearest 0.5 cm with a stadiometer (Invicta, IP 1465, United Kingdom (UK) ) and weight was determined on a portable electronic scale to the nearest 0.01 kg (Precision Health Scale, A & D Company, Japan). All the measurements were done according to the guidelines adopted at the National Institute of Health sponsored Arlie Conference. Body circumferences of participants were measured in light underwear with calibrated instruments (Holtain® unstretchable metal tape; John
Bull® calipers). Body mass index was calculated by dividing weight in kilograms by height in metre squared.

**HIV Status**

Every participant who signed an informed consent form was tested for HIV infection, but was given the choice of knowing his/her status. Whole blood was used for the determination of HIV status making use of the First Response (PMC Medical, India) rapid HIV card test. If tested positive, the test was repeated with the Pareeshak (BHAT Bio-tech India) card test. A pre-test counseling in groups of 10 persons before the blood sample was taken and individual post-test counseling was done according to the protocol of the National Department of Health of South Africa.

**Blood, serum and plasma samples**

A disposable needle was used by trained nurses to draw blood from the ante-cubital vein in the right arm of the participant. For plasma, each collection tube was filled to its capacity to ensure optimal blood:anticoagulant ratios. The tubes were inverted five times to ensure thorough mixing of the contents of the tube. The tubes were placed in ice boxes after labeling. A new sterile transfer pipette was used to aliquot blood cell, serum and plasma samples for analysis. Serum was prepared by allowing blood to clot at room temperature for 30 minutes; it was then centrifuged at 2000g for 15 minutes at 10°C. Blood was centrifuged within two hours of collection; after the blood was centrifuged and separated it was stored at -70°C in the laboratory. Plasma samples were collected in ethylenediamine tetra acetic acid (EDTA) tubes, centrifuged at 2000g for 15 minutes at 4°C and transferred to cryo tubes for storage at -70°C.

**Biochemical and physiological analysis**

Both systolic and diastolic blood pressure were obtained using OMRON automatic digital blood pressure monitor (Omron HEM-757). Subjects were resting and calmed for 10 minutes, did not smoke, eat, exercise or do any intense activities for 30 minutes before taking the measurements. Blood pressure measurements were performed twice (5 minutes) apart. Subjects were seated upright and relaxed with his/her arm supported at heart level and measurements were taken using the brachial artery. Blood glucose was measured using Vitros DT6011 Chemistry Analyser, an Ortho-Clinical Diagnostics tool (Rochester, New York, United States of America (USA)).
Quantitative determination of total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), C reactive protein and triglycerides (TG) was done by Sequential Multiple Analyzer Computer (SMAC) using the Konelab™ auto-analyzer. Plasma fibrinogen was measured using a modified Clauss method (Multi fibrin U test, Dade Behring, Deerfield Illinois, USA) on the Dade Behring BCS coagulation analyzer.

**Statistical analysis**

The SPSS package (version 17.0, SPSS Inc) was used to analyse the data. Means and 95% confidence intervals (CI) of CVD risk and dietary factors were calculated. Participants of both genders were divided into different groups (according to urbanisation, education and employment levels) and compared. Estimated significant differences between rural and urban participants were determined with analysis of variance using general linear model (GLM), multivariate procedure. Univariate analysis was used to explore further the influence of education on CVD risk factors and dietary intakes. Employment was used as a proxy for income, and pairwise comparisons using GLM, multivariate procedure were done for comparing the three groups (Not answered, employed and not employed). Tests were considered significant at P<0.05.

**Results**

The total energy as well as macronutrient intakes and some selected micronutrients are shown in Table 1. The table shows that mean total energy intakes of urban men and women were significantly higher than those of rural men and women. It can, therefore, be expected that other nutrient intakes will also be higher in urban subjects because more food was consumed. However, if differences in the percentages of energy contributed by the different macronutrients are compared, it is clear that not only total amounts of food, but also types of foods and, therefore, dietary patterns differed between urban and rural subjects. In urban men, the contribution of total protein, animal protein, total fat, saturated fat, and total carbohydrates to total energy were 12.5, 5.6, 25.3, 6.3 and 56.5% respectively. In rural men the corresponding figures were 10.8, 3.2, 17.7, 3.9 and 63.1%. The same pattern was observed when urban and rural women were compared. In rural subjects, animal protein formed about a third of total protein, while in urban subjects about half of the total protein was from animal sources in both genders. Total and saturated fat intakes were twice as high in
urban than in rural men and women. Percentage of total energy from fat moved from rural values of 17.7 and 20.3 % to urban values of 25.3 and 28.3% for men and women respectively. This is a major shift from a low-fat, “prudent” diet followed in the rural areas to a higher-fat, more “Westernized” type of diet in the urban areas.

Mean intakes of total dietary fibre were significantly higher in urban men and women compared to their rural counterparts. The percentage increases in energy intake from rural to urban men and women were 44 and 48%, while that of dietary fibre were 44 and 33% (percentages not shown in Table 1).

Mean intakes of selected key micronutrients (iron, calcium and vitamin C) were substantially and significantly higher in urban than rural subjects, and for calcium and vitamin C, more than double that of rural groups.

In Table 2 the mean levels of CVD risk factors of urban men and women are compared to that of their rural counterparts. Rural women were slightly, but significantly younger than urban women. There were no significant differences in total and HDL cholesterol, but urban women had significantly higher triglyceride levels than rural women. Their mean fasting glucose value was also significantly higher. Urban men and women had significantly higher blood pressures, and urban women had significantly higher mean BMI than rural women, although the rural women also had a mean BMI in the overweight range. Rural men and women had significantly higher plasma fibrinogen levels. There were no significant differences in C-reactive protein (CRP) between urban and rural groups. Both rural and urban men reported high alcohol intakes (17.8 and 20.0 g/day respectively). Women took less alcohol, but urban women had significantly higher intakes, namely 9.0 versus 6.6 g/day reported by rural women.
<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban (n=399)</td>
<td>Rural (n=347)</td>
</tr>
<tr>
<td><strong>Total energy (TE)</strong></td>
<td>10054.2(^a) (9681.9-10426.4)</td>
<td>6973.3(^a) (6568.7-7377.8)</td>
</tr>
<tr>
<td><strong>Total Protein (g)</strong></td>
<td>74.1(^a) (71.3-76.8)</td>
<td>44.4(^a) (41.4-47.4)</td>
</tr>
<tr>
<td>[% of TE]</td>
<td>[12.5]</td>
<td>[10.8]</td>
</tr>
<tr>
<td><strong>Animal protein (g)</strong></td>
<td>33.4(^a) (31.9-35.0)</td>
<td>13.3(^a) (11.6-14.96)</td>
</tr>
<tr>
<td>[% of TE]</td>
<td>[5.6]</td>
<td>[3.2]</td>
</tr>
<tr>
<td><strong>Total fat (g)</strong></td>
<td>67.1(^a) (64.3-69.8)</td>
<td>32.4(^a) (29.4-35.3)</td>
</tr>
<tr>
<td>[% of TE]</td>
<td>[25.3]</td>
<td>[17.7]</td>
</tr>
<tr>
<td><strong>Saturated fat (g)</strong></td>
<td>16.6(^a) (15.9-17.4)</td>
<td>7.2(^a) (6.3-8.0)</td>
</tr>
<tr>
<td>[% of TE]</td>
<td>[6.3]</td>
<td>[3.9]</td>
</tr>
<tr>
<td><strong>Total carbohydrates (g)</strong></td>
<td>334.3(^a) (321.3-347.4)</td>
<td>258.9(^a) (244.7-273.1)</td>
</tr>
<tr>
<td>[% of TE]</td>
<td>[56.5]</td>
<td>[63.1]</td>
</tr>
<tr>
<td><strong>Dietary fibre (g)</strong></td>
<td>26.7(^a) (25.6-27.8)</td>
<td>18.5(^a) (17.3-19.7)</td>
</tr>
<tr>
<td><strong>Iron (g)</strong></td>
<td>16.7(^a) (16.0-17.4)</td>
<td>12.4(^a) (11.6-13.1)</td>
</tr>
<tr>
<td><strong>Calcium (g)</strong></td>
<td>452.0(^a) (429.3-474.6)</td>
<td>247.9(^a) (223.2-272.5)</td>
</tr>
<tr>
<td><strong>Vitamin C (g)</strong></td>
<td>42.5(^a) (39.1-45.8)</td>
<td>12.6(^a) (9.0-16.2)</td>
</tr>
</tbody>
</table>

\(^a,b\): Means with the same symbol differ significantly (P<0.05); Significant differences based on GLM, analysis of variance (ANOVA)
### TABLE 2. MEAN (95% CI) CARDIOVASCULAR DISEASE RISK FACTORS (EXCLUDING DIET) OF URBAN AND RURAL SUBJECTS

<table>
<thead>
<tr>
<th>Risk factor (means and 95% CI)</th>
<th>Men</th>
<th>Urban</th>
<th>Rural</th>
<th>Women</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (n)</td>
<td>399</td>
<td>347</td>
<td>605</td>
<td>659</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>50.4 (49.3-51.6)</td>
<td>49.4</td>
<td>(48.3-50.6)</td>
<td>50.8* (49.8-51.7)</td>
<td>47.5* (46.7-48.3)</td>
<td></td>
</tr>
<tr>
<td>High density lipoprotein cholesterol (mmol/l)</td>
<td>1.62 (1.55-1.69)</td>
<td>1.54</td>
<td>(1.47-1.61)</td>
<td>1.46 (1.40-1.51)</td>
<td>1.51 (1.46-1.56)</td>
<td></td>
</tr>
<tr>
<td>Total cholesterol (mmol/l)</td>
<td>4.88 (4.73-5.02)</td>
<td>4.72</td>
<td>(4.58-4.87)</td>
<td>5.20 (5.07-5.32)</td>
<td>5.11 (5.0-5.22)</td>
<td></td>
</tr>
<tr>
<td>Fasting glucose (mmol/l)</td>
<td>4.93 (4.76-5.10)</td>
<td>4.81</td>
<td>(4.64-4.99)</td>
<td>5.19* (5.04-5.33)</td>
<td>4.94* (4.80-5.07)</td>
<td></td>
</tr>
<tr>
<td>Triglyceride (mmol/l)</td>
<td>1.27 (1.18-1.36)</td>
<td>1.15</td>
<td>(1.06-1.24)</td>
<td>1.47* (1.40-1.53)</td>
<td>1.25* (1.19-1.31)</td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>137.5* (134.0-140.0)</td>
<td>132.2* (129.6-134.7)</td>
<td>136.7* (134.5-138.8)</td>
<td>127.8 (125.8-129.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>87.9* (86.4-89.5)</td>
<td>84.9* (83.3-86.5)</td>
<td>89.5* (88.2-90.8)</td>
<td>86.4 (85.3-87.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>20.9 (20.5-21.4)</td>
<td>20.7</td>
<td>(20.2-21.1)</td>
<td>27.8* (27.2-28.5)</td>
<td>25.9* (25.4-26.5)</td>
<td></td>
</tr>
<tr>
<td>Fibrinogen (g/L)</td>
<td>3.17* (2.95-3.39)</td>
<td>3.50* (3.28-3.73)</td>
<td>3.74 (3.55-3.93)</td>
<td>4.04* (3.87-4.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-reactive protein (mg/L)</td>
<td>7.87 (6.50-9.23)</td>
<td>8.56</td>
<td>(7.10-10.0)</td>
<td>9.17 (8.18-10.16)</td>
<td>8.09 (7.14-9.04)</td>
<td></td>
</tr>
<tr>
<td>Alcohol consumption g/day</td>
<td>17.8 (15.0-20.7)</td>
<td>20.0 (117.0-23.1)</td>
<td>9.0 (7.3-10.5)</td>
<td>6.6 (5.0-8.1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a,b: Means with the same symbol differ significantly (P<0.05); Significant differences based on GLM, analysis of variance (ANOVA)
Table 3 shows the mean values of CVD risk factors of men with different reported education levels, while Table 4 gives the same data for women. The values of the 21 men and 37 women who did not answer the questions on education are also shown. In both men and women, the mean age of those with the higher education levels (secondary school and/or additional education) was significantly lower. There were more educated individuals in urban areas as compared to rural areas. However, 52 men and 136 rural men and women also completed secondary schooling and/or additional tertiary education.

Tables 3 and 4 further indicate that the serum lipids, glucose and fibrinogen levels did not differ significantly between subjects with different levels of education. In men there were also no differences in blood pressure, but women with the higher education levels had significantly lower systolic and diastolic blood pressure. These women also had lower serum triglyceride levels. The BMI of men and women were significantly higher in those subjects who had primary and secondary schooling compared to those without any schooling. The same pattern was observed in the dietary intakes, with sustained increases in energy, fat and protein intake and decreases in carbohydrate intake in men and women with primary education compared to those with no education. This change to a more “Westernised” diet was sustained in men with secondary education. However, women with secondary education reported a more prudent diet with lower energy, protein and alcohol intakes than those with primary education.

Table 5 compares the CVD risk factors of employed with unemployed men and women. Very few of the rural subjects were employed (15 men and 19 women) while 95 men and 95 women of the urban subjects were employed. Of the total sample of 679 men for whom employment data were available, 84.2% were unemployed and of the 1136 women who reported employment status, 90% were unemployed. The employed men and women were significantly younger than the unemployed subjects. The employed men and women had a significantly higher mean BMI and energy intakes but lower HDL-cholesterol (women), triglyceride (women), and fibrinogen (men and women) levels. Both the employed and unemployed women had mean BMIs in the overweight range. The diet of the employed showed all the characteristics of the higher-fat, more “Westernised” diet seen in urban and the more educated groups.
### TABLE 3. MEAN (95% CI) OF SELECTED CARDIOVASCULAR DISEASE RISK FACTORS IN MEN WITH DIFFERENT EDUCATION LEVELS

<table>
<thead>
<tr>
<th>Risk factor: Mean (95% CI)</th>
<th>Not answered</th>
<th>None</th>
<th>Primary</th>
<th>Secondary school and higher</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of subjects</strong></td>
<td>21</td>
<td>270</td>
<td>297</td>
<td>158</td>
</tr>
<tr>
<td><strong>Age in years</strong></td>
<td>48.2 (43.3-53.0)</td>
<td>52.5 (51.2-53.9)</td>
<td>49.4 (48.0-50.7)</td>
<td>45.5 (43.7-47.3)*</td>
</tr>
<tr>
<td><strong>Number of urban subjects</strong></td>
<td>9</td>
<td>90</td>
<td>194</td>
<td>106</td>
</tr>
<tr>
<td><strong>Number of rural subjects</strong></td>
<td>12</td>
<td>180</td>
<td>103</td>
<td>52</td>
</tr>
<tr>
<td><strong>High density lipoprotein cholesterol (mmol/l)</strong></td>
<td>1.42 (1.11-1.74)</td>
<td>1.68 (1.56-1.73)</td>
<td>1.54 (1.45-1.62)</td>
<td>1.58 (1.46-1.70)</td>
</tr>
<tr>
<td><strong>Total cholesterol (mmol/l)</strong></td>
<td>4.62 (3.98-5.25)</td>
<td>4.78 (4.60-4.96)</td>
<td>4.79 (4.62-4.97)</td>
<td>4.89 (4.66-5.13)</td>
</tr>
<tr>
<td><strong>Fasting glucose (mmol/l)</strong></td>
<td>4.77 (4.00-5.54)</td>
<td>4.78 (4.56-4.99)</td>
<td>4.93 (4.72-5.15)</td>
<td>4.84 (4.55-5.12)</td>
</tr>
<tr>
<td><strong>Triglyceride (mmol/l)</strong></td>
<td>1.15 (0.76-1.54)</td>
<td>1.14 (1.03-1.25)</td>
<td>1.25 (1.14-1.35)</td>
<td>1.27 (1.2-1.41)</td>
</tr>
<tr>
<td><strong>C-reactive protein (mg/L)</strong></td>
<td>9.55 (3.73-15.37)</td>
<td>9.30 (7.66-10.94)</td>
<td>8.23 (6.65-9.81)</td>
<td>6.02 (3.88-8.17)</td>
</tr>
<tr>
<td><strong>Systolic blood pressure (mmHg)</strong></td>
<td>132.1(121.2-143.0)</td>
<td>132.9 (129.9-136.0)</td>
<td>136.7 (133.6-139.7)</td>
<td>133.5 (129.4-137.5)</td>
</tr>
<tr>
<td><strong>Diastolic blood pressure (mmHg)</strong></td>
<td>86.9 (80.1-93.8)</td>
<td>84.4 (82.4-86.3)</td>
<td>87.4 (85.5-89.3)</td>
<td>86.7 (84.1-89.2)</td>
</tr>
<tr>
<td><strong>Body mass index (kg/m²)</strong></td>
<td>22.5 (20.6-24.3)</td>
<td>20.0 (19.5-20.5)</td>
<td>21.0 (20.5-21.6)</td>
<td>21.7 (21.0-22.4)*</td>
</tr>
<tr>
<td><strong>Fibrinogen (g/L)</strong></td>
<td>3.14 (2.16-4.11)</td>
<td>3.65 (3.78-3.92)</td>
<td>3.17 (2.90-3.44)</td>
<td>3.05 (2.65-3.41)</td>
</tr>
<tr>
<td><strong>Total energy (TE) in kiloJoules</strong></td>
<td>7963 (625-9667)</td>
<td>7626 (7141-8112)</td>
<td>9015 (8555-9474)</td>
<td>9390 (8676-10105)*</td>
</tr>
<tr>
<td><strong>Total fat in g (% of TE)</strong></td>
<td>49.4 (23.6%)</td>
<td>40.7 (20.3%)</td>
<td>52.9 (22.3%)</td>
<td>60.4 (24.4%)*</td>
</tr>
<tr>
<td><strong>Total protein in g (% of TE)</strong></td>
<td>53.9 (11.5%)</td>
<td>51.6 (11.5%)</td>
<td>63.4 (12.0%)</td>
<td>67.9 (12.3%)*</td>
</tr>
<tr>
<td><strong>Total carbohydrates in g (% of TE)</strong></td>
<td>282.3 (60.3%)</td>
<td>273.9 (61.6%)</td>
<td>315.2 (59.4%)</td>
<td>307.7 (55.7%)*</td>
</tr>
<tr>
<td><strong>Total fibre (g)</strong></td>
<td>20.0 (15.1-25.0)</td>
<td>20.4 (19.0-21.8)</td>
<td>24.7 (23.3-26.0)</td>
<td>23.4 (21.4-25.4)*</td>
</tr>
<tr>
<td><strong>Alcohol consumption (g/day)</strong></td>
<td>12.1 (-0.01-24.3)</td>
<td>17.7 (14.2-21.1)</td>
<td>18.8 (15.5-22.1)</td>
<td>22.0 (17.5-26.5)</td>
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</table>

*Significant difference across different education levels (P<0.05)
Significance differences based on GLM, analysis of variance (ANOVA)
<table>
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<tr>
<th>Risk factor : Mean (95% CI)</th>
<th>Not answered</th>
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<th>Primary</th>
<th>Secondary school and higher</th>
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<tr>
<td>Number of subjects</td>
<td>37</td>
<td>420</td>
<td>531</td>
<td>276</td>
</tr>
<tr>
<td>Number of urban subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of rural subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>47.0 (43.3-50.7)</td>
<td>50.2 (49.1-51.3)</td>
<td>50.7 (49.7-51.7)</td>
<td>44.0 (42.6-45.3)*</td>
</tr>
<tr>
<td>High density lipoprotein</td>
<td>1.36(1.12-1.59)</td>
<td>1.55 (1.48-1.61)</td>
<td>1.49 (1.43-1.55)</td>
<td>1.43(1.34-1.52)</td>
</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td>5.50 (4.98-6.01)</td>
<td>5.20 (5.05-5.35)</td>
<td>5.19 (5.05-5.33)</td>
<td>4.99 (4.80-5.18)</td>
</tr>
<tr>
<td>Total cholesterol (mmol/l)</td>
<td>5.29 (4.73-5.84)</td>
<td>5.04 (4.88-5.21)</td>
<td>4.94 (4.78-5.07)</td>
<td>4.88 (4.67-5.08)</td>
</tr>
<tr>
<td>C reactive Protein (mg/L)</td>
<td>10.01(6.04-14.00)</td>
<td>8.80(7.61-10.00)</td>
<td>8.67(7.61-9.73)</td>
<td>8.01(6.53-9.48)</td>
</tr>
<tr>
<td>Triglyceride (mmol/l)</td>
<td>1.38 (1.11-1.65)</td>
<td>1.40 (1.31-1.49)</td>
<td>1.36 (1.28-1.43)</td>
<td>1.22(1.12-1.32)*</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>130.6 (121.9-139.4)</td>
<td>130.4 (127.8-133.0)</td>
<td>134.5 (132.1-136.9)</td>
<td>126.9 (123.7-130.1)*</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>89.5 (84.3-94.7)</td>
<td>86.7 (85.2-88.2)</td>
<td>89.4 (88.0-90.9)</td>
<td>85.7 (83.7-87.6)*</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>28.6 (26.0-31)</td>
<td>25.2 (24.4-26.0)</td>
<td>27.6 (26.9-28.3)</td>
<td>27.4 (26.5-28.4)*</td>
</tr>
<tr>
<td>Fibrinogen (g/L)</td>
<td>4.51(3.69-5.32)</td>
<td>3.98 (3.74-4.22)</td>
<td>3.96 (3.73-4.18)</td>
<td>3.71 (3.41-4.01)</td>
</tr>
<tr>
<td>Total energy (TE) in KiloJoules</td>
<td>7115 (5985-8245)</td>
<td>6677 (6337-7017)</td>
<td>7997 (7693-8300)</td>
<td>7419 (6960-7877)*</td>
</tr>
<tr>
<td>Total fat in g (% of TE)</td>
<td>45.1 (24.1%)</td>
<td>38.0 (21.6%)</td>
<td>55.4 (26.3%)</td>
<td>50.2 (25.7%)*</td>
</tr>
<tr>
<td>Total protein in g (% of TE)</td>
<td>48.3 (11.5%)</td>
<td>44.6 (11.4%)</td>
<td>56.4 (12.0%)</td>
<td>52.1 (11.9%)*</td>
</tr>
<tr>
<td>Total carbohydrates in g (% of TE)</td>
<td>259.0 (61.9%)</td>
<td>245.3 (62.5%)</td>
<td>274.6 (58.4%)</td>
<td>261.2 (59.8%)</td>
</tr>
<tr>
<td>Total fibre (g)</td>
<td>18.1 (15.1-21.1)</td>
<td>18.2 (18.2-19.1)</td>
<td>21.0 (20.2-21.8)</td>
<td>19.3 (18.1-20.5)*</td>
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<tr>
<td>Alcohol consumption (g/day)</td>
<td>4.3 (-2.2-10.9)</td>
<td>10.4 (8.4-12.3)</td>
<td>7.2 (5.5-8.9)</td>
<td>4.9 (2.5-7.4)*</td>
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</tbody>
</table>

*Significant difference across different education levels population (P<0.05)

Significant differences based on GLM, analysis of variance (ANOVA).
<table>
<thead>
<tr>
<th>Risk factor: Means (95%CI)</th>
<th></th>
<th>Men</th>
<th></th>
<th></th>
<th>Women</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Not Answered</td>
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<td>Unemployed</td>
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<td>Employed</td>
<td>Unemployed</td>
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<td>Number of urban subjects</td>
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<td>47</td>
<td>95</td>
<td>15</td>
<td>257</td>
<td>330</td>
<td>120</td>
</tr>
<tr>
<td>Number of rural subjects</td>
<td></td>
<td>2</td>
<td>8</td>
<td>300</td>
<td>8</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td>52.8(49.3-56.3)</td>
<td>44.6(42.4-46.8)</td>
<td>50.4(49.5-51.4)</td>
<td>50.3(48.1-52.5)</td>
<td>45.6(43.4-47.8)</td>
<td>49.1(48.4-49.9)</td>
</tr>
<tr>
<td>High density lipoprotein</td>
<td></td>
<td>1.46(1.24-1.69)</td>
<td>1.53(1.40-1.66)</td>
<td>1.60(1.54-1.66)</td>
<td>1.19(1.06-1.32)</td>
<td>1.43(1.29-1.56)</td>
<td>1.53(1.49-1.56)</td>
</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td></td>
<td>4.62(4.17-5.07)</td>
<td>4.89(4.61-5.18)</td>
<td>4.80(4.68-4.92)</td>
<td>4.93(4.64-5.210</td>
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<tr>
<td>Total cholesterol (mmol/l)</td>
<td></td>
<td>5.45(4.89-6.00)</td>
<td>4.67(4.31-5.00)</td>
<td>4.84(4.70-4.99)</td>
<td>5.34(5.03-5.67)</td>
<td>4.67(4.35-5.00)</td>
<td>4.96(4.85-5.07)</td>
</tr>
<tr>
<td>Fasting Glucose (mmol/l)</td>
<td></td>
<td>7.43(3.04-11.81)</td>
<td>5.81(3.04-8.58)</td>
<td>8.29(7.12-9.47)</td>
<td>9.44(7.04-11.84)</td>
<td>6.05(3.56-8.84)</td>
<td>8.41(7.61-9.23)</td>
</tr>
<tr>
<td>C-Reactive Protein (mg/L)</td>
<td></td>
<td>1.30(1.01-1.57)</td>
<td>1.31(1.13-1.49)</td>
<td>1.18(1.11-1.26)</td>
<td>1.56(1.40-1.70)</td>
<td>1.16(0.99-1.31)</td>
<td>1.33(1.28-1.38)</td>
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<tr>
<td>Triglyceride</td>
<td></td>
<td>138.4(130.5-146.2)</td>
<td>134.1(129.2-139.1)</td>
<td>134.2(132.1-136.3)</td>
<td>133.0(128.0-138.0)</td>
<td>130.9(125.7-136.1)</td>
<td>131.1(129.4-132.8)</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td></td>
<td>88.8(83.8-93.7)</td>
<td>85.8(82.6-88.9)</td>
<td>86.0(84.6-87.3)</td>
<td>86.9(83.9-89.9)</td>
<td>87.8(84.8-90.9)</td>
<td>87.7(86.7-88.7)</td>
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<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td></td>
<td>21.5(20.1-22.8)</td>
<td>22.1(21.3-23.0)</td>
<td>20.6(20.2-20.9)</td>
<td>28.1(26.6-29.6)</td>
<td>27.9(26.3-29.4)</td>
<td>26.5(26.0-27.0)</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td></td>
<td>2.17(1.48-2.87)</td>
<td>2.98(2.55-3.42)</td>
<td>3.47(3.28-3.65)</td>
<td>3.62(3.16-4.09)</td>
<td>3.51(3.03-3.98)</td>
<td>4.01(3.85-4.16)</td>
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<tr>
<td>Fibrinogen (g/L)</td>
<td></td>
<td>7626.5(6248.4-9004.6)</td>
<td>10217.5(9348.5-11086.4)</td>
<td>8385.7(8016.6-8754.8)</td>
<td>6318.0(5612.3-7023.6)</td>
<td>8495.5(7764.2-9226.9)</td>
<td>7174.6(6938-7410.9)</td>
</tr>
<tr>
<td>Total energy (TE) (KiloJoules)</td>
<td></td>
<td>51.7(25.8)</td>
<td>67.9(25.3)</td>
<td>46.4(21.0)</td>
<td>45.1(27.1)</td>
<td>63.9(28.6)</td>
<td>44.0(23.3)</td>
</tr>
<tr>
<td>Total fat in g (% TE)</td>
<td></td>
<td>53.5(11.9)</td>
<td>74.8(12.4)</td>
<td>57.8(11.7)</td>
<td>44.9(12.1)</td>
<td>63.6(12.7)</td>
<td>48.6(11.5)</td>
</tr>
<tr>
<td>Total protein in g (% TE)</td>
<td></td>
<td>245.8(54.8)</td>
<td>342.7(57.0)</td>
<td>295.4(60.0)</td>
<td>214.4(57.7)</td>
<td>279.9(56.0)</td>
<td>259.5(61.5)</td>
</tr>
<tr>
<td>Total carbohydrates in g (% TE)</td>
<td></td>
<td>19.4(15.5-23.3)</td>
<td>25.4(22.9-27.9)</td>
<td>22.3(21.2-23.3)</td>
<td>15.4(13.6-17.2)</td>
<td>21.0(19.1-22.9)</td>
<td>19.4(18.8-20.0)</td>
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<td>Total dietary fibre (g)</td>
<td></td>
<td>17.6(7.6-27.6)</td>
<td>17.7(11.4-24.0)</td>
<td>20.7(18.0-23.4)</td>
<td>4.7(0.5-9.0)</td>
<td>4.0(-3.9-8.3)</td>
<td>8.2(6.8-9.6)</td>
</tr>
</tbody>
</table>

<sup>ab</sup>: Means with the same symbol for a specific variable indicate significant differences (P<0.05) based on GLM analysis of variance (ANOVA).
Discussion

The purpose of this study was to establish the association between SES and CVD risk factors (including dietary intakes) in an African population in the North West Province of South Africa. SES was differentiated by use of residential strata (urban or rural), employed or not employed, and education levels (none, primary schooling, or secondary schooling and/or higher education/training). The salient results will be briefly summarised and discussed, after which a possible socio-economic drift in the CVD risk factors will be critically evaluated.

Dietary intakes

The increased intakes in total energy, fat and protein, characterised by increases in animal protein and saturated fat, with a concomitant decrease in total carbohydrates during urbanisation confirm the changes in dietary patterns observed during the nutrition transition in other developing countries as well as in South Africa. The observed increases in dietary fibre and micronutrients in the urban subjects are probably related to the increased energy and thus food intake, although the increases are less than expected for dietary fibre in women, showing also changes in the types of foods consumed. Although the mean increases in the selected micronutrients were substantial, they did not reach recommended values, a phenomenon also observed in other urban black South Africans. The observation that intakes of macronutrients by the highly educated women compared to those with no or only primary school education, were actually more prudent (lower in energy and fat), suggests that the nutrition transition may have reached a point in these women where “healthier” diets are now being followed.

CVD risk factors

The only significant difference between rural and urban subjects regarding serum lipids, was the increased triglycerides in urban women. The same group was significantly older than the rural women, also had a higher fasting mean glucose, and higher BMI. It is, therefore, possible that the higher triglycerides and glucose in urban women could be related to the older age and higher BMI, both known to influence these variables. Both the urban men and women had higher mean blood pressure, while the rural subjects had higher mean plasma fibrinogen. Plasma fibrinogen is accepted as a risk factor for CVD. In addition, fibrinogen is an acute phase reactant. The higher fibrinogen levels in the rural subjects could, therefore, also
reflect chronic (perhaps low-grade) infection despite the fact that ‘apparently healthy’ subjects were recruited for the PURE study. However, the mean values of the highly-sensitive C-reactive protein did not differ significantly between urban and rural men and women. In the THUSA study, urban subjects tended to have higher plasma fibrinogen, although values were also raised in rural subjects, especially of those living on commercial farms.

**Effects of education level**

The salient observations regarding the effects of education level on CVD risk factors, were that with increased education there were increases in BMI and in energy and macronutrient intakes of both men and women when those with primary education were compared to those with no education. This change to a “Westernised” diet was sustained in men with secondary education but not in women. The other CVD risk factors did not show significant differences in uneducated and educated subjects, except for lower serum triglycerides and blood pressures in the more educated women. However, these women were also slightly, but significantly younger than the uneducated women and it seems that they followed a more prudent diet than women with only primary schooling. The diet of the educated subjects resembled that of the urban subjects, indicative of the changes observed in the nutrition transition, with indications that in the highly educated women, energy and macronutrient intakes were changing back to more prudent intakes.

**Effects of employment**

Of the 1833 subjects for whom data on employment were available, 84.2% of the men and 90.0% of the women were unemployed, which may indicate a bias in the sample selection. This bias could be the result of recruiting volunteers that are available for a very long week-day of measurements, for which employed people have to take leave. The official figure of the unemployment rate in South Africa between 2000 and 2006 averaged 26.38%, with the highest in March 2003, of 31%. However, the PURE questionnaires used to assess employment status have a category which is described as “home maker” which is interpreted as unemployment. It is possible that employed domestic workers, especially in the urban areas, indicated this category, which may be partially responsible for the high unemployment figure. The employed subjects were significantly younger than the unemployed. This may explain why, despite the higher
fat intake and more “Westernised” diet, the employed men and women had the significantly lower fasting glucose and triglyceride (women) levels.

Is there a social drift in CVD risk factors in this population?

To evaluate this question, one should consider the limitations of the study. Firstly, as already mentioned, the reported employment rates may suggest that the sample was biased. However, potential bias would be similar for all four sites where subjects were recruited. A second limitation was the absence of reliable data on personal income. In many African families, household income from different sources is shared by a varying number of extended family members. As proxy for socio-economic status, education level, employment and being urban or rural, were used. The data showed that many subjects with the higher education level were employed in the rural areas. None of these three variables are ideal, independent indicators of SES, but it is assumed that each could be used to distinguish between higher and lower socio-economic groups. Nevertheless, the data should be interpreted with care.

There were patterns of dietary intakes and risk factors for CVD that emerged, regardless which indicator of socio-economic status was used, with agreement in results of being urban, highly educated and employed. However, as indicated above, there were also some exceptions, which could be explained.

The analysis of the relationships between socio-economic position and CVD risk factors in the participants of the THUSA study showed that 9 years earlier, most (but not all) of the CVD risk factors were significantly higher in the subjects from the higher socio-economic group. The major difference between the THUSA study results and the PURE study results reported here is that total serum cholesterol levels did not differ between the higher and lower socio-economic groups, and that increased plasma fibrinogen levels were higher in subjects from the lower socio-economic groups in the PURE subjects. Although blood pressures were higher in urban subjects, in those groups with the higher education level or being employed, blood pressure did not differ significantly or were even lower than in those with the lower education level or unemployed. These results suggest a drift of CVD risk factors (lipids and fibrinogen) from those with high SES to those with lower SES.

The changes in dietary intakes are intriguing. The typical increases in energy and fat associated with urbanisation were seen in the PURE subjects (Table 1). However, in
women with the highest education level there were significant decreases in total energy and fat intake, suggesting that these women are now following a more prudent diet. However, urban men and women, men with the higher education level and employed men and women still had higher energy and fat intakes, reflected in higher BMIs and serum triglycerides. This raises the question if diet was in any way responsible for the drift of the CVD risk factors? It seems that the contribution of low intakes of macronutrients should also be considered. It has been mentioned that although micronutrient intakes of the urban subjects increased, recommended values were not reached. James and co-workers\textsuperscript{26} showed in the THUSA study, that low micronutrient status was associated with increased plasma fibrinogen. Also, it is known that several antioxidant micronutrients protect against CVD and other NCDs.\textsuperscript{17} It is, therefore, reasonable to suggest that not only a prudent diet regarding macronutrients, but also an adequate diet regarding micronutrients is a prerequisite for dietary protection against CVD. Also, the intakes of dietary fibre in all groups were low (see Table 1). High intake of dietary fibre (from whole grains, fruit and vegetables) is known to protect against CVD.\textsuperscript{29}

**Conclusions and recommendations**

South Africa is undergoing political changes which have led to rapid economic development and urbanisation of its African people, leading to especially Africans leaving underdeveloped rural areas to seek a better life in urban areas, experiencing a nutrition as well as a health transition.\textsuperscript{30} The results of this study showed that urban, educated and employed subjects have high levels of several dietary and biochemical risk factors for CVD. However, the results also indicated that many people living in the rural area of the North West Province and those who had lower education levels and being unemployed also had an increased risk of CVD despite still following a prudent but micronutrient deficient diet. It is, therefore, concluded that the burden of CVD is shifting from the more affluent groups with higher SES to the poor. At this point in time, it seems that many of the risk factors of CVD are prevalent in all SES groups of black South Africans. It is, therefore, recommended that intervention programmes to prevent CVD and other NCDs should be targeted to all SES groups. It is also recommended that efforts to improve dietary and nutrient intakes, should not only focus on steering the nutrition transition into consumption of a more prudent low-energy, low-fat diet, but should also ensure that sufficient micronutrients are
taken in by emphasising the importance of a varied diet with sufficient amounts of nutrient dense foods.
References


CHAPTER 4

GENERAL SUMMARY, RECOMMENDATIONS, DISCUSSION AND CONCLUSION
CHAPTER 4: GENERAL SUMMARY, DISCUSSION, RECOMMENDATIONS AND CONCLUSIONS

4.1 Introduction

South Africa, an emerging economy, is currently undergoing a health transition associated with the triple burden of disease which is characterised by high prevalence of under nutrition-related infectious diseases, the emergence of risks of non-communicable chronic diseases, and the human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) pandemic (Vorster, 2002).

The socio-economic drift phenomenon (SDP) is the drift (shift) of the non-communicable disease (NCD)/cardiovascular disease (CVD) prevalence in a population, from lower to higher or higher to lower socio-economic classes. In developing countries the burden is usually in higher socio-economic (SES) class (Gilberts et al., 1994; Reddy et al., 2002) and in developed countries the burden has shifted to the poor (Irribarren et al., 1997; Nishi et al., 2004; Panagiotakos et al., 2008; Ishizaki et al., 2000; Schroder et al., 2004). In this study we explored the associations between SES (measured by level of urbanisation, education and employment) and CVD risk factors in an African population undergoing transition in the NorthWest Province of South Africa, that were prevalent in 2005, when the baseline PURE data were collected. PURE is an acronym for Prospective Urban and Rural Epidemiological study which investigates the health transition in urban and rural Africans.

In this chapter a summary of the main findings, recommendations and conclusions for this study will be given.

4.2 Main findings

The results of the study showed that there was an increase in both systolic (SBP) and diastolic blood pressure (DBP) among men and women in the upper urban group. Among the women in the upper group there were an increase in triglycerides (TG), body mass index (BMI), fasting blood glucose (FBG) and higher intakes of alcohol. Results also showed that with higher education there was a significant decrease in BMI in both men and women. In women there was a further decrease in BP (SBP and DBP) and in TG. The diet of educated subjects resembled that of urban subjects i.e.
diet high in energy, carbohydrate, protein and fat. Among men and women in the employed group there was a significant increase in BMI and decreases in plasma fibrinogen and FBG. It was also seen that among women in the employed group there was a decrease in TG levels. Subjects in the employed group also consumed higher levels of macronutrients i.e. energy, protein, carbohydrate and fat.

Additionally, this study showed that urban, educated and employed subjects have high levels of several dietary and biochemical risk factors for CVD. However, the results also indicated that many people living in the rural area of the North West Province of South Africa and those who had lower education levels and being unemployed also had an increased risk of CVD, despite still following a prudent but micronutrient deficient diet. The major difference between the Transition and Health during Urbanisation of South Africans study (THUSA) and the Prospective Urban and Rural Epidemiology study (PURE) results were that total serum cholesterol levels did not differ between the higher and lower socio-economic groups, and that increased plasma fibrinogen levels were higher in subjects from the lower socio-economic groups in the PURE subjects. Although blood pressures were higher in urban subjects, blood pressures did not differ significantly or were even lower than in those with the lower education level or unemployed. These results suggest a drift of CVD risk factors (lipids and fibrinogen) from those with high SES to those with lower SES. It is, therefore, concluded that the burden of CVD is shifting from the more affluent groups with higher SES to the poor.

**4.3 Recommendations and conclusions**

In this study it seems that many of the risk factors of CVD are prevalent in all SES groups of black South Africans. It is, therefore, recommended that intervention programmes to prevent CVD and other NCDs should be targeted at all SES groups. For the South African population residing in both rural and urban areas we strongly recommend that they follow the South African Food Based Dietary Guidelines (FBDGs) in Table 1 (Vorster et al., 2001).
<table>
<thead>
<tr>
<th>FBDG-MESSAGE</th>
<th>SOME ADDITIONAL INFORMATION AND ADVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enjoy a variety of foods</td>
<td>Enjoy eating; do not feel guilty when eating; eat as large a variety of foods that is possible (affordable), and preferably not highly processed foods; eat from each food group per day if possible.</td>
</tr>
<tr>
<td>Be active!</td>
<td>Thirty minutes of moderate to vigorous activity on most days can reduce CVD mortality 1.5 to 2.0 fold. Advise on ways to increase activity (walking, climbing stairs) during daily life.</td>
</tr>
<tr>
<td>Make starchy foods the basis of most meals</td>
<td>When planning meals, plan around the starchy staple food such as maize porridge, rice, bread, pasta, potatoes, samp, and other staple grains and cereals, preferably in whole, unrefined, unprocessed form where possible.</td>
</tr>
<tr>
<td>Eat plenty of fruit and vegetables</td>
<td>At least 400-500 grams of fresh (or frozen) fruit (2 servings) and vegetables (3 servings) should be eaten daily. Explain cheaper options in season, how to grow own, the use of indigenous leafy green vegetables, and that diabetics should focus more on vegetables and less on fruit. Limit additions of salt, sugar and fat and explain cooking methods that will preserve micronutrients.</td>
</tr>
<tr>
<td>Eat dry beans, split peas, lentils and soya often</td>
<td>Legumes are rich sources of many nutrients and dietary fibre that helps to control blood lipids and glucose. For prevention of CVD, advise on 3 servings per week and for treatment one serving per day. A serving is 100g cooked legume. Tinned products are good but may contain too much salt. Best to cook own and serve as such, in salads, soups or mixed with starchy foods such as samp or bread.</td>
</tr>
<tr>
<td>Meat, chicken, fish, milk and eggs can be eaten every day</td>
<td>One serving of an animal-derived food per day is recommended (100g cooked meat, chicken or fish, or 2 eggs), preferably low-fat options and cooked with little added fat and salt. Adults should also have 500 ml milk or equivalent products daily, preferably the low-fat options. At least 3 fish dishes (servings) per week are advised to lower</td>
</tr>
<tr>
<td><strong>CVD risk factors.</strong></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Eat fats sparingly</strong></td>
<td>At present it is recommended to have 15-30% of total energy as fat, of which not more than a third should come from saturated (hard, animal) fats. To keep fat and oil intakes at this level, low-fat options of meat, and chicken without skin should be chosen as well as preparation methods with limited use of oils.</td>
</tr>
<tr>
<td><strong>Use salt sparingly</strong></td>
<td>Too much salt intake is linked with hypertension. It is difficult to keep salt intake low in diets with many processed foods. Advise people to use fresh herbs and spices to flavour food and not to put salt on the table. Make sure that all salt used is iodised.</td>
</tr>
<tr>
<td><strong>Drink lots of clean safe water</strong></td>
<td>Approximately 2 litres of fluids are needed daily, preferably as clean water and not too much sugary or other drink. Relevant advice on how to sterilise water, especially in rural areas, could be given.</td>
</tr>
<tr>
<td><strong>If you drink alcohol, drink sensibly</strong></td>
<td>This guideline takes the reality that there will always be people who drink alcoholic beverages into account. It does not promote drinking, but emphasises moderate drinking which means not more than 14 tots for men and 7 for women per week. The negative health and social consequences of binge drinking and over-consumption should be explained to target groups.</td>
</tr>
<tr>
<td><strong>Use food and drinks containing sugar sparingly and not between meals</strong></td>
<td>This guideline is mainly aimed at dental health but individuals and groups should be made aware that over-consumption of especially sugary drinks may contribute to obesity and risk of other NCDs.</td>
</tr>
</tbody>
</table>
4.4 References


ADDENDA

ADDENDA 1: IN DEPTH DESCRIPTION OF THE STUDIES AND MAIN FINDINGS USED FOR THE LITERATURE REVIEW
Addenda 1 consists of all summarised findings of various studies which were conducted in developed and developing countries relating to the association between CVD risk and SES. The studies had to meet a strict inclusion and exclusion criteria to be included.

**Inclusion criteria**
- Age: subjects had to be adults, no studies reported on children or teenagers were used.
- Type of study: Studies used for this literature study were observational and intervention.
- At least one of the cardiovascular disease risk factors should have been measured: diabetes, hypertension, lipid levels (high density lipoprotein (HDL), low density lipoprotein (LDL), triglycerides (TG) and total cholesterol (TC) and fibrinogen).
- SES: One of the three variables occupation, income or education should have been used to indicate SES.
- Dates: Studies from 1990 – 2010 were included in the analysis.

**Exclusion criteria**
- Studies where SES status and CVD risk factors were not measured.
- Studies done on children and adolescents.

The symbols in Table 1 are used in this section to indicate different study variables.

**Table 1. SYMBOLS USED TO DEPICT DIFFERENT VARIABLES**

<table>
<thead>
<tr>
<th>Symbols</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>**</td>
<td>Developed</td>
</tr>
<tr>
<td>*</td>
<td>Developing</td>
</tr>
<tr>
<td>+</td>
<td>Comparison between developing and developed country</td>
</tr>
<tr>
<td>1</td>
<td>Income</td>
</tr>
<tr>
<td>2</td>
<td>Education</td>
</tr>
<tr>
<td>3</td>
<td>Occupation</td>
</tr>
<tr>
<td>4</td>
<td>Income and education</td>
</tr>
<tr>
<td>5</td>
<td>Education and occupation</td>
</tr>
</tbody>
</table>
Study 1: Benetou et al., 2000 **; 2

- Objective
  To examine the relationship between educational level, a powerful indicator of SES in Greece, TC and HDL-cholesterol in a large sample of Greek adults.

- Subjects
  11,645 subjects, 4,398 men and 7,247 women.

- Socioeconomic status that was measured
  Education.

- Setting (urban/rural)
  Urban.

- Year
  2000.

- Hypothesis**
  (+).

- Country
  Greece.

- Comments**
  The TC values are inversely associated with educational level in both genders, a pattern contrasting with that found 20 years ago. The association is more prominent among women.

  The HDL-cholesterol values are inversely associated with educational level in men, whereas the association is less consistent in women. The results of this study indicate that the socio-economically less advantaged groups are characterized by less favourable cholesterol profiles.

- Results
  - The TC values are inversely associated with educational level in both genders, a pattern
contrasting with that found 20 years ago. The association is more prominent among women.

- The HDL-cholesterol values are inversely associated with educational level in men, whereas the association is less consistent in women.
- In comparison with women, men have lower levels of TC and HDL-cholesterol, but higher TC/HDL-cholesterol ratio.
- Mean TC decreases as educational level increases, in both sexes. In men, HDL-cholesterol is higher in the lower educational level compared with the medium level. Women in the high educational level, however, have somewhat higher mean HDL-cholesterol compared with those in the medium and low levels.
- In both genders, TC is inversely associated with educational level.

**Conclusion**

The TC levels decrease as educational level increases in both genders. The association was more evident among women.

With respect to HDL-cholesterol, the direction of the association differs between the genders. In men, education was found to be inversely associated with HDL-cholesterol. In women, the association was less consistent and HDL-cholesterol tended to show a positive association with educational level. Thus, women in high educational levels had higher HDL-cholesterol compared with women in the low and medium levels.

The results of our study indicate that the socio-economically less advantaged groups are characterized by less favourable cholesterol profiles, to the extent that cholesterol profiles are powerful predictors of CHD.
**Study 2:** Bennett S, 1995 **; 19 315.

- **Objective**
  To examine trends in socio-economic inequalities in CVD risk factors using educational attainment to indicate SES.

- **Subjects**
  19 315.

- **Socio-economic status that was measured**
  Education.

- **Setting (urban/rural)**
  Urban.

- **Year**
  1995.

- **Hypothesis**
  (+).

- **Country**
  Australia.

- **Comments**
  Decreased risk of coronary events with increasing educational attainment is consistent with the known socio-economic gradient in mortality for CHD. From these results it can be seen that CVD risk factors were higher in lower SES groups.

- **Results**
  - The LDL levels decreased significantly among older women with low or medium education.
  - The BMI was greatest among women of low educational attainment.
  - Mean blood pressure tended to be higher among those with lower educational attainment but the difference was not statistically significant at all points in time.
  - The BP was highly correlated with BMI and to a lesser extent with smoking status.
  - An inverse association between average TC and the level of education among women was found but not among men.
  - The overall lipid picture in this study favours women of high educational attainment, who in addition to lower TC concentrations, also had higher average concentrations of HDL-cholesterol, lower triglycerides, lower LDL-cholesterol, and lower
TC/HDL-cholesterol.

- The inverse relationship between BMI and educational attainment was also repeated at each survey.
- Women with higher education had lower TC and higher HDL-cholesterol, lower triglyceride, lower LDL-cholesterol and lower TC/HDL-cholesterol; younger women experienced no change in average TC at any level of educational attainment.
- Average TC concentration decreased in older women, especially those of low educational attainment. The most notable change in the lipid profile among men was the increase in TC/HDL-cholesterol ratios among men of low educational attainment.
- In this study correlation between education and occupation was highly significant i.e. men of lower educational attainment were more likely to be in manual occupations.

- **Conclusion**

The lower socio-economic group has improved its risk factor profile but its relative disadvantage compared with the higher socio-economic group persists. Health promotion activities in Australia seem to have been effective in reaching the lower socio-economic groups but the challenge to reduce inequalities remains. The steady increase in educational attainment in Australia may have been an important factor in the general improvement in the nation’s risk factor profile and in the decrease in mortality from CHD.

**Study3:** Bobak *et al.*, 1999 *

- **Objective**

This paper examined whether CVD risk factors are predicted by education and material conditions, and which of these two components of SES is a better determinant of CVD risk
Subjects 2353.

Socio-economic status that was measured.

Setting (urban/rural) Urban.

Year 1999.

Hypothesis** (-).

Country Czech Republic (developing).

Comments** There was a significant decrease in CVD risk factors with increasing education, this could be because better educated people may have felt more in control and may have expected to improve their lives after the fall of communism. At the same time they would benefit more from a wider choice of foods and health-related information. Although the precise mechanism of the link between education and CVD risk factors is difficult to identify, this study suggests that materialistic explanations for the social differences in this population are unlikely.

Results

- There was a strong inverse association between education and cholesterol in both genders.
- Ratio of HDL-cholesterol to TC increased with education in women but not in men.
- The BMI in both genders decreased with education.
- In men there was a significant decrease in cholesterol with higher education P< 0.001.
- In women there was a significant decrease in systolic BP with higher education P< 0.001.
- In women there was a significant decrease in BMI P< 0.001.
- In women there was a significant decrease in hypertension with education P< 0.001.

Conclusion The socio-economic differences in CVD risk factors in the Czech Republic in 1992 had the same direction and similar
magnitude as in Western Europe, and were strongly related to education rather than material conditions.

**Study 4:** Chaturvedi et al., 1998 **; 3

- **Objective**
  
  To assess whether the inverse socio-economic mortality gradient observed in the general population persists in diabetic people.

- **Subjects**
  
  17 264.

- **Socio-economic status that was measured**
  
  Employment.

- **Setting (urban/rural)**
  
  Urban.

- **Year**
  
  1998.

- **Hypothesis**
  
  (+).

- **Country**
  
  London.

- **Comments**
  
  From this study it can be concluded that mortality rate from CVD risk factors is higher in low SES groups in diabetic people.

- **Results**
  
  - Mortality was twice as high in diabetic people in the lowest socio-economic groups as in those in the highest groups.
  
  - The difference was largely due to higher rates of smoking and high blood pressure in the lowest social groups, while blood glucose concentration had little impact on the relation.
  
  - These results emphasise the importance of improving conventional CVD risk factors and reducing social inequality for reducing mortality in diabetic people.

- **Conclusion**
  
  Mortality risk, principally for CVD increases as SES declines in diabetic people. These findings highlight the urgent need to reduce the risk of CVD in diabetic people and emphasise the importance of addressing socioeconomic inequalities in health in all groups of people.
Study 5: Choiniere et al., 2004**; □; 4

- **Objective**  
  This study was designed to describe the distribution of risk factors for CVD by SES in adult men and women across Canada using the Canadian heart health surveys database.

- **Subjects**  
  23129.

- **Socio-economic status that was measured**  
  Education and income.

- **Setting (urban/rural)**  
  Urban.

- **Year**  
  2000.

- **Hypothesis**  
  (+).

- **Country**  
  Canada.

- **Comments**  
  CVD risk factors were more prevalent among the lower SES groups. The difference in the prevalence of risk factors for CVD between socio-economic groups are still important in Canada and should be considered in planning programme to reduce the morbidity and mortality from CVD.

- **Results**
  - For most of the risk factors examined, the prevalence of the risk factors was inversely related to SES, but the relationship was stronger and more consistent for education than for income.
  - Men and women with a university degree were less likely to have elevated cholesterol than those with no university degree, but no difference was found among income levels.
  - The relationship between education and CVD risk factors was stronger for women than for men.

- **Conclusion**  
  The differences in the prevalence of risk factors for CVD between socio-economic groups are still important in Canada and should be considered in planning programme to reduce the morbidity and mortality from CVD.
**Study 6:** Connolly and Kesson, 1996 **; 3

- **Objective** The aim of this study was to examine the relationship of SES on five risk factors: obesity, hypertension, high cholesterol, smoking and high HbA1c.

- **Subjects** 1553.

- **Socio-economic status that was measured** Employment.

- **Setting (urban/rural)** Urban.

- **Year** 1996.

- **Hypothesis** (+).

- **Country** UK.

- **Comments** It was seen from this study that the CVD risk factors were higher in the lower SES groups. The study was done on NIDDM patients attending diabetic clinic.

- **Results**
  - Comparing patients with NIDDM from the seven categories of SES, it was found that those from deprived categories experienced a higher prevalence of obesity. In the most affluent groups, 30% had a BMI > 30kg/m² compared with 47% in the most deprived categories.
  - Analysis of serum cholesterol levels in subjects younger than 70 years of age by deprivation category indicated higher cholesterol levels in the deprived categories.
  - When analysed for all patients, systolic blood pressure and diastolic blood pressure levels were higher in the deprived groups.
  - Using an area based index of SES and a diabetic clinic population, it was demonstrated that obesity and hypertension are higher among diabetic subjects of low SES.

- **Conclusion** Diabetic patients from areas of low SES are at increased risk
of CVD. To counter this, specific health education programme should be evolved and resources should be directed towards these areas.

Important issues about the impact of social deprivation on diabetes remain to be clarified. Although diabetes affects all aspects of life, it is also true that social circumstances affect aspects of diabetes.

**Study 7: Ezeamama et al., 2006 *;**;+; □; ∨; 5

- **Objective**
  
The purpose of this study is to describe cross-sectional and longitudinal associations between indicators of SES and CVD risk factors in a genetically homogenous population of Samoans at different levels of economic development.

- **Subjects**
  
  At baseline 1289 and at 4-year follow-up, 963.

- **Socio-economic status that was measured**
  
  SES was assessed by education, occupation, and material lifestyle at baseline.

- **Setting (urban/rural)**
  
  Participants were studied in the less economically developed Samoa and in the more developed American Samoa.

- **Year**
  
  2006.

- **Hypothesis**
  
  (+).

- **Country**
  
  Samoan Archipelago.

- **Comments**
  
  This study compares the CVD risk factors in two parts of an island of which one is a developing part (Samoa) and the other part (American Samoa) is developed. It was seen from this study that a pattern of high SES was associated with: (1) elevated odds of CVD risk factors in less developed Samoa, and (2) decreased odds of CVD risk factors in more developed American Samoa.

- **Results**
  
  - American Samoans have more years of education, higher material life styles and are more involved in the wage economy than their age and sex counterparts in Samoa.
  - At baseline all CVD risk factors had higher
proportions in American Samoa relative to Samoa. Incident hypertension and obesity were also higher in American Samoa relative to Samoa. Incident type-2 diabetes and hypertension were also higher for American Samoa than Samoa among both men and women.

- Women from American Samoa had approximately a twofold higher odds of hypertension and obesity, respectively, than employed or high material lifestyle American Samoan women.
- Samoan men in subsistence work or unemployed had twofold lower odds of hypertension relative to their employed counterparts.
- Among Samoan men obesity was highest in high SES groups and the predicted probability of obesity increased with SES in Samoa regardless of sex. In American Samoan women on the other hand, low material life style was associated with higher obesity.

Conclusion

- In both the models using specific SES measures and CVD risk factor outcomes, and the models using the ordinal SES index and predicted probabilities of CVD risk factors, the study detected a pattern of high SES associated with: (1) elevated odds of CVD risk factors in less developed Samoa, and (2) decreased odds of CVD risk factors in more developed American Samoa.
- It is noteworthy that the patterns of association between SES and CVD risk factors in American Samoa are becoming similar to what is observed in economically developed societies, whereas associations in the independent nation of Samoa largely resembles that previously described in previous research for nations at early stages of economic development.
Study 8: Fernald, 2007 *

- **Objective**
  This study explored the associations of body mass index (BMI), socio-economic status (SES), and beverage consumption in a very low-income population.

- **Subjects**
  12873.

- **Socio-economic status that was measured**
  Education and occupation.

- **Setting (urban/rural)**
  Rural.

- **Year**
  2007.

- **Hypothesis** (+).

- **Country**
  Mexico.

- **Comments**
  Since Mexico is still a developing country and results from this study show that as SES increases BMI and overweight is higher, which proves the hypothesis to be true.

- **Results**
  - Greater educational attainment was significantly associated with higher BMI and a greater prevalence of overweight.
  - The positive associations between SES and BMI in this low-income, rural population are likely to be related to the changing patterns of food availability.
  - Greater educational attainment was significantly associated with higher BMI and a greater prevalence of overweight and obesity in men and women.
  - The BMI and household income were significantly correlated in women and not in men.

- **Conclusion**
  - The BMI was positively associated with SES, regardless of how it was measured - as education, occupation, household income, housing, assets or subjective social status - in a low-income population of adults in rural Mexico.
  - From the bottom quintile of the income distribution, those with the highest BMIs were the most educated, with the best occupations, and the best
equipped houses.

- Data from this study suggest that within the poorest quintile of the Mexican population, individuals with higher relative SES are more likely to be obese or overweight than those with lower SES.

**Study 9: Gilberts et al., 1994 *; V; 3**

- **Objective**
  The objective of the study was to establish the prevalence of hypertension and to assess determinants of blood pressure with special reference to SES in a rural south Indian community.

- **Subjects**
  1027 subjects, 456 men and 571 women.

- **Socio-economic status that was measured**
  Occupation.

- **Setting (urban/rural)**
  Rural.

- **Year**
  1994.

- **Hypothesis**
  (+).

- **Country**
  South India.

- **Comments**
  There was a significantly higher (P< 0.001) prevalence of hypertension in rich people than poor people. Prevalence of hypertension in this south Indian community increases with age, body weight, heart rate, and SES.

- **Results**
  - The prevalence of hypertension in the highest socio-economic group (22-5%) was more than twice than that in the lowest socio-economic group (8-8%).
  - The prevalence of hypertension was significantly (p<0.001) higher in rich people (22-5%) than poor (8-8%).

- **Conclusion**
  - In this study, hypertension was observed more than twice as often in rich than in poor people. The risk of developing atherosclerosis in the first group is, therefore, considerably raised.
  - As this study has indicated, the blood pressure
differences between high and low socio-economic classes were considerably reduced after statistical adjustment for body weight. Unfortunately, being obese is still a deeply rooted status symbol in these rural areas and it might be a challenge for the local health services to try to change this attitude.

- From this study we conclude that the prevalence of hypertension in this south Indian community increases with age, body weight, heart rate, and SES.

**Study 10:** Gupta *et al.*, 1994

- **Objective**
  To define the association between educational level and prevalence of CHD and coronary risk factors in India.

- **Subjects**
  3148.

- **Socio-economic status that was measured**
  Education.

- **Setting (urban/rural)**
  Rural.

- **Year**
  1994.

- **Hypothesis**
  (-).

- **Country**
  India.

- **Comments**
  - Although India is a developing country, more CHD risk factors are found in the lower SES group. Except for BMI which was higher among educated people.

- **Results**
  - Among uneducated and less educated people there was higher prevalence of coronary risk factors and hypertension.
  - Educational level showed an inverse relation with systolic and diastolic blood pressure.
  - Physical activity was higher among uneducated people
  - Men with more education were heavier and had a higher BMI
- Hypertension was more prevalent among uneducated people.
- Physical activity was greater among uneducated people, and men with more education had a higher BMI.
- Less educated and illiterate people had higher CHD.

**Conclusion**

Uneducated and less educated people in rural India have a higher prevalence of CHD and of the coronary risk factors smoking and hypertension.

**Study 11: Hoeymans et al., 1996 **

**Objective**

The study objective was to describe the association between SES and CVD risk factors.

**Subjects**

36,000.

**Socio-economic status that was measured**

Education.

**Setting (urban/rural)**

Urban.

**Year**

1996.

**Hypothesis**

(+)

**Country**

Netherlands.

**Comments**

In the lower educated groups the prevalence of individual risk factors and of concurrence of risk factors was higher than in the higher educated groups. Concurrence of risk factors can have a synergistic effect on the risk for CVD. Therefore socio-economic differences in risk factors may explain a greater part of the socioeconomic differences in CVD morbidity and mortality than is generally assumed.

**Results**

- The age adjusted prevalence of physical inactivity in men was significantly higher in men with lowest education than in all other educational groups. In women a decrease in inactivity was observed with an increase in educational level.
- The age-adjusted prevalence of obesity decreased
with increasing level of education.

- Body mass index was strongly related to cholesterol levels and blood pressure.
- The age adjusted prevalence of hypercholesterolemia and low HDL-cholesterol decreased with increasing educational level, but not in all age groups.
- Socioeconomic differences in hypertension were relatively small. In women the association was stronger than in men. Only men with the highest educational level had a significantly lower prevalence of hypertension than men in the other educational groups.
- This study showed an inverse association between educational level and the prevalence of physical inactivity during leisure time, obesity, hypercholesterolemia, low HDL-cholesterol levels and hypertension.
- Concurrence of CVD risk factors occurred more frequently in the lower educated than in the higher educated groups.

**Conclusion**

For all risk factors, except alcohol intake, a significant inverse association was found with educational level. Concurrence of risk factors was more prevalent in lower educated groups than in higher educated groups. In the lower educated groups the prevalence of individual risk factors and of occurrence of risk factors was higher than in the higher educated groups.

**Study 12: Iribarren et al., 1997**

**Objective**

The aim of the study is 2-fold: first, to re-examine the association of educational attainment and income level with the prevalence of elevated CVD risk factors, and second, to test the hypothesis that differences in CVD risk factor trends across education and income groups have widened during
the last decade.

- **Subjects**

- **Socio-economic status that was measured**
  - Education and household income.

- **Setting (urban/rural)**
  - Minneapolis (Urban).

- **Year**
  - 1997.

- **Hypothesis**
  - (+)

- **Country**
  - Minneapolis.

- **Comments**
  - This study supports an inverse association between SES and CVD risk profile.

- **Results**
  - Education and income were found to be inversely associated with CVD risk factors during the decade of the 1980s.
  - However, there were some inconsistencies between education and income for serum cholesterol level and for blood pressure and BMI in men.
  - Taken together these data from a random sample of a Midwestern US population do not support a widening of CVD risk across SES groups.

- **Conclusion**
  - The data suggests an inverse association between SES and CVD risk factors but suggests no widening of socio-economic differences in risk factor trends during the last decade in a representative sample of the Minneapolis-St Paul population.

**Study 13: Ishizaki et al., 2000**

- **Objective**
  - This study evaluated whether the relationship between SES and plasma fibrinogen level exists in Japanese male employees, and whether this relationship is independent of other correlates of plasma fibrinogen.
<table>
<thead>
<tr>
<th>Subject</th>
<th>4375 employees.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-economic status that was measured</td>
<td>Employment and Education.</td>
</tr>
<tr>
<td>Setting (urban/rural)</td>
<td>Urban.</td>
</tr>
<tr>
<td>Year</td>
<td>2000.</td>
</tr>
<tr>
<td>Hypothesis**</td>
<td>(+).</td>
</tr>
<tr>
<td>Country</td>
<td>Japan.</td>
</tr>
<tr>
<td>Comments**</td>
<td>The relationship between educational background and plasma fibrinogen level was considerably attenuated when employment grade was adjusted. This may indicate that a large part of the effect of educational background on plasma fibrinogen level was mediated by employment grade. In contrast, the association between employment grade and plasma fibrinogen level was largely independent of educational background, indicating that employment grade more broadly reflects the effects of SES on plasma fibrinogen level than educational background.</td>
</tr>
<tr>
<td>Results</td>
<td>Employment grade and educational background were inversely and significantly associated with plasma fibrinogen level in our study of Japanese males.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>- Low employment grade and low educational background were associated with increased age-adjusted plasma fibrinogen level.</td>
</tr>
<tr>
<td></td>
<td>- In conclusion, there was an inverse association between employment grade and plasma fibrinogen level after adjusting for age, educational background, BMI, waist to hip ratio, height, smoking, and alcohol.</td>
</tr>
</tbody>
</table>
Study 14: Jonnalagadda et al., 2000 **; ☐: 7

- **Objective**
  This study examined the dietary intake and socioeconomic factors that contribute to CVD risk among elderly, African-American women.

- **Subjects**
  36 African American women.

- **Socio-economic status that was measured**
  Income, occupation and education.

- **Setting (urban/rural)**
  Urban.

- **Year**
  2000.

- **Hypothesis**
  (+).

- **Country**
  America.

- **Comments**
  This study does not specify the significant increase or decrease in CVD risk factors according to SES. Only 36 people were used in this study so the power of this study was low, despite this it can be seen from this study that CVD risk factors were higher in low SES groups.

- **Results**
  - Both current annual income and educational attainment were significantly correlated (p< 0.05) with number of CVD risk factors, educational attainment having the strongest relationship.
  - The results of the study further suggest that income, education, and occupation can impact risk factors, such as BMI, hypertension, hypercholesterolemia, diabetes, diet quality all of which can significantly influence CVD morbidity and mortality in this African-American population.

- **Conclusion**
  - These results suggest that SES may have a significant impact on the risk of CVD in African-American women and imply that individuals with low educational attainment should be targeted for dietary intervention and education as early as possible, to prevent CVD.
**Study 15: Kanjilal et al., 2006 ***

- **Objective**
  
  The objective of this study was to examine 31-year trends in CVD risk factors by annual income and educational levels among US adults.

- **Subjects**
  
  NHANES I, 10 900; NHANES II, 12 939; NHANES III, 12 870; and NHANES 1999-2002, 6997.

- **Socio-economic status that was measured**
  
  Education

- **Setting (urban/rural)**
  
  Urban

- **Year**
  

- **Hypothesis**
  
  +/- .

- **Country**
  
  USA.

- **Comments**
  
  From this study it can be seen that the hypothesis shows negative for hypertension and cholesterol, whereas for diabetes it shows positive. i.e. the prevalence of high blood pressure declined by about half in all income and education groups. High cholesterol prevalence also declined in all groups, with the largest decline (15.9 percentage points) among people with the highest income. Diabetes prevalence increased most among persons with low incomes and education.

- **Results**
  
  - Between 1971 and 2002, the prevalence of all CVD risk factors, except diabetes, decreased in all income and education groups, but there has been little reduction in income and education-related disparities in CVD risk factors and few improvements during these 10 years.
  - The prevalence of high blood pressure declined by about half in all income and education groups,
ranging from 30.3% to 40.6% in 1971-1974 and 16.4% in 1999-2002, with the greatest reduction among those in the lowest income quartile and those with less than a high school education (18.0 and 15.9 percentage points, respectively).

- The prevalence of high blood pressure declined for all income groups from NHANES I to NHANES III and was followed by no change between the last 2 surveys. Trends by education were similar to those for relative income. People with less than a high school education had a decrease in prevalence from NHANES I to NHANES 1999-2002 of 15.9 percentage points, compared with a decrease of 13.4 percentage points for those with more than a high school education.

- High cholesterol prevalence also declined in all groups and ranged from 28.8% to 32.4% in 1971-1974 and 15.3% to 22.0% in 1999-2002, with the largest decline (15.9 percentage points) among people with the highest income.

- Diabetes prevalence increased most among persons with low incomes and education. All surveys found that the prevalence of diagnosed diabetes was higher for people in the lowest income quartiles. The prevalence increased from 1971 to 1974 to 1999 to 2002 for all groups except those with the highest relative income.

**Conclusion**

In this national survey which was conducted over 30 years, it was found that reductions in blood pressure and cholesterol levels generally benefited the full spectrum of income and education, albeit with cholesterol level improving most among the rich and educated and blood pressure improving most among the poor and less educated. However, disparities in smoking and diabetes worsened, because there was a doubling of the difference in prevalence.
between people who are rich or well-educated and those who are poor or not well educated.

**Study 16:** Larrañaga *et al.*, 2005 **; 5

- **Objective**
  
  To establish the relationship between SES and the prevalence of known Type 2 diabetes, CVD risk factors and chronic diabetic complications.

- **Subjects**
  
  2985.

- **Socio-economic status that was measured**
  
  Education, employment.

- **Setting (urban/rural)**
  
  Urban.

- **Year**
  
  2005.

- **Hypothesis**
  
  (+).

- **Country**
  
  Spain.

- **Comments**
  
  From this study it can be seen that the lower SES was affected more than the higher SES. The SES in this study was based on area-based SES measures. The observed association between SES and diabetes could be because of a combination of both individual-level effect (poorer people, as individuals, have poorer health) and contextual effects (people living in poorer areas have poorer health because of area-related factors).

- **Results**
  
  - The prevalence of known Type 2 diabetes was higher in patients of lower socio-economic status, especially among women.
  
  - In Type 2 diabetes patients, obesity, sedentary lifestyle, and abnormal levels of LDL cholesterol and HbA1c were more prevalent among those from lower SES.
  
  - Among Type 2 diabetic patients, obesity and sedentary lifestyle were inversely related to SES in both sexes, after adjusting by age and duration of the diabetes. These risk factors were highly prevalent
among diabetic patients, particularly among women living in areas of lower SES.

- In our study, the higher prevalence of diabetes in deprived areas was apparent in both sexes, but increased risk of diabetes as SES drops is more marked in women than in men.
- Abnormal LDL cholesterol levels ($\geq 2.58 \text{ mmol/l}$) were more frequent among patients of lower SES.

**Conclusion**

The results of our study show a greater prevalence of chronic complications of Type 2 diabetes among patients of lower SES.

**Study 17: Luepker et al., 1993**

**Objective**

The present study examines several SES factors, i.e., education, income, and occupation, in representative samples of men and women surveyed 5 years apart in a large metropolitan area. Trends in risk factors over time were analysed to determine whether the observed declines in risk factors previously reported are associated with SES.

**Subjects**

3243 adults participated in the 1980 to 1982 survey and 4538 in the 1985 to 1987 survey.

**Socio-economic status that was measured**

Education and income.

**Setting (urban/rural)**

Urban.

**Year**

1993.

**Hypothesis**

(+) for education.

(-/+ for income.

**Country**

Minnesota.

**Comments**

From this study it can be seen that SES and education were inversely related, whereas SES and income were positively related.

**Results**

- Education was significantly and inversely related to blood pressure, cigarette smoking, and body mass.
index.

- Serum cholesterol was inversely related to education in women but not in men.
- Education was positively associated with physical activity.
- The most educated men and women had the lowest BMI levels and the least educated had the highest.
- For men increasing household income was associated with higher BMI.
- Income was positively related to blood cholesterol and to BMI in men. In women, BMI was negatively associated with income.
- In women, BMI was negatively associated and cholesterol not associated with income. In general relations of risk factors with income were weaker than for educations.
- For men, income was positively associated with serum cholesterol level, with higher income groups having higher blood cholesterol levels.
- Low education groups continue to have the highest expected CHD rates.

**Conclusion**

Although the observations described here indicate that risk characteristics in all SES segments of the community are improving over time, it is clear that significant social class differences persist. The challenge is to continue the downward trend in all groups and to focus particularly on low SES groups, who continue to face excess risk of CHD.

**Study 18: Mendez et al., 2003 *; □; 4**

- **Objective**
  This cross-sectional study examined associations between SES and BP in 2082 adults from a periurban area of Jamaica, a middle-income developing country.

- **Subjects**
  2082.

- **Socio-economic**
  Income and education.
status that was measured

- Setting (urban/rural)  Peri-urban.
- Year  2002.
- Hypothesis**  +/-.
- Country  Jamaica.
- Comments**  From this study it can be concluded that BP and hypertension levels were elevated in low as well as high-income groups. In men with some high school education, income was positively associated with BP. Unlike women; mean BP was highest in poor men with limited education. In contrast to generally positive associations with income, associations with education were generally negative or insignificant.

- Results
  - In both men and women, the income distributions of BP and hypertension were non-linear, indicating elevated levels in low as well as in high-income groups.
  - In contrast to the negative relationships typical for industrialized countries, multivariate-adjusted BP and hypertension were highest in the wealthiest women.
  - In men with some high school education, income was positively associated with BP, while there were negative associations in men with lesser education.
  - Unlike women, mean BP was highest in poor men with limited education.

- Conclusion
  - In this middle-income developing country, BP and hypertension levels were elevated in low as well as high-income groups.
  - Income was also associated with significantly higher BP among men with some high school education. In men with more limited education, however, there was a negative relationship. In contrast to generally
positive associations with income, associations with education were generally negative or insignificant.

- The SES is related to BP and hypertension in Jamaica, although relationships are non-linear. Behavioural and environmental factors that explain elevated BP among both low and high SES adults in developing countries must be identified to develop effective prevention strategies.

**Study 19:** Metcalf *et al.*, 2007 **; 4

- **Objective**
  To compare CVD risk factor level of men and women in a local workforce with measures of SES status.

- **Subjects**
  5677.

- **Socio-economic status that was measured**
  Income, education.

- **Setting (urban/rural)**
  Urban.

- **Year**
  2007.

- **Hypothesis**
  +.

- **Country**
  New Zealand.

- **Comments**
  There was trend to a more adverse pattern of CVD risk factor levels in the low SES groups. Effective strategies for reducing the risk level among deprived groups are needed to minimise the adverse social gradient in CVD risk factors.

- **Results**
  - Both income and education showed 5 year CVD risks and lower leisure time physical activity levels in the lower SES strata compared to the highest.
  - Raised blood pressure was highest in people with no tertiary education compared to those with a university education.
  - Lower income had >diabetes compared to higher income group.
  - High cholesterol and TG in people with no tertiary education compared to a university education.
• Diabetes was higher in low income groups compared to highest income group.

• Low income and low education were associated with higher risk of CVD compared to the highest income and education groups respectively. Low SES is associated with higher BMI and obesity.

• Conclusion

There was trend to a more adverse pattern of CVD risk factor levels in the lower SES groups. The strongest associations were related to income and education. Raised blood pressure was associated with education and diabetes with income. An increased living standard, more resources for primary health care, and health promotion targeting the community level should be beneficial. Effective strategies for reducing the risk level among deprived groups are needed to minimise the adverse social gradient in CVD risk factors.

Study 20: Nishi et al., 2004 **; □; 5

• Objective

To compare the effects of SES indicators on coronary risk factors and subjective well-being in an urban Population.

• Subjects

1361 civil servants (968 men and 393 women).

• Socio-economic status that was measured

Education level and employment grade.

• Setting (urban/rural)

Urban area of Japan.

• Year

2004.

• Hypothesis**

(+).

• Country

Japan.

• Comments**

It can be seen from the results that it was mostly people in the low SES groups that were more prone to develop CVD risk factors.

• Results

• An inverse relationship between hypercholesterolemia and SES was only found by education level in women.
• In men, manual workers had a significantly higher risk of developing hypertension than did higher-level non-manual workers.
• Women with a lower level of education were more likely to have high TC.
• Men with a low level of education were more likely to be diabetic.

● Conclusion

The different effects of two SES indicators, education level and employment grade were seen in some coronary risk factors and self-rated health in an urban Japanese population. They have different effects on behavioural and biological risk factors and on self-rated health.

**Study 21:** Osler et al., 2000 **; NBC 2

● Objective

This study examines whether the increased social inequality in CVD mortality has been accompanied by a different trend in CVD risk factors in different educational groups.

● Subjects

6695.

● Socio-economic status that was measured

Education.

● Setting (urban/rural)

Urban.

● Year

2000.

● Hypothesis**

(+).

● Country

Denmark.

● Comments**

Much cannot be concluded from this study, but most CVD risk factors seemed to have decreased with education, except for BMI and weight.

● Results

• In Denmark the increased socio-economic difference in CVD mortality during the 1980s only seems to be accompanied by growing social differences in the prevalence of smoking.
• The analyses of time trends from 1982 to 1992 in biological risk factors in each educational group
showed that HDL-cholesterol concentrations declined in women in all educational groups, and in the highest educated men.

- Increases in height, and diastolic BP were significant in men and in women with less than 10 years of schooling, while an increase in weight and BMI was significant for men with 10-11 years of schooling and in women with 8-9 years.

**Conclusion**
The difference between educational groups in prevalence of smoking increased during the 1980s, and this is accounted for widening of an existing social difference in the total CVD risk.

**Study 22:** Panagiotakos et al., 2008 ***, □, ▼, 4**

- **Objective**
The aims of the present work were to investigate whether dietary habits are associated with SES, and if they modify the relationship between SES and CVD risk factors, in a sample of men and women free from known CVD.

- **Subjects**
3042.

- **Socio-economic status that was measured**
Education and income.

- **Setting (urban/rural)**
78% urban and 22% rural.

- **Year**
2008.

- **Hypothesis**
(+).

- **Country**
Athens (Greece).

- **Comments**
Low SES groups exhibited higher prevalence of CVD risk factors, such as obesity, hypertension, diabetes mellitus and hypercholesterolemia (all P<0.001).

- **Results**
  - Low SES groups exhibited higher prevalence of CVD risk factors, such as obesity, hypertension, diabetes mellitus and hypercholesterolemia (all P<0.001).
Higher SES index was associated with lower likelihood of having hypercholesterolemia (95% CI 0.83, 1.00) and diabetes (95% CI 0.72, 0.95), after adjusting for various potential confounders.

Comparisons between SES groups showed that the low and medium education groups had a higher prevalence of CVD risk factors than the high education groups.

**Conclusion**

Hypertension, diabetes mellitus and hypercholesterolemia were more prevalent in the low education groups, across all income classes.

As mentioned above, the prevalence of common CVD risk factors, such as obesity, hypertension, diabetes mellitus and hypercholesterolemia, was higher in the low SES groups compared with the higher SES groups.

**Study 23:** Panagiotakos et al., 2008 **, □, 4

- **Objective**
  The aim of this work was to investigate the association between SES and clinical and biochemical factors related to CVD, in a sample of elderly men and women.

- **Subjects**
  937 men and women.

- **Socio-economic status that was measured**
  Education and income.

- **Setting (urban/rural)**
  Urban.

- **Year**
  2008.

- **Hypothesis** **
  (+)

- **Country**
  Greece.

- **Comments** **
  The study shows that as SES increases, CVD risk factors decreases which support the hypothesis.

- **Results**
  - Multiple logistic regression analysis revealed that people in the lowest SES group, compared to highest
were 2.14-times (95% CI 1.24–3.71) more likely to have four or more of the common CVD risk factors, i.e. smoking, physical inactivity, obesity, hypertension, diabetes and hypercholesterolemia, irrespective of age, sex, dietary habits and depression status.

- Studying elderly people living in Mediterranean islands it was found that participants in the upper SES group had a lower prevalence of hypercholesterolemia and hypertension.

- An inverse relationship between SES and factors related to CVD risk exists among elderly people.

- The results clearly show that there is a gap between high and low-SES groups regarding various CVD risk factors. This finding underlines the importance of primary prevention and control of these risk factors levels, especially in low SES people. Nevertheless, further studies are needed to understand why lower SES groups have more adverse levels of CVD risk factors.

**Conclusion**

- An inverse relationship between SES and factors related to CVD risk exists among elderly people.

- The results clearly show that there is a gap between high and low-SES groups regarding various CVD risk factors. This finding underlines the importance of primary prevention and control of these risk factors levels, especially in low SES people. Nevertheless, further studies are needed to understand why lower SES groups have more adverse levels of CVD risk factors.

**Study 24:** Reddy et al., 2007 *,  □, 2

- **Objective**
  
  To examine whether risk factors of CHD are predicted by level of education and influenced by the level of urbanisation in Indian industrial populations.

- **Subjects**
  
  19,969.

- **Socio-economic status that was measured**
  
  Education.

- **Setting (urban/rural)**
  
  Highly urban, urban, and periurban.

- **Year**
  
  2007.

- **Hypothesis**
  
  (-).

- **Country**
  
  India.

- **Comments**
  
  Although India is a developing country more CHD risk
Factors are found in the lower SES group. Except for dyslipidaemia prevalence which was higher in the higher education group.

- **Results**
  - The CHD risk becomes higher in the less-educated, less-income groups and even in the rural population.
  - In urbanised areas Reversal of social gradients for hypertension, diabetes, and overweight was seen.
  - In less urbanised location such reversal was only for hypertension.
  - Hypertension were significantly more prevalent in the low compared with the high education group (P<0.001).
  - Dyslipidaemia prevalence was significantly higher in high-education group (P<0.01).
  - Higher education group had lower prevalence for hypertension, diabetes, and overweight.
  - This study indicates the growing vulnerability of lower socioeconomic groups to CHD.
  - Prevalence of diabetes and obesity was directly associated with educational status in the less-urbanized locations.

- **Conclusion**
  The current study stresses the scale and seriousness of the emerging challenge of CHD risk factors in India, with particular emphasis on socially deprived groups. The differences in risk factor levels observed in this study may contribute to social disparities in morbidity and mortality because of CHD, especially because awareness and treatment are at very low levels. Strategies to reduce major CHD risk factors should focus on socially disadvantaged groups.

**Study 25:** Reddy et al., 2002 *

- **Objective**
  The aim of the present study was to assess the prevalence of CHD risk factors in a semi urban population of Andhra
Pradesh, India.

- Subjects: 650.
- Socio-economic status measured.
- Setting (urban/rural): Urban.
- Hypothesis**: (+).
- Country: India (semi-urban areas).
- Comments**: The findings from this study show that coronary risk factors such as hypercholesterolemia, hypertriglyceridemia, and sedentary life style were more prevalent among higher SES groups. Low HDL-cholesterol, on the other hand, was more common in lower SES groups. Men in the higher SES groups had higher prevalence of hypertension and obesity.

- Results
  - In men a significant positive rank correlation was observed between SES and Serum cholesterol (SC), TG, systolic and diastolic BP, and BMI. In women the same trend was found only with SC, and TG.
  - Higher the SES groups have greater prevalence of CHD risk factors than lower SES groups.
  - Increases in hypercholesterolemia, hypertriglyceridemia and leisure time physical activity in both men and women were positively associated with SES.
  - In women low HDL-cholesterol was more common among the lower SES groups, whereas in men the prevalence of obesity and hypertension increased with higher social class.
  - Socio-economic levels were positively associated with mean levels of cholesterol and TG.
  - Among men systolic BP and BMI were positively associated with SES levels.
- Negative relationship between HDL-cholesterol and SES levels among women.

**Conclusion**

In conclusion these findings suggest that higher social classes in developing countries may have greater CHD risks than lower social classes. Rapid growth in industrialisation and urbanisation may have led to changes in dietary patterns and a reduction in physical activity in this study population. It is estimated that, more than 40% of the population in developing countries like India are now living in urban areas. CHD mortality rates are likely to increase among the higher social groups in urban areas.

**Study 26: Roohafza et al., 2005* , □, ▽, 2**

**Objective**

The goal is to describe the distribution of CVD risk factors according to educational level in Iranian adults.

**Subjects**

9587.

**Socio-economic status that was measured**

Education.

**Setting (urban/rural)**

Study regions include urban and rural areas in middle sized and large towns.

**Year**

2005.

**Hypothesis**

(-).

**Country**

Iran.

**Comments**

- All CVD risk factors showed an inverse relationship with educational level in all subjects except HDL-cholesterol level in women.
- Results from the present study show an inverse association between educational attainment and the prevalence of dyslipidaemia, hypertension, and being overweight. However, there was no significant relationship between low HDL-cholesterol in Iranian women and their educational attainment.

**Results**

- All CVD risk factors showed an inverse relationship
with educational level in all subjects except HDL-cholesterol level in women.

- High TC, HDL-cholesterol and LDL-cholesterol were inversely related to educational level (P<0.05). However, this relationship was not significant with Mantel Haenszel test in men.

- Results from this study show an inverse association between educational attainment and the prevalence of dyslipidaemia, hypertension, and being overweight. However, there was no significant relationship between low HDL-cholesterol in Iranian women and their educational attainment.

**Conclusion**

- Educational level is shown to be inversely associated with some major CVD risk factors in Iranian adults.
- In general the least educated adults had an adverse risk factor profile than the more educated.

**Study 27: Stelmach et al., 2004 **

**Objective**

The main purpose of this paper was to examine the effects of income and education on CVD risk factors in an elderly population who had lived in an industrial area.

**Subjects**

1461.

**Socio-economic status that was measured**

Income and education.

**Setting (urban/rural)**

The study area was Lodz, a large industrial city in Poland.

**Year**

2003.

**Hypothesis**

(+)/(-).

**Country**

Poland.

**Comments**

Some results prove the hypothesis to be true whereas some results prove it to be wrong.

**Results**

- Generally, higher education level decreased and higher income increased the number of CVD risk factors in all participants.
• A higher risk of diabetes and obesity associated with lower levels of education.
• Older age and university education decreased the risk of obesity in females.
• In males, university education increased the risk of hypercholesterolemia.
• Higher education (high school or university) decreased the risk of diabetes in women; less-educated respectively); men were more likely to smoke and have hypercholesterolemia than women.

Conclusions
This study found that education is more strongly associated than material status with CVD risk factors in the elderly. The best predictors of risk factors were age, sex and education. This study suggests that a higher level of education may be the strongest and most consistent predictor of good health.

Study 28: Schroder et al., 2004 **, V, 2

• Objective
To analyse the relationship between SES and both CVD risk factors and behaviour.

• Subjects
838 men and 910 women.

• Socio-economic status that was measured
Education.

• Setting (urban/rural)
Rural.

• Year
2004.

• Hypothesis**
(+).

• Country
Spain.

• Comments**
The LDL cholesterol in men and BMI in women were independently and directly related to lower levels of SES. Leisure-time physical activity, and dietary and alcohol drinking habits were similar among different groups of educational level. This fact might partially explain the associations between CHD risk factors and SES in this
population.

- **Results**
  - Age adjusted linear regression analysis revealed a direct association of educational status with LDL cholesterol in men, and with BMI, and systolic and diastolic BP in women.
  - The relationships between SES and LDL cholesterol in men, and BMI in women remained significant after adjusting for several confounders including lifestyle variables.
  - Only LDL cholesterol in men and BMI in women were independently related to lower levels of SES in this population.

- **Conclusion**
  In conclusion, LDL cholesterol in men and BMI in women were independently and directly related to lower levels of SES.

**Study 29: Vorster et al., 2007 *, □, ▽, 4**

- **Objective**
  To determine the interaction between SES position and risk factors for CVD in the African population of the North

- **Subjects**
  1854

- **Socioeconomic status that was measured**
  Income, education

- **Setting (urban/rural)**
  Urban and rural

- **Year**
  2007

- **Hypothesis**
  (+)

- **Country**
  South Africa

- **Comments**
  Higher CVD risk factors were found in to be higher in higher SES groups at that point in time and also in the near future.

- **Results**
  - Increased total serum and LDL cholesterol levels in men and women with urbanisation (higher income and education).
  - Increased BMI levels in men.

- **Conclusion**
  The results of this analysis showed that with urbanisation,
increasing income and increasing education, there were marked and sustained increases in some CVD risk factors, notably total serum and LDL cholesterol levels in men and women, and BMI in men.

**Study 30:** Winkleby *et al.*, 1992 ***,**, 7

- **Objective**
  The study examines the association between income, education, occupation, and a set of risk factors for CVD.

- **Subjects**
  2380.

- **Socio-economic status that was measured**
  Income, education, occupation.

- **Setting (urban/rural)**
  Urban.

- **Year**

- **Hypothesis**
  (+).

- **Country**
  Stanford (USA).

- **Comments**
  All three SES variables were used in this study but education was the only measure that was significantly associated with the risk factor (P< 0.05).

- **Results**
  - Higher CVD risk factor was associated with lower levels of education.
  - Correlation:
    Men: Higher the education < TC
    Higher income < systolic BP
    Higher income > diastolic BP
    Better occupation > TC
    Better occupation > HDL-cholesterol
    Woman: Higher income < systolic BP
    Higher income > diastolic BP
    Higher income < TC
    Occupation < TC

- **Conclusion**
  Higher CVD risk factor was associated with lower levels of
education; higher education may be the best SES predictor of health.

**Study 31: Winkleby et al., 1998 *, **, □, 2**

- **Objective**
  To determine whether differences in CVD risk factors by ethnicity could be attributed to differences in SES.

- **Subjects**
  1762 black, 1481 Mexican American, and 2023 White women.

- **Socio-economic status that was measured**
  Education.

- **Setting (urban/rural)**
  Urban.

- **Year**
  1998.

- **Hypothesis**
  (+).

- **Country**
  Mexican American (developing).

  African American.

  White American.

- **Comments**
  Ethnicity and SES have important and independent associations (P<0,001) with CVD risk factors. Ethnic minority status was significantly associated with BMI, systolic BP, NIDDM, and physical inactivity. The SES was significantly associated with BMI, physical inactivity, cigarette smoking, and high non-HDL-cholesterol.

- **Results**
  - Women with lower SES from each of the 3 ethnic groups had significantly higher levels of BMI and non HDL-cholesterol and higher prevalence of physical inactivity than women with higher SES (P<0,001).
  - There were higher levels of CVD risk factors among black and Mexican American women than among white women of comparable age and SES.

- **Conclusion**
  These findings provide the greatest evidence to date of higher CVD risk factors among black and Mexican American women than among white women of comparable age and SES.
SES. The striking differences by both ethnicity and SES underscore the critical need to improve screening, early detection, and treatment of CVD-related conditions for black and Mexican American women, as well as for women of lower SES in all ethnic groups.

**Study 32**: Wong and Donnan, 1992 **, 4

- **Objective**
  The aim was to explore the relationships between five SES variables and three main CVD (ischemic heart disease, hypertensive disease, and cerebrovascular disease) in Hong Kong.

- **Subjects**
  7726 – ischemic heart disease
  2738 – hypertension
  9030 – cerebrovascular disease

- **Socio-economic status that was measured**
  Education and Income.

- **Setting (urban/rural)**
  Whole of Hong Kong divided into 24 districts.

- **Year**

- **Hypothesis**
  (+).

- **Country**
  Hong Kong.

- **Comments**
  This study only measured hypertension no other CVD risk factor was measured. The results show that lower SES groups had higher hypertension.

- **Results**
  - Higher levels of SES were associated with higher mortality from ischemic heart disease in men.
  - Lower SES was associated with higher risks of men from cerebrovascular disease and hypertensive disease.

- **Conclusion**
  The study suggests that in Hong Kong in recent years, a higher level of SES is associated with higher risk of death from ischemic heart disease; but this association is not
present for hypertensive disease and cerebrovascular disease.

**Study 33: Yu et al., 2000 *, □, 7**

- **Objective**
  The present article reports the results of a cross-sectional assessment to investigate the association between SES and CVD risk factors in a Chinese urban Population.

- **Subjects**
  3207.

- **Socio-economic status**
  Education, occupation and income.

- **Setting (urban/rural)**
  Urban.

- **Year**
  2000.

- **Hypothesis**
  (-).

- **Country**
  China.

- **Comments**
  From this study it can be seen there was a significant increase in CVD risk factors with lower SES.

- **Results**
  - People with lower SES had higher levels of CVD risk factors. The association between SES and CVD risk factors was more consistent among women than men.
  - Men with lower incomes had significantly higher mean diastolic BP.
  - For women, educational attainment and occupation were consistently and inversely associated with mean values of systolic and diastolic BP, BMI.
  - Occupation was inversely associated with BMI.

- **Conclusion**
  - Our results showed that, in age-adjusted analyses, educational level was inversely associated with mean values of BP and BMI for women, and with cigarette smoking for both sexes.
  - Overall, people with lower SES tended to have higher levels of CVD risk factors.
  - Men with higher SES tended to have lower mean BP levels and had lower relative risks of being
obese.

- Women with lower SES seemed to have higher mean BP levels, BMI.

**Study 34: Yu et al., 2002**

- **Objective**
  The association between SES and serum lipids in a Chinese urban population.

- **Subjects**
  4541.

- **Socio-economic status**
  Education, occupation, and income.

- **Setting (urban/rural)**
  Urban.

- **Year**
  2002.

- **Hypothesis**
  (+).

- **Country**
  China.

- **Comments**
  The findings in this study prove that there is a significant increase in serum lipids in higher SES groups.

- **Results**
  - People in higher SES groups had a more unfavourable serum lipid profile compared with those in lower SES groups.
  - In this study, people with high SES had more unfavourable serum lipids compared with those individuals with low SES. However, the significant association of SES and serum lipids was more evident in men than in women.

- **Conclusion**
  - Significant association was especially apparent in men. Education seemed to be the most important predictor of serum lipids in the three SES indicators. The direction of the association between high SES and poor serum lipid profiles appears to be opposite to those observed in the developed countries.
**Study 35: Yarnell et al., 2005**

- **Objective**
  This study examined the contribution of SES factors to risk of CHD in a large cohort study in France and Northern Ireland.

- **Subjects**
  10,593 men.

- **Socio-economic status**
  Education and employment.

- **Setting (urban/rural)**
  Urban.

- **Year**
  2005.

- **Hypothesis**
  (-).

- **Country**
  France.
  Northern Ireland.

- **Comments**
  Among men who were initially free of CHD there were clear SES differentials (years of full-time education, unemployment, and educational level) in the distribution of several risk factors for CHD like systolic BP, BMI and fibrinogen. TC in contrast showed no SES differentials.

- **Results**
  - Among men who were initially free of CHD there were clear SES differentials (years of full-time education, unemployment, and educational level) in the distribution of several CHD risk factors for CHD, notable smoking habit, systolic BP, BMI and fibrinogen.
  - In this cohort of men free of CHD at baseline few SES indicators showed relationships with risk of CHD by 5 years of follow up.
  - All 842 men showed some evidence of CHD at screening examination and these men were more likely to be living in poorer material circumstances, be unemployed, or have less full-time education than men without CHD at screening in both France and Northern Ireland. These relationships persisted following adjustment for all known risk factors for
Among men who were initially free of CHD there were clear SES differentials (years of full-time education, unemployment, and educational level) in the distribution of several risk factors for CHD like systolic BP, BMI and fibrinogen. Total cholesterol in contrast showed no SES differentials.
ADDENDA

ADDENDA 2: PURE study
ADDENDUM 1: Appointment letter
Dear Participant
Thank you for being willing to help us in this very important project. We are sure that the project will contribute to improve health of all the people of the North West Province.
The aim of the project is to get enough information regarding the development of chronic diseases like Diabetes, Stroke, Lung disease and Heart disease with urbanisation to plan appropriate health and nutrition intervention strategies. At the time you receive this letter you would have been visited by a fieldworker and you already have filled out several questionnaires and signed consent to give a blood sample. This letter serves to inform you of the date and time the blood sample and other measurements will be done at the premises of the North-West University on the Potchefstroom Campus.

IMPORTANT INFORMATION

1. You will be picked up by a taxi accompanied by Ms Susan Legwete on ...................... by 0....h00. Susan will tell you the place where you will be picked up.
2. You MUST NOT EAT OR DRINK anything after ten o'clock of the previous night (10 pm of the night before). This is necessary for the glucose test to be accurate.
3. You MUST BRING YOUR ID DOCUMENT with you
4. Your taxi fare will be paid by us and you will receive food after the blood sample is taken.
5. If you are employed, please show this letter to your employer.

Dear Employer
This serves to ask you to give one day’s paid leave to.................. in order to allow him/her to attend his appointment with the research team of the PURE-SA study at the North-West University.
Thank you for your cooperation. For any further information please contact Dr A Kruger at 082 7715778

A Kruger (project leader)
ADDENDUM 2: Recruitment and informed consent form
Title of the project: PURE-Project (Prospective Urban and Rural Epidemiology)

INFORMED CONSENT (Phase 1)

I, the undersigned …………………………………………………………………………… (full names)
understand that the only information that will asked from me is the family census and household questionnaires. I understand that a field worker from the PURE-study will ask me the questions and that all the information gained from me will kept confidential.

I indemnify the University, also any employee or student of the University, of any liability against myself, which may arise during the course of the project.

I will not submit any claims against the University regarding personal detrimental effects due to the project, due to negligence by the University, its employees or students, or any other subjects.

……………………………………..
(Signature of the subject)

Signed at ……………………………………………………….. on ……………………………………………………………

Witnesses

1. ………………………………………………………

2. ………………………………………………………

Signed at ……………………………………………………… on ……………………………………………………………
Dear Participant

Thank you for being willing to help us in this very important project. We are sure that the project will contribute to improve health of all the people of the North West Province.

The aim of the project is to get enough information regarding the development of chronic diseases like Diabetes, Stroke, Lung disease and heart disease with urbanisation to plan appropriate health and nutrition intervention strategies.

For this study we need 2 000 subjects whom we can follow for 12 years. The baseline survey will be done from April 2005 to November 2005. The subjects must be from rural as well as urban communities. Therefore, 500 subjects from 4 different levels of urbanisation will be needed. Ganyesa and Tlakgameng were chosen for the rural and semi-rural areas because they are still under tribal law with a good infrastructure and stability. We also spoke to Chief M. Letlhogile and the mayor Mr E. Tladinyane and both gentlemen gave us permission to do the research in these two communities. Ikageng and the informal Ikageng were chosen as it is convenient and near the University. Cllr GG Megalanyane and Cllr Mahesh Roopa are informed about the study.

All the questionnaires will be filled out at your houses by trained research field workers who are from your communities. After a household survey and a family census on most of the households in your community to give us an overview of the total community, 250 men and 250 women from all four sites (Ganyesa, Tlakgameng, Ikageng, and the Informal Ikageng) will be asked to proceed with the study. These subjects should be

- Older than 35 years
- Healthy – which means that they must not be aware of any disease and do not take any chronic medication

These 2 000 subjects will be asked to fill out the adult questionnaire, the food frequency questionnaire, the health questionnaire and the physical activity questionnaire. We will also make an appointment with each subject to take some measurements such as weight, height, skinfold thicknesses, ECG (test for heart abnormalities), lung functions, blood pressure, blood glucose, blood samples and a urine sample.
It is very important that we gather quality data and knowledge. Because HIV/AIDS is such a devastating illness and affects almost all aspects of health, it is necessary to know if HIV is absent before we analyse the data. Therefore we will ask questions about your HIV status which you are allow not to answer.

It is also very important to us that you feel free to participate in this study and that you understand what the study is all about. The fieldworker will ask you to sign this form after you have read and understood it.

Kind regards

Dr ANNAMARIE KRUGER
Contact details: 082 7715778 / 018 2994037(W) / 018 2907024(H)
ADDENDUM 3: Referral letter
To whom it may concern

Dear Doctor/Sister

Mr/Ms …………………………………………………………………participated in a project of our research group on ………………………………………

His/her fasted/random blood glucose was …………………..mmol/L

His/her resting blood pressure was ……………………….mmHg

Will you please be so kind to attend to this patient?
Thank you and warm regards

…………………………………
Dr A Kruger (project leader)
Contact details:  082 7715778
ADDENDUM 4: Quantitative food frequency questionnaire
1. Name: ____________________________________________

2. Not applicable in South Africa

3. National identity # or equivalent ______________________________ N/A

4. DOB: ________ ________ ________ OR Age ________ years

5. Sex: [ ] Female [ ] Male

Please think carefully about the food and drink you have consumed during the past month (four weeks). I will go through a list of foods and drinks with you and I would like you to tell me:

- If you eat the food
- How the food is prepared
- How much of the food you eat at a time
- How many times a day you eat it and if you do not eat it everyday, how many times a week or a month you eat it.

To help you to describe the amount of a food you eat, I will show you pictures of different amounts of the food. Please say which picture is the closest to the amount you eat, or if it is smaller, between the sizes or bigger than the pictures.

There are no right or wrong answers.

Everything you tell me is confidential. Only your subject number appears on the form.

Is there anything you want to ask now?

Are you willing to go on with the questions?
FOOD FREQUENCY QUESTIONNAIRE

INSTRUCTIONS: Circle the subject's answer. Fill in the amount and times eaten in the appropriate columns.

I shall now ask you about the type and the amount of food you have been eating in the last few months. Please tell if you eat the food, how much you eat and how often you eat it. We shall start with maize meal porridge.

<table>
<thead>
<tr>
<th>FOOD</th>
<th>DESCRIPTION</th>
<th>AMOUNT</th>
<th>TIMES EATEN</th>
<th>CODE</th>
<th>AMOUNT / DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Per day</td>
<td>Per week</td>
<td>Per month</td>
</tr>
<tr>
<td>PORRIDGE AND BREAKFAST CEREALS AND OTHER STARCH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize-meal porridge</td>
<td>Stiff (pap)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize-meal porridge</td>
<td>Soft (slappap)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize-meal porridge</td>
<td>Crumbly (phutu)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mabella</td>
<td>Stiff</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mabella</td>
<td>Soft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other cooked porridge</td>
<td>Type: ______________</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakfast cereals</td>
<td>Brand name of cereals at home now:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you pour milk on your porridge or cereal?</td>
<td>Yes</td>
<td>1</td>
<td>No</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>If yes, what type of milk (whole fresh, sour, 1%, fat free, milk blend, etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If yes, how much milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| FOOD        | DESCRIPTION            | AMOUNT | TIMES EATEN | CODE | AMOUNT /
|-------------|------------------------|--------|-------------|------|--------
|             |                        |        | Per day     |      |        |
|             |                        |        | Per week    |      |        |
|             |                        |        | Per month   |      |        |
|             |                        |        | Seldom / Never |    |        |
| Do you put sugar on your porridge or cereal? | Yes 1 | No 2 |
| If yes, how much sugar | | 3989 |
| Samp        | Bought                 | 3250   |             |      |        |
|             | Self ground            |        |             |      |        |
| Samp and beans | Give ratio of samp:beans | 3402 (1:1) | | | |
| Samp and peanuts | Give ratio of samp:peanuts | 3250 (samp) | | | |
| Rice        | White                  | 3247   |             |      |        |
|             | Brown                  | 3315   |             |      |        |
|             | Maize Rice             | 3250   |             |      |        |
| Pasta       | Macaroni               | 3262   |             |      |        |
|             | Spaghetti              |        |             |      |        |
|             | Other specify:         |        |             |      |        |
|             | _______________________ |        |             |      |        |
|             | _______________________ |        |             |      |        |
| Pizza       | Home made: Specify topping | 3353 (base+ch) | | | |
|             | Bought: Specify topping | 3353 (base+ch) | | | |
You are being very helpful. Can I now ask you about meat?

**CHICKEN, MEAT, FISH**

How many times do you eat meat (beef, mutton, pork, chicken, fish) per week?

<table>
<thead>
<tr>
<th>FOOD</th>
<th>DESCRIPTION</th>
<th>AMOUNT</th>
<th>TIMES EATEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Per day</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Chicken (codes with skin)**

- Boiled: 2926
- Fried: in batter/crums: 3018
- Eg Kentucky: 2926
- Fried: Not coated: 2926
- Bought: Chicken Licken: 2925
- Bought: Nando’s: 2925
- Roasted / Grilled: 2925
- Other: ______________

**Do you eat chicken skin?**

<table>
<thead>
<tr>
<th></th>
<th>Always</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken bones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stew</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken feet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken offal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Red meat**

- How do you like meat?
  - With fat
  - Fat trimmed

**Red meat**

- Fried
- Stewed
- Mince with tomato and onion: 2987
- Other:

**Beef Offal**

- Intestines: boiled nothing added: 3003
- Stewed with vegetables
- Liver: 2920
- Kidney: 2923
<table>
<thead>
<tr>
<th>FOOD</th>
<th>DESCRIPTION</th>
<th>AMOUNT</th>
<th>TIMES EATEN</th>
<th>CODE</th>
<th>AMOUNT / DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Per day</td>
<td>Per week</td>
<td>Per month</td>
</tr>
<tr>
<td>Goat meat</td>
<td>Boiled</td>
<td>4281</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stewed with vegetables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grilled / Roasted</td>
<td>4281</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wors / Sausage</td>
<td></td>
<td>2931</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacon</td>
<td></td>
<td>2906</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold meats</td>
<td>Polony</td>
<td>2919</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ham</td>
<td>2967</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vienna</td>
<td>2936</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other: Specify</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned meat</td>
<td>Bully beef</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other: Specify</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat pie</td>
<td>Beef</td>
<td>2939</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steak and kidney</td>
<td>2957</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cornish</td>
<td>2953</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chicken</td>
<td>2954</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamburger</td>
<td>Bought</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What type of vegetables is usually put into meat stews?

__________________________________________________________________________________________________________________________________________________

___
<table>
<thead>
<tr>
<th>FOOD</th>
<th>DESCRIPTION</th>
<th>AMOUNT</th>
<th>TIMES EATEN</th>
<th>CODE</th>
<th>AMOUNT / DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Per day</td>
<td>Per week</td>
<td>Per month</td>
<td>Seldom / Never</td>
</tr>
<tr>
<td>Dried beans/peas/lentils</td>
<td>Soup</td>
<td></td>
<td></td>
<td></td>
<td>3145</td>
</tr>
<tr>
<td></td>
<td>Salad</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soya products eg. Toppers</td>
<td>Brands at home now:</td>
<td></td>
<td></td>
<td></td>
<td>3196</td>
</tr>
<tr>
<td></td>
<td>(Toppers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilchards in tomato/chilli/brine</td>
<td>Whole</td>
<td></td>
<td></td>
<td></td>
<td>3102</td>
</tr>
<tr>
<td></td>
<td>Mashed with fried onion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fried fish</td>
<td>With batter/crumbs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Without batter/crumbs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other canned fish</td>
<td>Tuna</td>
<td></td>
<td></td>
<td></td>
<td>3056 (oil)</td>
</tr>
<tr>
<td></td>
<td>Pickled fish</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other: Specify</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish cakes</td>
<td>Bought: Fried</td>
<td></td>
<td></td>
<td></td>
<td>3080</td>
</tr>
<tr>
<td></td>
<td>Home made with potato</td>
<td></td>
<td></td>
<td></td>
<td>3098</td>
</tr>
<tr>
<td>Fish fingers</td>
<td>Bought</td>
<td></td>
<td></td>
<td></td>
<td>3081</td>
</tr>
<tr>
<td>Eggs</td>
<td>Boiled/poached</td>
<td></td>
<td></td>
<td></td>
<td>2867</td>
</tr>
<tr>
<td></td>
<td>Scrambled: milk + fat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fried: Fat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Now we come to vegetables and fruit

**VEGETABLES AND FRUIT**

<table>
<thead>
<tr>
<th>Cabbage</th>
<th>How do you cook cabbage?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boiled, nothing added</td>
</tr>
<tr>
<td></td>
<td>Boiled with potato and onion and fat</td>
</tr>
<tr>
<td></td>
<td>Fried, nothing added</td>
</tr>
<tr>
<td></td>
<td>Fried in ......................</td>
</tr>
<tr>
<td></td>
<td>Boiled, then fried with potato, onion</td>
</tr>
<tr>
<td></td>
<td>Other:</td>
</tr>
<tr>
<td></td>
<td>Don't know</td>
</tr>
<tr>
<td>FOOD</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinach/morogo/ beetroot leaves other green leafy</td>
<td>How do you cook spinach?</td>
</tr>
<tr>
<td></td>
<td>Boiled, nothing added</td>
</tr>
<tr>
<td></td>
<td>Boiled with fat added</td>
</tr>
<tr>
<td></td>
<td>Type of fat ………………</td>
</tr>
<tr>
<td></td>
<td>With onion, tomato, potato</td>
</tr>
<tr>
<td></td>
<td>With peanuts</td>
</tr>
<tr>
<td></td>
<td>Other:</td>
</tr>
<tr>
<td></td>
<td>Don’t know</td>
</tr>
<tr>
<td>Tomato and onion gravy</td>
<td>Home made with fat</td>
</tr>
<tr>
<td></td>
<td>Type of fat ………………</td>
</tr>
<tr>
<td></td>
<td>Without fat</td>
</tr>
<tr>
<td></td>
<td>Canned</td>
</tr>
<tr>
<td>Pumpkin (yellow)</td>
<td>How do you cook pumpkin?</td>
</tr>
<tr>
<td></td>
<td>Boiled, nothing added</td>
</tr>
<tr>
<td></td>
<td>Cooked in fat and sugar</td>
</tr>
<tr>
<td></td>
<td>Fat …………………</td>
</tr>
<tr>
<td></td>
<td>Boiled, little sugar and fat</td>
</tr>
<tr>
<td></td>
<td>Fat …………………</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td>Don’t know</td>
</tr>
<tr>
<td>Carrots</td>
<td>How do you cook carrots?</td>
</tr>
<tr>
<td></td>
<td>Boiled, nothing added</td>
</tr>
<tr>
<td></td>
<td>Boiled, sugar and fat</td>
</tr>
<tr>
<td></td>
<td>Fat …………………</td>
</tr>
<tr>
<td></td>
<td>With potato and onion: Fat</td>
</tr>
<tr>
<td></td>
<td>Raw, salad</td>
</tr>
<tr>
<td></td>
<td>Chakalaka</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td>Don’t know</td>
</tr>
<tr>
<td>Mealies/ Sweet corn</td>
<td>How do you eat mealies?</td>
</tr>
<tr>
<td></td>
<td>On cob – fat added</td>
</tr>
<tr>
<td></td>
<td>Fat …………………</td>
</tr>
<tr>
<td></td>
<td>On cob – no fat added</td>
</tr>
<tr>
<td>FOOD</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Creamed sweet corn /</td>
<td></td>
</tr>
<tr>
<td>canned</td>
<td></td>
</tr>
<tr>
<td>Whole kernel/canned</td>
<td></td>
</tr>
<tr>
<td>Beetroot</td>
<td>Salad</td>
</tr>
<tr>
<td></td>
<td>Boiled, nothing added</td>
</tr>
<tr>
<td>Potatoes</td>
<td>How do you cook potatoes?</td>
</tr>
<tr>
<td>Boiled/baked with skin</td>
<td></td>
</tr>
<tr>
<td>Boiled/baked without skin</td>
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If subject eats canned fruit: Do you have custard with the canned fruit? Yes 1 No 2

Custard

Home made: Milk

Commercial eg Ultramel 2716

BREAD AND BREAD SPREADS

Bread / Bread rolls

White 3210

Brown 3211

Whole wheat 3212
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<tr>
<td><strong>SNACKS AND SWEETS</strong></td>
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<tr>
<td>Potato crisps</td>
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<td>3417</td>
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<tr>
<td>Peanuts</td>
<td>Raw</td>
<td>4285</td>
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<tr>
<td></td>
<td>Roasted</td>
<td>3458</td>
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<tr>
<td>Cheese curls, Niknaks, etc</td>
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<tr>
<td>Raisins</td>
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<td>Peanuts and raisins</td>
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<td>Chocolates</td>
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<tr>
<td>Candies</td>
<td>Sugus, gums, hard sweets, etc</td>
<td>4000</td>
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<td>Sweets</td>
<td>Toffees, fudge, caramels</td>
<td>3991</td>
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<td>Biscuits/cookies</td>
<td>Type:</td>
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<td>Cakes and tarts</td>
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<td>Rusks</td>
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<td>Savouries</td>
<td>Sausage rolls</td>
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<td>Samoosas: Meat filling</td>
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<td>Samoosas: Vegetable filling</td>
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<td>Biscuits eg bacon kips</td>
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<td>Other specify:</td>
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<td>Jelly</td>
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<tr>
<td>Baked pudding</td>
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<td>Instant pudding</td>
<td>Milk type:</td>
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**SAUCES, GRAVIES AND CONDIMENTS**

|                      |             |        |         |          |           | 3139           |
| Tomato sauce /      |             |        |         |          |           |                |
| Worcester sauce     |             |        |         |          |           |                |
| Chutney             |             |        |         |          |           | 3168           |
| Pickles             |             |        |         |          |           | 3866           |
| Packet soups        |             |        |         |          |           | 3165           |
| Other:              |             |        |         |          |           |                |
|                     |             |        |         |          |           |                |

**WILD BIRDS, ANIMALS OR INSECTS (hunted in rural areas or on farms)**

<p>| | | | | | | |
|                      |             |        |         |          |           | |
| Wild fruit           |             |        |         |          |           | |</p>
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<th>FOOD</th>
<th>DESCRIPTION</th>
<th>AMOUNT</th>
<th>TIMES EATEN</th>
<th>CODE</th>
<th>AMOUNT / DAY</th>
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<td>Seldom</td>
<td>Seld</td>
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<td>/ Never</td>
<td>/ Ne</td>
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</table>

**MISCELLANEOUS:** Please mention any other foods used more than once/two times a week which we have talked about:

**INDIGENOUS/TRADITIONAL FOODS/PLANTS/ANIMALS**

Please tell me if you use any indigenous plants OR other indigenous foods like mopani worms, locusts ect to eat

Specify

Thank you very much for your cooperation and patience.

Good-bye!
ADDENDUM 5: PURE 24 hour recall dietary intake
PURE 24-hour recall dietary intake

Subject ID
Centre #    Community #    Household #    Subject #

Subject Initials
F    M    L

Today's date:

1. Name: __________________________________________

2. Not applicable in South Africa

3. National identity # or equivalent __________________________________________ N/A

4. DOB: ___________ ___________ ___________ OR Age ___________ years

5. Sex: □ Female □ Male

6. What day was yesterday? (tick correct one)

Monday    Tuesday    Wednesday    Thursday    Friday    Saturday    Sunday

7. Would you describe the food that you ate yesterday as typical of your usual food intake?

Yes 1

No 2

Greetings!

Thank you for giving up your time to participate in this study. I hope you are enjoying it so far. Here we want to find out what people living in this area eat and drink. This information is important to know as it will tell us if people are eating enough and if they are healthy.

There are no right or wrong answers.

Everything you tell me is confidential. Only your subject number appears on the form.

Is there anything you want to ask now?

Are you willing to go on with the questions?
I want to first ask you a few general questions about your food intake, the preparation of food and the type of food that you use in your home.

**Instruction**
Circle the subject’s answer.

8. **What type of pot do you usually use to prepare food in? (may answer more than one)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron pot</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Stainless steel pot</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminium pot</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass ware</td>
<td>4</td>
<td></td>
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<tr>
<td>Other (specify)</td>
<td>5</td>
<td></td>
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</tbody>
</table>

9. **Do you eat maize meal porridge?**

If YES, what type do you have at home now?

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
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</tbody>
</table>

If brand name is given, do you usually use this brand?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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</table>

Where do you get your maize meal from? (may answer more than one)

<table>
<thead>
<tr>
<th>Shop</th>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
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<tr>
<td>Employer</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Harvest and grind self</td>
<td>3</td>
<td></td>
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<tr>
<td>Other (specify)</td>
<td>4</td>
<td></td>
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<tr>
<td>Don’t know</td>
<td>5</td>
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</table>

10. **Do you eat fat/margarine or use it in the preparation of food?**

If YES, what type do you have at home now?

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
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</table>

If brand name is given, do you usually use this brand?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
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<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
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</tbody>
</table>
11. Do you use oil in the preparation of food?  
   Yes [1]  No [2]

If YES, what type do you have at home now?

Brand name: ________________________________________________________________

Don’t know: ______  [2]

If brand name is given, do you usually use this brand?  

What type of oil do you buy for deep frying?

Brand name: ________________________________________________________________

Do you use the same oil more than once?  
   Yes [1]  No [2]

If yes, how many times will you use the same oil? __________________________________________

12. What type of salt do you use?

Give brand names
________________________________________________________________________________

Do you add salt to food while it is being cooked?  

Do you add salt to your food after it has been cooked?

Do you like salty foods eg salted peanuts, crisps, chips, fritos, biltong, dried sausage, etc


13. Do you use any of the following:

<table>
<thead>
<tr>
<th>Name of product</th>
<th>Amount per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamins/vitamins and minerals</td>
<td></td>
</tr>
<tr>
<td>Tonics</td>
<td></td>
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<tr>
<td>Health foods</td>
<td></td>
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<tr>
<td>Body building preparations</td>
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<tr>
<td>Dietary fibre supplement</td>
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<td>Other: Specify</td>
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</table>
I want to find out about everything you ate or drank yesterday, including water or food you pick from the veld. Please tell me everything you ate from the time you woke up yesterday up to the time you went to sleep. I will also ask you where you ate the food and how much you ate.

To help you describe the amount of a food you eat, I will show you pictures and examples of different amounts of the food. Please say which picture or example is the closest to the amount you eat, or if it is smaller, between the sizes or bigger than the pictures.

<table>
<thead>
<tr>
<th>Time</th>
<th>Place</th>
<th>Description of food and preparation method</th>
<th>Amount</th>
<th>Amount in gram</th>
<th>Code (office use)</th>
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<td>Place</td>
<td>Description of food and preparation method</td>
<td>Amount</td>
<td>Amount in gram</td>
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