RED MEAT IN NUTRITION AND HEALTH

Communicating current science about red meat as part of a healthy South African diet

Includes updated information and guidelines on nutrient content, food-based dietary guidelines, consumption trends, bioavailability, weight management, cancer, fats, hypertension, and red meat in a sustainable environment.

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Lamb & mutton South Africa
Skaapvleis Suid-Afrika

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INTRODUCTION

Possible health benefits of foods have introduced modern consumers to the concept of food as medicine. As the incidence of chronic diseases continues to increase, consumer interest in the positive role food can play in controlling these afflictions, is growing. Individuals are moving from efforts to optimize balanced nutrition to improve their health through positive eating, which has resulted in the concept of "food today for medicine tomorrow".

A double burden of nutrition-related diseases is prevalent in many households and communities in South Africa, as both over- and undernutrition occur due to rapid urbanization and acculturation. Numerous South Africans suffer from the health implications of inappropriate diets. Obesity is regarded as the most important nutritional disease, that causes many of the major non-communicable diseases. An estimated 24% of deaths in Sub-Saharan Africa are attributed to non-communicable diseases, and this percentage is constantly increasing. This forms part of the massive global burden of diet-related diseases that drives consumers to improve their health through optimized nutrition, positive eating and by following a healthy lifestyle.

The International Conference on Nutrition of 1992 in Rome identified strategies and actions to improve nutritional well-being and food consumption globally. Governments were called upon *"to provide advice to the public by disseminating, through use of mass media and other appropriate means, qualitative and/or quantitative dietary guidelines relevant for different age groups and lifestyles and appropriate for the country's population"* (FAO/WHO, 1992). In May 2004, the 57th World Health Assembly (WHA) endorsed the World Health Organization (WHO) Global Strategy on Diet, Physical Activity and Health. The Strategy was developed through a wide-ranging series of consultations with all concerned stakeholders in response to a similar request from Member States at the World Health Assembly in 2002. The strategy is currently being rolled out into policies at international level and implemented through the Codex Alimentarius Commision and country level legislation such as reduction of salt and limiting the saturated fat content of foods.

Promoting healthy lifestyles to reduce the global burden of non-communicable diseases requires a wide multisectoral approach. This approach needs to involve various sectors in societies and promotion of lifestyle changes such as controlled dietary intake and increased physical activity. The availability of current and correct, scientifically based, nutritional information which the public can relate to, plays a major role in promoting healthy lifestyle choices.

Today, consumers should have the knowledge, as well as the means, to make informed food choices.

As health professionals are considered one of the most important and trustworthy sources of information, this document aims to communicate current scientific knowledge about red meat and health within a South African context, to local health professionals.

The revised South African Food-Based Dietary Guideline relating to eating foods derived from animals reads **"fish, chicken, lean meat or eggs can be eaten daily"**, but what specifically has recent research found regarding the role of red meat as part of a healthy diet?

The influence of data and recommendations from developed countries on nutrition guidance has overshadowed the recognition of key micronutrients and protein contributed inter alia by red meat to nutrient delivery to less adequately fed populations. Based on epidemiological studies a positive association was observed between obesity and high saturated fat intake, which has led to the consumption of smaller portions of red meat less frequently, in an aim to restrict fat intake. However, meat plays an integral role in global eating and the nutritional attributes of meat make a significant contribution to an individual's requirements for protein, vitamins and minerals as part of a balanced diet. Various studies also reflect the substantial changes over time in the composition of red meat, especially reduction in the amount of fat both on the carcass itself and after trimming in the shop or at home. Choosing condiments and cooking methods more wisely, and controlling portion sizes can contribute to healthier food patterns, particularly when seen against our obesogenic environment.

In this document the nutrient composition of South African lamb and mutton, as recently determined in studies performed at the University of Pretoria in collaboration with the Agricultural Research Council, Irene, is interpreted within the most recent scientific evidence surrounding current health and nutrition topics.

We hope that you will be able to utilise this document as a useful up-to-date reference source on the role of red meat within a healthy diet.

The Authors,

Prof Hettie Schönfeldt & Mrs Nicolette Hall

CHAPTER 1

THE NUTRIENT CONTENT OF RED MEAT

WHY IS THIS IMPORTANT?

"The knowledge of the chemical composition of a food is the first essential in dietary treatment of disease or in any quantitative study of human nutrition."
(McCance & Widdowson, 1940)

√ Recent research found that our local lamb and mutton is a more nutrient dense food, and contains significantly less fat than what has been previously reported.

√ Previous reference values on the nutrient content of sheep meat used by health professionals in SA were borrowed from the United States Department of Agriculture (USDA) as no local values were available.

√ These values did not reflect our unique breeds and/or animal husbandry and industry practices.

CHAPTER AT A GLANCE

√ The nutrient composition of red meat is non-homogenous and changes continuously.

√ Modern day lean red meat contains less fat and subsequently more nutrients per edible portion (high nutrient density).

√ Recent local scientific research have found that lean South African lamb and mutton:

- Contain less than 10% fat.
- Can be included as part of a healthy, well-balanced diet.
- Are significant sources of many nutrients essential for health and wellbeing, contributing significantly to an individual's daily nutrient requirements.

1.1 REDUCTION IN THE FAT CONTENT OF RED MEAT OVER TIME

Various studies around the globe reflect the changes over time in the composition of red meat, including, lamb, mutton and beef, and especially indicate a reduction in total fat content. The percentage of fat present in New Zealand beef carcasses has decreased from 23.3% in 1981 to 7.1% in 1997 (EuroFIR, 2008). In South Africa (SA) similar results have been found with the average fat content of target grade beef decreasing from 32% in 1949 to 18% in 1981 to 13% in 1991 (Naudé, 1994), and currently reported as 11.3%. To be relevant, a new study on lean SA beef is currently being conducted at the University of Pretoria (UP).

The reduction in fat content of red meat is directly linked to the increase in consumer demand for leaner red meat products, and a response by the science fraternity to adopting better animal diets and breeding techniques, slaughtering at the desired fatness, trimming carcasses and cuts, as well as changing preparation techniques.

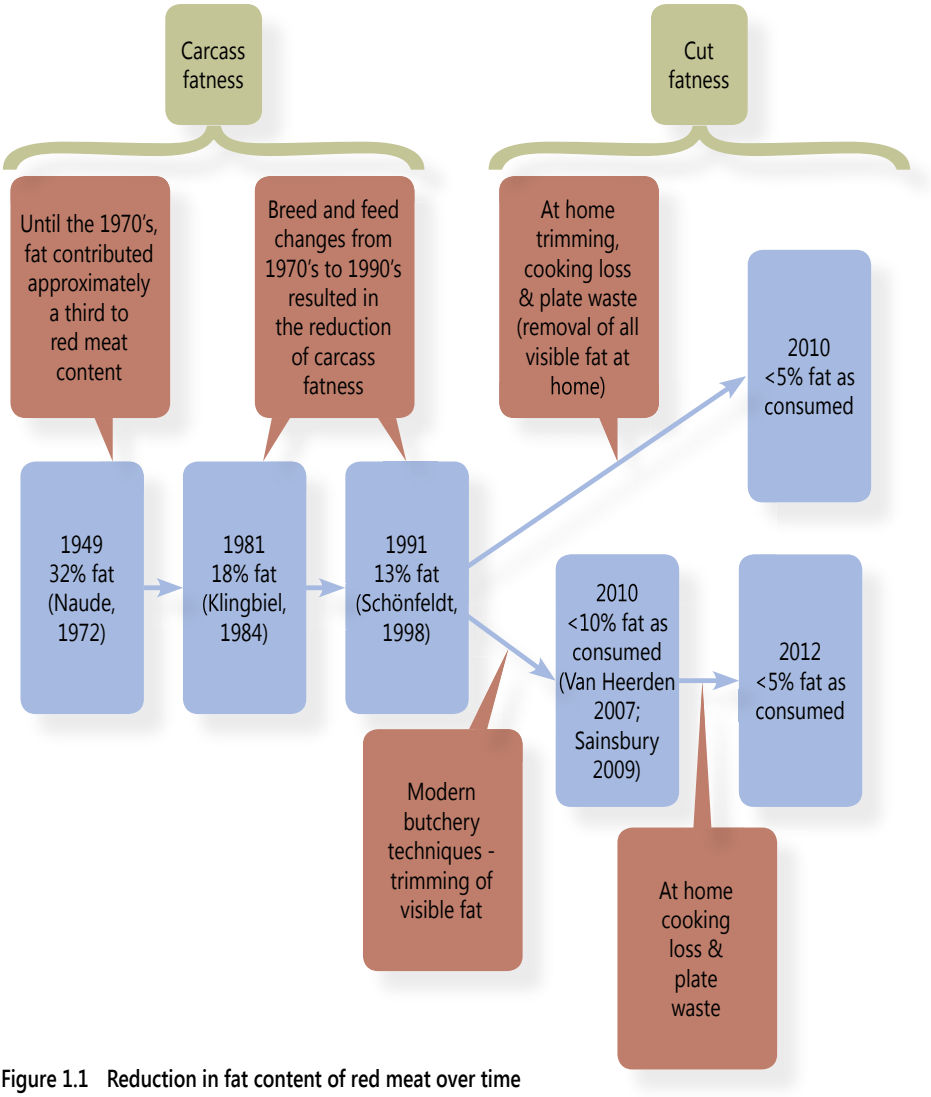

Figure 1.1 Reduction in fat content of red meat over time

1.2 THE NUTRIENT COMPOSITION OF SOUTH AFRICAN LAMB AND MUTTON

Why was scientific research needed to determine the composition of South African lamb and mutton?

Research was commissioned by the SA Red Meat Industry to determine the nutrient composition of sheep meat (lamb and mutton) during the period from 2003 to 2009. Two large, but related research studies on lamb and mutton respectively were conducted by UP and the Agricultural Research Council Irene (ARC). This formed part of a first attempt to obtain our own nationally representative data on the nutrient content of sheep meat.

The previous values used for the composition of mutton available to South Africans in the Medical Research Council (MRC) National Food Composition Tables (2010) were borrowed from data of the USDA Food Composition Databank (1991). **No values for lamb have been available until now**, although more than 85% of all sheep meat consumed currently in SA is lamb with a fatness code 2 according to our national carcass classification system. The main aims of the projects were to determine the carcass and nutrient composition of local sheep meat (lamb and mutton) and subsequently update the National Food Composition Database with South African data.

NOTEWORTHY RESEARCH FINDINGS ON SA LAMB AND MUTTON:

√ When trimmed, contains less than 10% fat on average.

√ Without trimming, contains nearly as much health promoting unsaturated fatty acids as saturated fatty acids.

√ Provides essential nutrients in significant quantities, including:

- *Protein* containing all the essential amino acids in the right proportions, necessary for optimal body functions.
- Health benefitting *fatty acids* including Conjugated Linoleic Acid (CLA), omega-3 and omega-6 fatty acids.
- *Vitamins,* including the B vitamins.
- *Minerals,* including iron and zinc, with the mineral content increasing with animal age.

How were the analysis performed?

The studies were designed to represent sheep meat supply in SA. The carcasses included Dorper and Merino breeds from two different abattoirs, and represented three different production regions (Karoo, Kalahari and Ermelo districts). Eighteen carcasses per age group (lamb (A2) and mutton (C2)) were analysed for each cut in line with the Regulations Relating to the Labelling and Advertising of Foodstuffs (No. R.146 of 1 March 2010 as part of Act 54 of 1972). Analyses were performed on a double-blind basis in SANAS (South African National Accreditation Services) accredited laboratories on both raw and cooked cuts, including two levels of trimming; untrimmed and trimmed of subcutaneous fat.

Researchers involved included Prof Hettie Schönfeldt (study promoter) (UP), Dr Ina van Heerden (first study PhD student; 2nd study co-promoter) (ARC & UP), Dr Phillip Strydom (collaborator) (ARC) and Ms Jeanine Sainsbury (MSc student) (UP). The research was performed over a period of six years (2003 to 2009), and the total cost of the project exceeded R1 million, co-funded by Red Meat Research and Development South Africa (RMRDSA), Meat and Livestock Australia (MLA), the National Research Foundation (NRF), the ARC and UP. Both studies were performed under the supervision of the RMRDSA committees, consisting of eminent scientists from a selection of organisations representing both research institutions and industry.

Results

The findings of these studies have been published by Schönfeldt *et al.*, 2012 as part of the educational campaign of Lamb and Mutton South Africa, and the document is available from www.lambandmutton.co.za upon request. Selected nutrients found in trimmed and untrimmed South African lamb and mutton are reported in Table 1.1.

Table 1.1 Selected nutrients in 100g cooked South African lamb and mutton*

Nutrient	Unit	Trimmed		Untrimmed	
		Lamb	Mutton	Lamb	Mutton
Moisture	g	65.9	64.4	60.7	60.5
Protein	g	24.8	25.7	22.8	24.4
Total Fat	g	8.76	8.52	15.6	14.0
Total Fatty Acids, of which:	g	6.75	7.80	12.4	12.9
Saturated Fatty Acids (SFA)	g	3.61	4.13	6.72	7.13
Monounsaturated Fatty Acids (MUFA)	g	2.91	3.36	5.29	5.34
Polyunsaturated Fatty Acids (PUFA)	g	0.24	0.31	0.44	0.46
Omega 3 (N3)	g	0.04	0.07	0.07	0.11
Omega 6 (N6)	g	0.20	0.23	0.36	0.35
Omega 9 (N9)	g	2.63	3.12	4.79	4.94
Cholesterol	mg	89.2	61.3	89.1	60.9

*Carcass values were calculated

Are the results trustworthy?

The results of these studies have been published in scientific journals, after undergoing strict international peer-reviewing to ensure validity of the research methodology and findings. Some of these publications to date include:

- Sainsbury, J., Schönfeldt, H.C. & Van Heerden, S.M. 2011. The nutritional composition of South African mutton. Journal of Food Composition and Analysis, 24, 720-726.
- Schönfeldt, H.C., Hall, N. & Van Heerden, S.M. 2012. The nutrient content of South African lamb and mutton. Lamb and Mutton South Africa. Menlo Park. ISBN 978-0-620-52922-8.
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EXPERT OPINION

Dr Ina van Heerden is a registered member of the Health Professional Council of South Africa (HPCSA) and work as a researcher at the Human Nutrition and Sensory Analyses Unit of the ARC, Irene. She is chairperson of the National Food Data Base Compiler group for SAFOODS (MRC) and Vice-President of the South Africa Association of Family Ecology and Consumer Science (SAAFECS) since 2008.

"Good food composition information is essential for those examining the relationship between diet and health as well as on an individual level where dietitians provide advice to those with specific medical needs. The new information on nutrient content, nutrient density and reduced fat content of South African red meat will help to act as a reference for health professionals, industry and ultimately consumers to improve nutritional well-being towards healthy lifestyles."

Red meat, including SA lamb and mutton, is a valuable source of essential nutrients in the human diet required for optimal nutrition and health. When trimmed, lean red meat contains less than 10g fat per 100g product and can be included as part of a healthy and balanced diet.

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CHAPTER 2

THE NUTRITIONAL STATUS OF SOUTH AFRICANS

WHY IS THIS IMPORTANT?

"Diet and nutrition are important factors in the promotion and maintenance of good health throughout the entire life cycle." (WHO/FAO, 2003)

CHAPTER AT A GLANCE

√ Diet and nutrition are important in promoting and maintaining health.

√ Many South Africans suffer from a double burden of nutrition-related diseases:

- *Overweight and obesity* - South Africa has a high (and growing) prevalence of overweight and obesity, in the midst of prevailing high incidences of undernutrition.
- *Protein deficiency* - More prevalent than previously understood, particularly in the elderly.
- *Iron deficiency and anaemia* - Iron deficiency and anaemia remain significant public health concerns, despite fortification of staple foods (bread flour and maize meal) with iron. A third of women and children in SA are anaemic, 1 in 5 women have a poor iron status, and 1 in 7 children have a poor iron status.
- *Vitamin A deficiency* - Drawing significantly more attention today.

√ Sustainable food-based approaches are often recommended to combat over- and undernutrition, and food-based dietary guidelines (FBDGs) globally recommend a balanced varied diet for optimal health.

2.1 THE ROLE OF FOOD AND NUTRITION IN HEALTH

Food is a major determinant of health and well-being, and plays a role in many of the major causes of illness and mortality, including gastroenteritis, cardiovascular diseases, obesity, diabetes and certain types of cancer (WHO/FAO, 2003). It is, therefore, essential to educate individuals, both from over- and undernourished backgrounds, on the role of a healthy, well balanced diet, containing a wide variety of different foods, to maintain health and well-being (Schönfeldt & Gibson, 2009).

Over the past decade, there has been an accelerated change in the diets and lifestyles of individuals due to industrialisation, urbanisation, economic development and market globalisation. These changes are reflected in the health and nutritional status of populations, particularly in developing countries and in countries in transition such as SA. While standards of living have improved, food availability has expanded and become more diversified. Unfortunately, these lifestyle changes often ensue with significant negative consequences in terms of inappropriate dietary patterns, decreased physical activities and increased tobacco use, with a corresponding increase in diet-related chronic diseases. Although increased chronic disease risks have been well highlighted in developed communities as a result of overnutrition (excessive consumption of energy and certain types of fats), the consequences of continuing bad dietary choices are becoming increasing notable, especially among the poor in industrialised countries such as SA (WHO/FAO, 2003). Many undernourished individuals (suffering from hidden micronutrient deficiencies), are increasingly recorded overweight due to excessive intakes of energy dense foods as part of a diet limited in dietary diversity.

SOUTH AFRICAN NUTRITION PROFILE OVER TIME

1999 (NFCS, 1999)

- √ 1 in 10 children (1-9yrs) were underweight.
- √ 1 in 5 children (1-9yrs) were stunted.
- √ Limited variety of food consumed by households.

2003 (SADHS, 2003)

- √ 56.6% of the adult population was overweight or obese.
- √ More than 20% of adult females were obese.
- √ 1 in 2 children had an energy intake less than two thirds of their needs.
- √ Mean intakes of many micronutrients were low, including vitamins A, B2, B6, D, E, C, and niacin.
- √ Mandatory fortification of staple foods implemented in 2003.

2005 (NFCS-FB-I, 2008

- √ 2 out of 3 children and 1 out of 4 women had poor vitamin A status.
- √ 1 out of 5 women and 1 out of 7 children had poor iron status.
- √ 45% of children had an inadequate zinc status.

2.2 THE NUTRITIONAL STATUS AND HEALTH OF SOUTH AFRICANS

The majority of South African households consume a limited variety of foods (mainly consisting of staple foods within the home (National Food Consumption Survey (NFCS), 1999). According to the 1999 NFCS, 1 in 10 children between the ages of 1 and 9 years were underweight, and more than 1 in 5 were stunted (NFCS, 1999). Four years later, the Demographic and Health Survey (SADHS) recorded mean intakes of calcium, iron, zinc and the vitamins A, D, E, C, B6, B2 and niacin as low compared to recommended dietary allowances (RDAs) (SADHS, 2003). One in 2 children had an energy intake less than two thirds of their energy needs, and a great number of children consumed a diet with poor nutrient density, not meeting their daily nutrient (macro and micro) requirements (SADHS, 2003). The fortification baseline summary of the 2005 NFCS reported that at a national level 1 in 2 households (51.6%) experienced hunger. Even after the implementation of the mandatory South African food fortification program in 2003, the 2005 NFCS still found that 2 out of 3 children and 1 out of 4 women had poor vitamin A status, 1 out of 5 women and 1 out of 7 children had poor iron status and 45% of children had an inadequate zinc status (NFCS-FB-1, 2008). These current findings indicate increases in deficiencies compared to previous nutritional data, regardless of the mandatory fortification of staple foods. As a consequence, inadequate food intake continues and malnutrition is widespread in SA.

In contrast to the nutrient deficiencies in SA, 56.2% of the adult population was recorded as overweight or obese during the SADHS in 2003. The highest prevalence of overweight and obesity was seen in the female population, with more than 20% being obese or morbidly obese. This trend is continuing and urgently requires intervention. Increasingly children are now being classified as overweight or obese. In 2002 SA had a death rate of around 679,900 deaths per year, 65% of which could be assigned to communicable diseases, 28% to noncommunicable diseases and 7% to injuries (WHO, 2006). The global burden of disease has seen a visible increase in the number of people suffering and dying from noncommunicable disease. In 1990 the global death rate due to noncommunicable diseases was 27%, which in developing countries is predicted to increase to 50% of the total burden by 2020 (WHO, 2008; Meyrowitsch, 2007).

In SA, as in many developing and industrialised countries, malnutrition is exacerbated by a double burden of disease often seen within the same household, and even within a single individual where both over- and undernutrition are experienced. Apart from continued urbanisation and acculturation contributing to the complexity of malnutrition, a pronounced discrepancy is observed between individuals living in rural and urban areas, and between different living standards within the same area. The 1998 SADHS recorded significant differences in the health status of people with different living standards within the country, with the mortality rate in rural areas as high as 7.1%, compared to a 4.3% rate in urban areas (SADHS, 1998). Obesity rates in children in urban areas (5.5%) were recorded as higher compared to the national average (4.8%) (Kruger *et al.*, 2007) while stunting rates are often higher in those living in rural areas or on commercial farms (NFCS, 1999).

EXPERT OPINION

Dr Nelia Steyn (MPH; PhD, RD.SA) has been focusing on the nutrition transition in sub-Saharan Africa for many years. She has published more than 100 articles and numerous book chapters and reports. She has also served on the Professional Board for Dietitians of the HPCSA for 8 years.

"The chapter describes the nutrition transition taking place in SA where underweight, stunting and overweight are often prevalent in the same household. In addition, overweight and obesity are frequently the result of poverty since people may eat a lot of cheap food of low quality to satisfy their hunger. Usually these foods are high in energy and fats while not containing important essential nutrients. The quality of foods consumed is, therefore, very important to meet not only energy requirements, but also those of essential micronutrients and amino acids."

2.3 PROTEIN DEFICIENCY

The WHO Technical Report on Protein and Amino Acid Requirements in Human Nutrition (2007) states that the best estimate for a population average requirement is 105mg nitrogen/kg body weight per day, or 0.66g protein/kg body weight per day. In many developing countries protein intake falls significantly short of these values. Apart from protein quantity, protein quality including bioavailability and digestibility, from different food sources, is currently being discussed on the global nutrition agenda. The 1st International Symposium on Dietary Protein for Human Health held in Auckland, in March 2011, and the follow-up Food and Agricultural Organization of the United Nations (FAO) Expert Consultation on Protein Requirements, both highlighted the importance of assessing the quality of protein from different food sources through determination of amino acid content.

Throughout the developed world, animal products and cereals are the two most important sources of protein, respectively. In developing countries such as South Africa, this order is reversed (Layman, 2010). In low income countries only 3% of total dietary energy as an indicator of diet composition, is derived from meat and offal, 11% from roots and tubers and 6% from pulses, nuts and oilseeds (FAO, 2008). The remainder of the dietary energy is mainly obtained from cereal-based staple foods. Although the production of livestock has increased in developing countries, the consumption of protein in these countries is continually decreasing. Undernutrition, including insufficient consumption of protein, remains a persistent problem in developing communities, and although many diets within these communities are deficient in the quantity of protein compared to recommendations, the quality of the protein is as important. Read more on protein quality and bioavailability in Chapter 4, page 22.

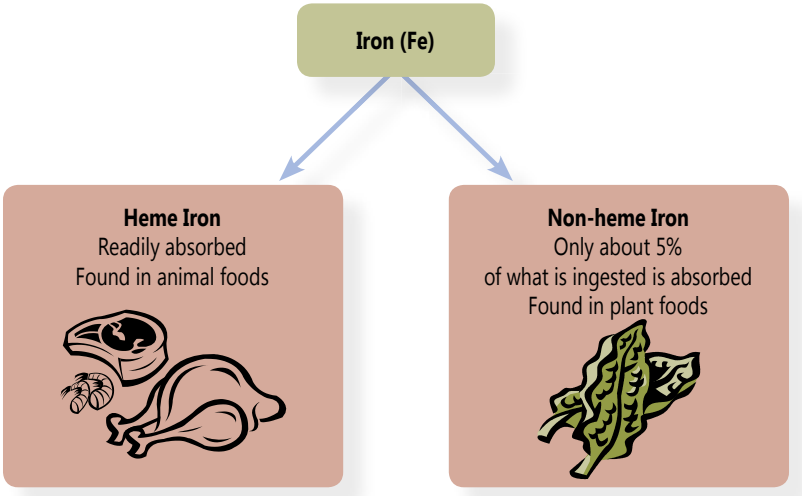
2.4 IRON DEFICIENCY

In 2005, 1 in 5 women and 1 in 7 children had poor iron status, and more than 1 in 3 women and children suffered from anaemia (NFCS-FB-I, 2008). The consequences of iron deficiency include a lack of energy, impaired concentration and memory (affecting learning ability), as well as an impaired immune system.

Iron is found in two forms: heme and non-heme iron. The body absorbs heme iron more easily than non-heme iron. Heme iron is found in animal foods such as lamb and mutton, beef, liver and other offal, pork and poultry. Only about 5% of non-heme iron, found in plant-based foods, supplements and fortification mixes, gets absorbed into the body. Red meat (a good source of heme iron), also increases the absorption of non-heme iron up to four times if consumed at the same meal. A significant proportion of the population consumes very limited amounts of red meat, rich in heme iron on a daily basis. This could be one of the factors contributing to the high prevalence of iron deficiency, despite mandatory fortification of staple foods. Read more on the bioavailability of iron in Chapter 4, page 23.

2.5 VITAMIN A DEFICIENCY

Vitamin A is required for many physiologic processes, including tissue growth, normal metabolism and resistance to infection (WHO, 2009). Vitamin A deficiency is a major public health concern, especially in lower income countries such as SA. In SA, 1 in 3 preschool children has a serum retinol concentration of 0.7µmol/L (SAVACG, 1996), and 55–68% of children aged 1–9 years consumed only 50% of the recommended dietary intake of vitamin A (700µg retinol equivalents) (NFCS, 1999). The main underlying cause of vitamin A deficiency is the insufficient consumption of bioavailable vitamin A from the diet. Read more on the bioavailability of vitamin A in Chapter 4, page 24.



Malnutrition is widespread in SA and includes both overnutrition (overweight and obesity), as well as undernutrition (energy, protein and micronutrient deficiencies). Industrialisation of our economy and subsequent urbanisation of the population have led to increased overweight and obesity due to lifestyle changes, yet micronutrient deficiencies remain persistent because of the intake of energy-dense, nutrient-poor foods. Informing the public on healthy, nutrient-dense food choices becomes an essential component of combatting malnutrition throughout South Africa.

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CHAPTER 3

THE SOUTH AFRICAN FOOD-BASED DIETARY GUIDELINES AND RED MEAT INTAKE

WHY IS THIS IMPORTANT?

√ The South African Food-Based Dietary Guidelines (FBDGs) were developed to be used as a consistent communication tool.

√ They represent expert agreement on how diet-related public health problems should be addressed by dietary recommendations to consumers.

√ Doctors, dietitians and nurses are considered the most trusted sources of nutritional information for South African consumers.

CHAPTER AT A GLANCE

√ Most foods can form part of a healthy diet.

√ Lean red meat, like South African lamb and mutton, can contribute significantly to meeting dietary needs of many nutrients, including iron, if eaten in the correct amounts.

√ Recommendations

- Previous South African FBDG: Chicken, fish, milk, meat or eggs can be eaten daily.
- Proposed revised South African FBDG: Fish, chicken, lean meat or eggs can be eaten daily.
- Up to 560g cooked lean red meat per week is recommended, which equals approximately 80g to 90g per day.

√ Consumption

- According to large national food consumption studies the average red meat intake of South Africans is below the recommended 80g to 90g per day (cooked edible portion).
- According to agricultural data (production and import of the raw unprocessed product), approximately 70g red meat, 100g white meat, 20g eggs and 20g fish are available per person per day in South Africa.

3.1 THE SOUTH AFRICAN FOOD-BASED DIETARY GUIDELINES

FBDGs are dietary recommendations based on foods and food patterns. They include a collection of short, positive, country-specific and science-based messages aimed to educate the general population on how to attain a prudent diet that will meet all nutrient requirements while simultaneously protecting against the development of noncommunicable diseases.

In 2003 the first set of South African FBDGs was adopted by the National Department of Health to form the basis of nutrition communication to the public. These guidelines were developed by the Nutrition Society of South Africa (NSSA) in partnership with the Department of Health, Directorate Nutrition (DoHDN), the Medical Research Council, and several other stakeholders from different United Nations Agencies and Food Producer's Organisations in South Africa.

In 2011 a national working group was established to revise these FBDGs to increase relevance to the rapidly urbanising South African population as well as address previous misinterpretations. In Table 3.1 the proposed revised dietary guidelines are compared to the previous set of eleven South African FBDGs.

Table 3.1 The reviewed South African Food-Based Dietary Guidelines compared to the previous guidelines

Previous South African Food-Based Dietary Guidelines (2003)	Proposed Revised South African Food-Based Dietary Guidelines (2012)
1. Enjoy a variety of foods	1. Enjoy a variety of food
2. Be active	2. Be active
3. Make starchy foods the basis of most meals	3. Make starchy food part of most meals
4. Eat plenty of vegetables and fruits everyday	4. Eat plenty of vegetables and fruit every day
5. Eat dry beans, peas, lentils and soy regularly	5. Have milk, maas or yoghurt every day
6. **Chicken, fish, milk, meat or eggs can be eaten daily**	6. Eat dry beans, split-peas, lentils and soya regularly
7. Eat fats sparingly	7. **Fish, chicken, lean meat or eggs can be eaten daily**
8. Use salt sparingly	8. Use fats sparingly; choose vegetable oils rather than hard fats
9. Drink lots of clean, safe water	9. Use salt and food high in salt sparingly
10. If you drink alcohol, drink sensibly	10. Drink lots of clean, safe water
11. Use food and drinks containing sugar sparingly and not between meals	11. Use sugar and food and drinks high in sugar sparingly

MEAT RECOMMENDATIONS

Optimal intake of foods from the meat and meat alternatives group are:

√ Up to 560 g lean red meat per week (approximately 80 – 90 g per day).

√ 2 to 3 fish dishes per week.

√ ± 4 eggs per week.

WHERE DO FOOD CONSUMPTION FIGURES COME FROM?

√ *Consumption surveys* are a direct method used to determine food intake. In South Africa there has been a lack of recent, large national consumption surveys cross-cutting gender, age, ethnicities and socioeconomic groups.

√ *Food balance sheets* report statistical data on production, import and export. For red meat, this is based on raw, whole carcasses. As little as 65% of this gets consumed, due to bone and cartilage loss, cooking losses (moisture and fat), plate loss etc.

3.2 RED MEAT INTAKE OF SOUTH AFRICANS

Urbanisation and westernisation is a growing trend in South Africa, with people continually moving from rural areas into urban settlements in the search of better work opportunities and income generation potential. These changes in lifestyle are often accompanied by an increase in the utilisation of animal source foods (Vorster, 2010). In contrast, factors such as the global recession, poverty, unemployment and food insecurity, may make it increasingly difficult for South Africans to purchase foods derived from animals, as such foods are more expensive than plant-based products.

Consumption surveys

There have been very few large, well-controlled, representative food consumption studies conducted in South African since 2000. Most of the studies conducted tended to concentrate on smaller population groups. Major surveys since 2000 include:

- The National Food Consumption Survey, Fortification Baseline (NFCS-FB-II), 2005.
- The ongoing Birth-To-Twenty (Bt20) Study at the University of the Witwatersrand which developed from the Birth-To-Ten Study (Bt10) initiated in 1990.
- The PURE Study (Prospective Urban and Rural Epidemiology study) which is coordinated from the Population Health Research Institute, Ontario, Canada, to track the development of chronic diseases in urban and rural subjects in approximately 20 developing countries.
- The study of the food intake of South African Indians conducted in Kwa-Zulu Natal (MacIntyre *et al.*, 2010), which provided the first insight into food intake of the Indian population since 1999.

In summary, the NFCS (1999) recorded a surprisingly high intake of meat (which probably also included chicken) and offal in children aged 1 to 9 years, with urban children consuming nearly 60g per day, and rural children 34g/day. The Bt20 study reported increased intakes of meat, particularly processed meat (sausages, hamburger patties, polony) with a high fat content by teenage black subjects living in the Soweto-Johannesburg metropolis. The majority of these 17-year-old subjects reported eating at least one fast-food item or meal per day. The PURE Study indicated that approximately three quarters of adult black men and women living in urban and rural areas consumed red meat (26g/day), and less than two thirds consume offal (18g/day). The Indian Study found that adult Indians living in Kwa-Zulu Natal ate mainly mutton (30g/day) and Indian women ate smaller quantities of offal (15g/day).

Red meat intakes of the South African population, as recorded in these studies, are all in line with the recommendations made by the Food-Based Dietary Guidelines allowing up to 560g red meat per week.

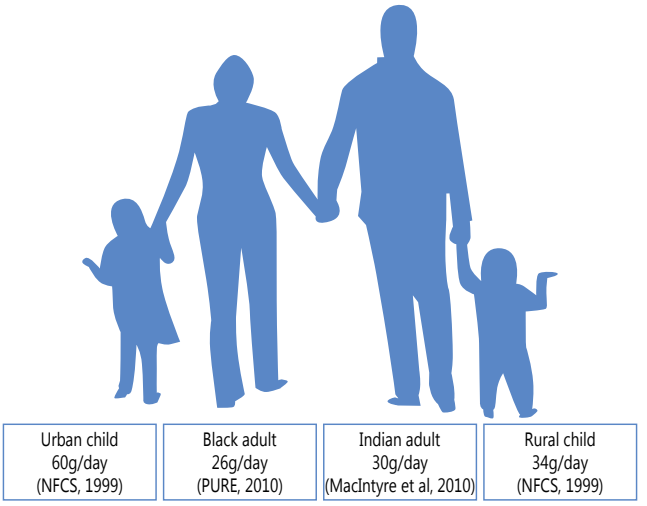

Figure 3.1 Average red meat intakes of South Africans based on recent consumption surveys

CONSUMPTION OF MEAT

National food consumption surveys:

√ There are a limited number of recent, nationally representative food consumption surveys for South Africa.

√ Most recent studies concentrate on small population groups.

√ Available consumption data indicate that the average red meat consumption by South Africans are in-line with the FBDG recommendation of 80g to 90g per day.

Food-balance sheets:

√ The Abstract of Agricultural Statistics (2012) reports in increase in the availability of beef, pork, chicken and eggs, but less lamb and mutton.

√ According to the latest South African production figures, there is approximately 70g red meat, 100g white meat, 20g eggs and 20g fish available per person per day.

√ These figures from agricultural data refer to raw carcass weight available per person and include bones and fat.

√ From slaughtering to consumption, up to 70% of the carcass goes to waste, including slaughtering waste, cooking loss, bones and dissectible fat.

Limitations of food consumption studies

Accurately quantifying the amount of meat consumed in the diet is problematic, as meat is typically consumed as part of a composite meal, often containing different proportions of non-meat components such as vegetables or starches (Cosgrove *et al.*, 2004). The food consumption studies performed in South African populations, although valuable, also had limitations:

- The paucity of studies conducted and published on nutrient/food intake in South Africa in the period 2000 to 2009 (Van Heerden & Schönfeldt, 2011).
- The skewed age emphasis of large studies.
- The emphasis on the black population, which while fully justified in terms of the demographics of this country, has resulted in a lack of relevant studies or publications reporting food intakes of white, coloured or Indian South Africans since the late 1990s.
- The lack of information gathered about the emerging black middle class.
- The heterogeneity of the South African population has always posed a problem in regard to food intake and nutrient surveys, and it continues to be a stumbling block.
- Most often, no definition of red meat is included, and 'meat' often includes white and red meat, offal (i.e. chicken feet), and bones which significantly affect the nutritional contribution of the product to the diet.

EXPERT OPINION

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"FBDGs are valuable tools which can be used to make healthful nutrition messages understandable to all citizens of a country without discrimination in terms of education or income. Red meat can make a valuable contribution to the diet of all South Africans provided it is used judiciously."

Food balance sheets

According to data extrapolated from the Abstract of Agricultural Statistics (Table 3.2) there was an increase in the last decade in beef, veal, pork, chicken and egg production and consumption, while sheep meat consumption, based on agricultural production data during the same period, has decreased.

Publications such as the Abstract of Agricultural Statistics, The South African Agricultural Baseline and FAO Fishery Statistical Collections from which the production and consumption data are extrapolated, provide broad statistical data on population, food production and consumption. Such statistics are used to obtain estimates of food consumption; however, these estimates are not fully representative of actual food intake. Food balance sheets are based on statistical data on the production, import and export of carcasses, and eventual shifts in stock. Due to the large quantity of material discarded prior to meat reaching the table for consumption (e.g. slaughtering loss, intestines, bones, cartilage and cooking losses) and at the table (e.g. trimmed fat, wastage), the apparent supply from this source will always be an overestimation of actual intake. From time of slaughter to actual consumption, up to 70% of the slaughtered products goes to waste (bone, fat, cooking loss, plate waste, etc.) (FAO, 2009). In Table 3.2 estimated actual consumption of animal products (including meat and offal) is calculated from the consumption data reported in the Agricultural Abstracts (2012) using yield factors to consider losses (Bognár, 2002).

Table 3.2 Estimated edible portion available for consumption, calculated from agricultural statistics using yield factors

Species	Raw product (g)/ capita/day	Yield factor (Cooking loss, bone, waste)	Estimated edible portion (g)/ capita/day
Beef + veal	46.8	±0.60	28.1
Pork	12.6	±0.60	7.56
Sheep + goat	8.0	±0.50	3.98
White meat	95.6	±0.40	38.3
Eggs	23.2	±0.90	20.9
Fish	20.8	±0.60	12.5

Furthermore, agricultural data, such as those reported in the Abstract of Agricultural Statistics (2012), do not differentiate between population groups and/or more/less affluent communities but present an average available to each individual in the total population per day. Table 3.3 compares the estimated values from the Abstract of Agricultural Statistics (raw slaughtered product and estimated cooked product available for consumption using yield factors) with values adopted from Food Consumption Surveys.

Table 3.3 Estimated food consumption data from agricultural statistics over the last decade compared to data adopted from National Food Consumption Surveys

Group (g/day)	2000/2001				2010/2011			
	Agricultural Statistics*		Food Consumption Surveys (1983-2000)#		Agricultural Statistics*		Food Consumption Surveys (2000 to 2010)&	
	Raw slaughtered product	Estimated edible portion	Children 1 to 5 yrs	Adults & Children 10+ yrs	Raw slaughtered product	Estimated edible portion	Children <9 yrs	Adults
Meat$	119	63.6	45	86	163	77.9	58	44-60
Fish	17	10.2	10	12	21	12.5	7	15
Eggs	19	17.1	7	15	23	20.9		16.5

$Meat value includes consumption of red and white meat, meat products and offal
*Abstract of Agricultural Statistics, 2012
#Nel & Steyn, 2002
&Van Heerden & Schönfeldt, 2011

R&D TOWARDS BETTER CONSUMPTION DATA

- √ There is a lack of nationally representative food consumption data to calculate the contribution of red meat in the diet of South Africans.
- √ South African Red Meat Research and Development (RMRDSA) is funding a large national consumption project to determine intake of animal products by South Africans.
- √ The study divides the South African population into three socio-economic groups based on living standards and a methodology specific to each groups has been developed to collect data.

The project aims to:

- √ Develop & update data collection tools for the different socioeconomic groups.
- √ Determine the contribution of red meat to the dietary intake of the South African population.
- √ Evaluate how nutrient contribution and delivery relate to the impact of the production of red meat on the environment.

In conclusion, there seems to be a need for comprehensive national food intake studies as limited national data is available to compare dietary intake to national guidelines. Such data will aid in the understanding of the current and progressing dietary intake patterns and make it possible to define the extent to which specific food groups to the nutritional quality of the diets of South Africans. Although sparse, the current studies indicate that the South African population consume quantities of red meat within the daily recommended amount of up to 560g of cooked lean red meat per week.

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CHAPTER 4

BIOAVAILABILITY OF NUTRIENTS – FOCUS ON PROTEIN, IRON AND VITAMIN A

WHY IS THIS IMPORTANT?

- √ Different types of food supply different amounts and forms of nutrients, in different proportions.
- √ Nutrients which are ingested through foods, but not released during the digestive process for absorption are of no nutritional value to the human body.
- √ Understanding nutrient bioavailability helps optimise diets and set appropriate nutrient recommendations.
- √ The bioavailability of macronutrients (carbohydrates, proteins, fats) is usually very high at more than 90% of the amount ingested.
- √ The bioavailability of micronutrients, i.e. vitamins and minerals, and bioactive phytochemicals (e.g. flavonoids, carotenoids) can vary widely in the extent they are absorbed and utilized (1% to 90%).

CHAPTER AT A GLANCE

Bioavailability refers to the extent to which a nutrient present in the food is available for absorption and utilization in the human body, i.e. the proportion of a nutrient that is absorbed from the diet and used for normal body functions.

- √ For *protein* to be adequately absorbed and utilized in the human body, all the essential amino acids (building blocks of protein) should be present (in the right proportions) in the meal. Animal based foods, like red meat, contain the correct proportions of all these essential amino acids and are called sources of complete protein.
- √ *Heme iron* is the most bioavailable form of iron, found only in animal products, with red meat and offal being excellent sources of heme iron.
- √ *Vitamin A* found in animal foods occurs as retinyl esters (retinol). The bioavailability of retinol is generally high (ranging from 70 to 90%) when compared to the bioavailability of other forms of vitamin A.

4.1 NUTRIENT BIOAVAILABILITY

The correct assessment of the adequacy of dietary intakes of nutrients requires not only knowledge of the nutrient content of the foods ingested, but also the extent to which the nutrient present in the diet is available for absorption and utilization.

Bioavailability is the technical term used to convey the fact that not 100% of nutrients ingested will be absorbed, irrespective of whether consumed in the form of food or supplements. Bioavailability aims to describe the effect of a sequence of metabolic events, including digestion, solubilisation, absorption, organ uptake and release, enzymatic transformation, secretion and excretion.

Enhancers of nutrient bioavailability

Nutrients can interact with one another or with other dietary components at the site of absorption, resulting in either a change in bioavailability or – if enhancers and inhibitors cancel each other out – a nil effect. Enhancers can act in different ways such as keeping a nutrient soluble or protecting it from interaction with inhibitors. For example, since carotenoids (pre-form of vitamin A) are fat-soluble, adding small quantities of fat or oil to the meal (3-5g per meal) improves their bioavailability. Similarly, meat, fish and poultry, while containing highly bioavailable iron themselves, are also known to enhance the absorption of iron from other foods ingested at the same time. Although this 'meat factor' has yet to be identified, it has been suggested that muscle protein exerts and influence.

Inhibitors on nutrient bioavailability

Inhibitors may reduce nutrient bioavailability by:

- Binding the nutrient in question into a form that is not recognized by the uptake systems on the surface of intestinal cells
- Rendering the nutrient insoluble and thus unavailable for absorption
- Competing for the same uptake system.

Phytic acid is highly abundant in certain plant foods (e.g. pulses, whole-grain cereals, seeds, nuts) and strongly binds minerals such as calcium, iron and zinc in soluble or insoluble complexes that are unavailable for absorption. Ways to reduce the phytic acid content of foods include fermentation (e.g. extensive leavening of wholemeal bread dough) or the soaking and germination of pulses.

The inhibitory effect of food constituents can also be used advantageously, as is done in the case of phytosterols. These natural compounds are extracted from certain plant foods and added in higher doses (about 2g per portion) to various other foods (for example enriched spreads, fermented milk drinks) to lower the absorption of cholesterol, be it from dietary sources or produced in the human body.

The following components describe the different steps of the metabolic pathway where changes in nutrient bioavailability may occur:

- release of the nutrient from the physiochemical dietary matrix
- effects of digestive enzymes in the intestine
- binding and uptake by the intestinal mucosa
- transfer across the gut wall (passing through the cells, in-between them or both) to the blood or lymphatic circulation
- systemic distribution
- systemic deposition (stores)
- metabolic and functional use
- excretion (via urine or faeces)

FACTORS INFLUENCING BIOAVAILABILITY

There are a number of factors which affect bioavailability:

External factors (factors contained in the food)

√ The chemical form in which the nutrient appears in the food.

√ The presence of other factors in the food that may enhance or depress absorption.

Internal factors (e.g. health, age, life stage and nutrient status of the host)

√ Gastro-intestinal factors, i.e. the functional decline of mucosa as may occur in the elderly and with certain conditions.

√ Systematic factors, i.e. in the case of a deficiency of a certain nutrient or changes in physiologic state (e.g. pregnancy) the body may respond by increasing the respective nutrient absorptive pathway or utilisation to meet the increased demand. In contrast, some inflammatory conditions or infections may reduce the absorptive capacity of the gut.

EXPERT OPINION

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"Knowledge of nutrient bioavailability is important in understanding of the role of nutrients in maintaining human health. Consumers continually change their dietary patterns due to health, economics, personal preferences or lifestyle changes. New food products are also introduced onto the market continually, increasing the range of products to choose from. Knowledge and understanding of nutrient bioavailability in addition to nutrient content is necessary to provide dietary guidance, and to translate this knowledge into optimal and desirable eating patterns and food choices."

4.2 PROTEIN QUALITY AND BIOAVAILABILITY

Although protein is a macronutrient which is considered to be easily absorbed into the human body, its bioavailability is directly linked to its digestibility. To be most bioavailable, a meal needs to supply all the required essential amino acids in the correct proportions.

Amino acids, the building blocks of proteins, containing sulphur (methionine and cysteine) most commonly limit the nutritive values of proteins in the human diet. These sulphur containing amino acid concentrations are generally considered lower in legumes and fruits than in animal foods. The roles of these amino acids in the human body are crucial, as methionine is the initiating amino acid in the synthesis of almost all eukaryotic proteins, and cysteine (due to its ability to form sulphur bonds), playing an important role in protein structure. Other indispensible amino acids, lysine and tryptophan, are consistently found at lower concentrations in plant-based foods, than in animal foods.

Research has shown that adding even small amounts of animal proteins to a plant-based diet can yield large improvements in maternal health and child development (Neumann *et al.*, 2003). Significant associations have been found between animal protein intake and lean mass, but no such association with vegetable protein intake has been reported. High quality protein in combination with micronutrients provided by lean meat intake, facilitates protein synthesis during active growth, repair such as after extreme physical activity, for normal growth and repair, and even in elderly individuals to postpone and treat sarcopenia (Paddon-Jones & Rasmussen; 2009).

4.3 BIOAVAILABILITY AND IRON

Minerals and other nutrients exist in different chemical forms in food and this can influence their bioavailability. A classic example is iron. We talk about two types of dietary iron, heme and non-heme iron. The former is only found in animal products such as red meat, fish and poultry, in which approximately 40% of the iron content is in the heme form. Foods of plant origin only contain non-heme iron.

Heme iron mainly stems from the haemoglobin and myoglobin molecules responsible for oxygen transport and storage in the blood and muscles, respectively. Once released from the food matrix, the heme molecule acts like a protective ring around the central iron atom. It shields the iron from interaction with other food components, keeps it soluble in the intestine, and is absorbed intact through a specific transport system on the surface of the gut cells. In contrast, non-heme iron is poorly soluble under intestinal conditions and easily affected by other components in the diet. Therefore only a small fraction of non-heme iron is taken up by the cells.

An example of competition for the same uptake system is the interaction between calcium and non-heme iron. Both minerals bind to a transporter on the surface of intestinal absorptive cells, but whereas non-heme iron enters the cells this way, calcium basically stays in the doorway and hinders further entry of the iron. This effect is mainly relevant when calcium and/or iron supplements are used outside the meal setting. Therefore, the best advice is to use those supplements at different times of the day so as to avoid this interference.

Vitamin C is also a strong 'helper', being able to increase iron absorption two- to threefold in both heme and non-heme food sources. This means, for example, having a glass of orange juice with a bowl of breakfast cereal would help the body to absorb more of the non-heme iron in the fortified cereal. Adding vitamin C containing foods, e.g. tomato sauce, to meat dishes rich in bioavailable heme iron will increase absorption to the greatest extent improving both the bioavailability of the heme and non-heme iron found in the dish.

SNAPSHOT: IRON

Why do we need iron?

√ Iron is a mineral essential for good health and wellbeing.

√ It helps carry oxygen to the brain and muscles, and maintains physical and mental activity.

How much iron do we need?

√ Requirements differ between age groups, gender and life stage (pregnancy).

√ The Regulations Relating to the Labelling and Advertising of Foodstuffs (No. R. 146 1 March 2010) states that **18mg iron** is required daily by individuals 4 years and older (Nutrient Reference Value or NRV).

√ According to other countries' national guidelines, pregnant women might need around 27mg iron per day, while men older than 19 years might need only 8mg per day.

Who needs iron the most?

√ Infants, children and teenagers to sustain rapid growth.

√ Women at childbearing age, due to monthly blood loss.

√ Pregnant women.

√ Athletes and very active people.

Until a nutrient passes from the digestive system into the bloodstream, it has little or no value. Although bioavailability is only a partial measure of the body's ability to benefit from a nutrient, this factor quantifies the amount of a substance that successfully enters the bloodstream. Once in the bloodstream, the nutrient must cross cellular membranes before it can nourish body cells. Although red meat is a nutrient-dense food, i.e. contains many nutrients in ample amounts, it also contains many of these nutrients in their most bioavailable forms, i.e. protein, iron and vitamin A.

4.4 BIOAVAILABILITY AND VITAMIN A

Although an essential nutrient needed in only small amounts, vitamin A is necessary for normal functioning of the visual system; growth and development; and maintenance of epithelial cellular integrity, immune function and reproduction. Vitamin deficiency disorders occur when body reserves are depleted to the limit at which physiological functions are impaired (O'Byrne & Blaner; 2005). Vitamin A in the diets of most human communities comes from a very wide variety of plant and animal sources. In the more industrialised countries over two-thirds of dietary vitamin A is derived from animal sources as preformed vitamin A, whereas in developing countries, communities depend primarily on provitamin A carotenoids from plant sources.

Preformed vitamin A in animal foods occurs as retinyl esters (retinol) of fatty acids in association with membrane-bound cellular lipid and fat-containing storage cells. Normal digestive processes free vitamin A from the food matrices. Vitamin A is absorbed more efficiently from animal products than from vegetable tissues (Blomhof, 1994). Products of fat digestion (e.g., fatty acids, monoglycerides, cholesterol and phospholipids) and secretions in bile (e.g., bile salts and hydrolytic enzymes) are essential for the efficient solubilisation of retinol. If not immediately needed, retinol is re-esterified and retained in the fat-storing cells of the liver.

When vitamin A intake is adequate, more than 90% of total body vitamin A is located in the liver, which releases the nutrient into the circulation when needed. Factors such as dietary fat, intestinal infections, the food matrix, and food processing can affect the absorption of vitamin A by the body. Dietary fat appears to enhance absorption, whereas absorption is reduced in individuals with diarrhoea, intestinal infections and infestations.

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CHAPTER 5

THE ROLE OF RED MEAT IN WEIGHT MANAGEMENT

WHY IS THIS IMPORTANT?

- √ Overweight and obesity are major risk factors for chronic diseases such as cardiovascular disease, type 2 diabetes and some cancers.
- √ Obesity is increasing globally and is no longer restricted to affluent countries with the majority of South African adults being either overweight or obese.
- √ Individuals base decisions regarding nutrition on the knowledge they have gained throughout their life (De Boer *et al.*, 2007).
- √ Although science is in its nature innovative, and information is updated regularly, most individuals continue to base their decisions on information they have learned in the past.
- √ This may be due both to the lack of communication or misinterpretation of new data, or confusion and scepticism on what to believe due to the lack of credible information available from public sources (Patterson *et al.*, 2001; Van Dillen *et al.*, 2003).
- √ Health professionals are considered the most trustworthy source of nutrition information, and it is therefore imperative that they communicate the most recent findings to consumers.

CHAPTER AT A GLANCE

- √ Controlled energy intake with moderately increased protein intake has shown to increase and maintain weight loss.
- √ Lean red meat, including South African lamb and mutton, is low in fat and high in protein, and is thus suitable as part of a weight-reducing diet.
- √ An 80g to 90g serving of lean South African lamb or mutton contains more than 20g protein, and less than 10g fat, the remainder being moisture, micronutrients and small amounts of carbohydrates.
- √ Protein increases satiety and thermogenesis and favours the retention of lean muscle mass.

RED MEAT AND SATIETY

- √ Satiety is defined as the sensation of fullness that persists after eating until hunger returns (Benelam, 2009).
- √ There has been great interest in the manipulation of satiety in order to control energy intake and body weight.
- √ Many studies have found that higher protein meals significantly increase satiety compared to low protein meals (1 to 24 hours) (Wyness *et al.*, 2011).
- √ In diets where energy intake is unrestricted, increased consumption of high protein foods are associated with lower body weight (Halton & Hu, 2004).

5.1 OVERWEIGHT AND OBESITY IN SOUTH AFRICA

Obesity, with its co-morbidities such as metabolic syndrome and cardiovascular diseases, is a growing public health concern around the world, with significant statistics reported for South Africans (SADHS, 2003; Ammerman *et al.*, 2006).

To address this problem, it is imperative to identify treatment interventions that target a variety of short- and long-term mechanisms. An energy appropriate, nutrient-dense total diet that includes minimally processed and fibre-rich foods helps to support a healthy body weight throughout the life cycle (McNeill & Van Elswyk, 2012). Although any dietary or lifestyle change must be personalized, controlled energy intake in association with a moderately elevated protein intake may represent an effective and practical weight loss strategy (Paddon-Jones *et al.*, 2008).

Health problems associated with being overweight have escalated during the last 10 years, and even more recently within developing countries. Currently, overweight and obesity are linked to more deaths worldwide than underweight (WHO, 2012). In 2008, more than 1.4 billion adults were overweight, and in 2010 40 million children under the age of five years were overweight (WHO, 2012). In South Africa in 2003, 56.2% of the adult population was recorded as being either overweight or obese (SADHS, 2003), with many smaller studies indicating increasing numbers of overweight and obese individuals over the past decade.

5.2 FACTORS CAUSING OBESITY

It is well known that lifestyle and nutrition choices of individuals influence the occurrence of obesity. Individuals are increasingly becoming more aware of the fact that eating a healthy nutrient-dense, energy controlled diet and participating in more physical activity to increase energy expenditure will decrease the chance of becoming overweight.

Obesity is a complex disorder with a diverse range of causal factors, including metabolic (e.g. control of food selection) and behavioural (e.g. binge eating or limited physical activity) traits (Butland *et al.*, 2007). One undeniable fact, however, is that for an individual to become obese, **energy intake must be higher than energy expenditure for an extended period of time**. This means that either more energy than needed is consumed and/or that too little energy is used by the body because of a lack of physical activity. In general, weight gain seems to be a result of a combination of both increased energy intake and decreased energy expenditure.

Table 5.1 Energy intake and expenditure in relation to weight management

Maintaining weight	**In balance** – Energy consumed through food and drink is equal to energy spent
Gaining weight	**Energy excess** – Energy consumed is exceeding energy spent, and the body deposits excess energy in fat storage cells
Losing weight	**Energy deficit** – Energy consumed is less than energy spent, thus the body is forced to burn fat in storage cells as energy

5.3 RED MEAT AND OBESITY

Red meat contains high biological value protein and important micronutrients required for optimal body functioning, but red meat is a source of fat and contributes to the intake of total fat and saturated fatty acids in the diet. As a result of consumer demand, the fat content of South African red meat has decreased to less than 10g per 90g portion through breeding, farming and butchering techniques. Refer to Chapter 1, page 3, for detailed information on the nutrient content of South African lamb and mutton and how the fat content of red meat has decreased over time.

Contrary to popular belief, lean red meat such as South African lamb, mutton and beef, compares favourably in terms of fat content to other animal source foods including chicken with, or without the skin. Red meat, including South African lamb and mutton, contains less than 10% fat when trimmed (refer to Chapter 6, page 46 for the fat content of various South African animal products).

It is important to maintain or reduce the fat content of the protein source. This can be done through choosing lean cuts, trimming visible fat (including skin) prior to consumption and limiting the addition of fats or oils during cooking or basting. It is also important to keep within recommended portion size and spread protein intake throughout the day to increase the benefit of satiety derived from the protein and moderate fat content.

RECENT CLINICAL INTERVENTION STUDIES

- √ Several studies conducted in overweight or obese men and women indicate equivalent weight loss when comparing diets rich in lean red meat vs. chicken/fish or carbohydrates (Campbell & Tang, 2010; Leslie *et al.*, 2002; Belobrajdic *et al.*, 2010; Benassi-Evans *et al.*, 2009).
- √ Studies of beef in weight loss diets for overweight and obese women report equivalent results with weight loss diets rich in chicken or fish, carbohydrates, fat and vegetable protein (Campbell & Tang, 2010; Melanson *et al.*, 2003; Mahon *et al.*, 2007; Yamashita *et al.*, 1998).
- √ Higher protein diets (>15%) promote weight loss, improve body composition and promote long-term weight maintenance to a greater extent than lower protein diets (Layman, 2010).
- √ A meta-analysis of 5 trials including 447 individuals following a low carbohydrate diet (not restricted in protein, fat or energy) lost more weight than individuals on low-fat diets (Nordmann *et al.*, 2006).

5.4 RED MEAT AND WEIGHT LOSS

To lose weight, an energy deficit is required, either through an increased energy expenditure of the host (increased physical activity), or a decrease in the energy intake (controlled dietary consumption). Conventionally, fat intake is often limited in energy controlled diets, as fat contributes more than double the kilojoules per gram when compared to protein or carbohydrates. As dietary fat comes from a variety of sources, the fat content of the diet as a whole needs to be reduced. The target recommendation is that no more than 35% of total food energy (total kilojoules ingested) should be from fat.

In addition to controlling fat intake, there is ample evidence suggesting that diets restricted in carbohydrates and with a stronger emphasis on protein intake can aid weight loss. Some of the reasons why red meat may help decrease weight include the increased satiating properties of protein which may explain decreased food intake (Benelam, 2009), as well as the effect that increased protein intake has on thermogenesis, body composition and decreased energy efficiency (Wyness *et al.*, 2011). It should be noted that although low-carbohydrate, high-protein diets may support weight loss in the short-term, a diet that is very restricted in carbohydrate-containing foods is not desirable over a longer period of time, as cutting out a whole food group can result in low intakes of important nutrients. Keeping this in mind, the most adequate weight loss diet, that provides all the nutrients necessary for optimal bodily functioning, is an energy-restricted diet that provides a moderately increased proportion of protein (30% of dietary energy) and a moderately decreased proportion of carbohydrates (40% of dietary energy), with fat intake limited to 30% of total energy intake.

VEGETARIANISM

- √ A review of 31 observational studies reported bodyweight to be lower in vegetarians compared with non-vegetarians at a range of 4–20% (Berkow & Barnard, 2006).
- √ It is difficult to establish the factors contributing to lower bodyweight, but vegetarians often tend to be more health conscious than non-vegetarians, leading an overall healthier lifestyle, including more physical activity and health-conscious dietary choices (Phillips, 2005).
- √ Research has shown that parents should be more aware and guide children in making a healthy food choice when they decide to follow a vegetarian lifestyle, as they often choose high fat, processed and pre-prepared vegetarian alternatives in combination with a low consumption of fruit, vegetables and dairy.

5.5 THE POWER OF PROTEIN

Protein is the dietary component that evokes the widest array of complex scientific, economic, environmental and political issues. It is the most expensive component of any diet, and is an essential part of a healthy balanced diet.

A high intake of the amino acid leucine and providing more than 1.2g protein/kg body weight per day, or a minimum of 30g protein at each of three daily meals, have been shown to promote muscle health and long-term weight (Layman, 2010). Evidence has shown that adding even small amounts of animal protein to a plant-based diet can yield large improvements in maternal health and child development, as plant-based diets are often low in normally limited amino acids, including lysine and the sulphur containing amino acids (methionine and cysteine). Recommended intakes for protein are presented in Table 5.2.

Table 5.2 Recommended daily protein intake (g/kg body weight) per population group

Group	g/kg body weight/day
Population average	0.66
Sedentary people	0.8 – 1.0
Recreational exercisers	0.8 – 1.0
Athletes in early phase of training	1.5 – 1.7
Athletes in established programme	1.0 - 1.2
Serious endurance athletes	1.2 – 1.6
Adolescent athletes	1.5 – 2.0
Female athletes	15% less

EXPERT OPINION

Prof Timothy Noakes (MBChB, MD, DSc, FACSM, (hon) FFSEM (UK)) is a Professor in the Discovery Health Chair of Exercise and Sports Science at the University of Cape Town and Director of the UCT/MRC Research Unit for Exercise Science and Sports Medicine, and co-founder of the Sports Science Institute of South Africa (SSISA). He is a well-known A-rated scientist and has authored numerous scientific books and papers.

"In 2011 a Cochrane report, the highest, independent judge of what is the scientific "truth" concluded that there is no evidence that saturated fat in the diet causes heart disease or that reducing the fat content of the diet is a proven method of preventing such disease. The greatest casualties of the unfortunate and unproven low fat "prudent" heart-healthy diet, first promoted in 1977 as part of a USDA initiative to produce cheap carbohydrate-rich foods in excess, have been the meat, dairy and egg producers. It is time to call an end to this non-science and again to promote the eating of those real foods that sustained humans in a state of far greater health in the first half of the 20th Century, before the US Government single-handedly and without proper scientific proof, declared these foods unhealthy. This action plunged humans in the developed and developing worlds into the worst dietary mess in recorded history (or at least since the development of agriculture 12000 years ago)."

What is protein?

- Protein is made up of chemical units called amino acids.
- Protein substances make up the muscles, tendons, organs, glands, nails and hair. Growth, repair and maintenance of all cells are dependent upon protein.
- Next to water, protein makes up the greatest portion of our body weight.
- Amino acids that must be obtained from the diet are called essential amino acids.

Sources of protein

- Protein can be derived from both plant and animal sources.
- Animal source foods, especially lean red meat, in general, contain the greatest *quantity* of protein per edible portion (Table 5.3).
- Animal protein is considered the best *quality* protein, providing all the essential amino acids in adequate amounts.

Table 5.3 Protein content of selected South African food products (Schönfeldt *et al.*, 2012; Wolmarans *et al.*, 2010; Schönfeldt *et al.*, 1996)

Food products (100g edible portion)	Protein (g)
Meat & meat products	
Lamb, trimmed (lean)	24.8
Lamb, untrimmed	22.8
Mutton, trimmed (lean)	25.7
Mutton, untrimmed	24.3
Beef, untrimmed	27.7
Chicken, white meat, roasted	29.4
Chicken, dark meat, roasted	25.4
Fish, hake, steamed	20.0
Egg, whole, boiled	12.6
Dairy	
Cheese, cheddar	24.7
Milk, whole, fresh	3.2
Vegetables & fruit	
Broccoli, boiled	2.2
Potato, baked	1.9
Banana	1.3
Cereals	
Bread, brown, fortified	9.0
Bread, white, fortified	8.8
Rice, white	2.7
Rice, brown	2.6
Maize, soft, fortified	1.1
Legumes	
Soybeans, dried, cooked	16.6
Lentils, split, cooked	9.0
Chickpeas, dried, cooked	8.9
Beans, white kidney, dried, cooked	7.8
Baked beans in tomato sauce	4.8

Protein has been shown to promote healthy weight maintenance and weight loss as part of an energy controlled diet because of various factors, including its satiating effects. To keep energy intake from red meat low, consumers should be advised to choose lean or trimmed red meat cuts, to trim visible fat from meat at home, and utilize healthy cooking methods, i.e. avoid frying, adding high kilojoule basting sauces or fatty condiments, etc. Yet, meat is always consumed as part of a meal, and the composition of the red of the food on the plate should not be neglected when healthy choices are made. Portions of food consumed with meat, i.e. vegetables and starch dishes, could contribute significantly more energy and fat than the meat portion depending on the type of ingredients selected and what recipes are used.

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CHAPTER 6
RED MEAT AND CANCER

WHY IS THIS IMPORTANT?

- √ Worldwide, cancer kills more people every year than AIDS, tuberculosis and malaria combined.
- √ In 2001, 1 in 6 men, and 1 in 8 women had a lifetime risk of developing cancer (NHLS, 2012).
- √ Usually various factors act together or in sequence to initiate or promote carcinogenesis, including dietary choices.

CHAPTER AT A GLANCE

- √ A critical review of thousands of epidemiologic studies found the totality of the available scientific evidence not supportive of an independent association between red meat or processed meat and cancer.
- √ The link between cancer and red meat consumption is likely to be in relation with other westernised lifestyle factors, including obesity and low physical activity, increased consumption of refined foods, alcohol and smoking and a decreased consumption of vegetables and fruits.
- √ A moderate amount of red meat (up to 500g cooked) is recommended by the World Cancer Research Fund (1997), in line with the recommendation of the South African Food-Based Dietary Guidelines.

6.1 OVERVIEW OF CANCER

In normal cells, division is controlled and new cells are only formed for growth or to replace dead cells. Cancerous cells divide repeatedly out of control and crowd out normal cells, which can destroy the functioning of major organs.

A whole series of changes has to occur to lead to the final stages of cancer. Cancer develops from one single cell by mutation in DNA. DNA damage can be caused by radiation, or inhaled or consumed as chemicals. Normally, mutated DNA will be repaired by enzymes in the human body. Cancer thus only develops if DNA is extensively damaged and over a long time, or if cells are ineffective in repairing mutated DNA.

6.2 CAUSES AND PREVENTION OF CANCER

A plethora of studies have investigated the association between environmental and lifestyle factors, including dietary factors, and the risk of cancer. It has been suggested that cancer is a largely preventable disease, with the World Cancer Research Fund and the American Institute for Cancer Research (2007) describing changes in the rates of different cancers in genetically identical populations that migrate from native countries to other countries around the world. Patterns of production and consumption of food and drink, physical activity and body composition have changed significantly over time (WCRF/AICR, 2007).

Most changes are in-line with urbanisation and industrialisation and in South Africa these changes often go hand in hand with acculturation from traditional cultures and habits to westernised cultures and habits. Studies consistently show changes in patterns of cancer development as populations shift, and projections indicate that rates of cancer are liable to increase as countries progress towards westernised diets.

Cancer, however, remains a disease of genes which are vulnerable to mutation, particularly over the increasing human lifespan (WCRF/AICR, 2007). Yet, only a small proportion of cancers are inherited while environmental factors have been proven to be the most important contributors and can be modified.

External factors include tobacco, chemicals, radiation, infectious organisms, etc., while internal factors include genetic mutations, hormones, immune conditions, metabolism mutations, etc. Normally various factors act together or in sequence to initiate or promote carcinogenesis, and it should be remembered that no single study can prove that any single factor is a cause of, or is protective against, any specific type of cancer. Therefore, as listed in Table 6.1, risks should be considered against prevalence to provide insights which drive suitable guidance.

Table 6.1 The most common risk factors for the development of cancer

Ranking	Risk Factor
1	Growing older
2	Tobacco
3	Sunlight
4	Ionizing radiation
5	Certain chemicals and other substances
6	Some viruses and bacteria
7	Certain hormones
8	Family history of cancer
9	Alcohol
10	Poor diet, lack of physical activity, or being overweight

INCIDENCE OF CANCER

√ More than 13% of all deaths globally are related to cancer (WHO, 2012).

√ It is estimated that about 70% and rising of all cancer deaths occur in industrialised countries with the incidence rising (WHO, 2012).

√ In 2001, cancer was the 2nd leading cause of death in developed countries, and the 3rd leading cause of death in developing countries (Cancer Resource UK, 2005).

√ The burden of cancer is increasing in developing countries as childhood mortality declines and more people live to older ages while adopting western lifestyles, such as smoking, higher consumption of saturated fat and energy dense foods, and reduced physical activity (American Cancer Society, 2007).

South African statistics (NHLS, 2012)

√ 1 in 6 men have a lifetime risk of getting cancer:
- Prostate cancer (1 in 23)
- Lung cancer (1 in 69)
- Esophageal cancer (1 in 82)
- Colorectal cancer (1 in 97)

√ 1 in 8 women have a lifetime risk of developing cancer:
- Breast cancer (1 in 29)
- Cancer of the cervix (1 in 35)
- Colorectal cancer (1 in 162)

6.3 RED MEAT AND CANCER

Numerous international studies have looked at the association between environmental and lifestyle factors, including dietary factors, and the risk of developing cancer. To ascertain if there is a link between red meat and processed meat and cancer, it must first be noted that this association is complex and involves various factors related to the nutrient composition of meat, methods of processing and/or preparation, not ignoring the accountability of other lifestyle patterns and choices that may impact on the risk of cancer (Alexander *et al.*, 2010).

The most common cancers investigated in relation to red meat consumption include bowel, colorectal, oesophagus, stomach, lung, pancreas, endometrium and breast cancer. Cancers of the colon and rectum (colorectal cancer) are the third most common type of cancer worldwide, and rates of this type of cancer increases with industrialisation and urbanisation (WCRF/AICR, 2007). Food and nutrition play an important role in the prevention and causation of colorectal cancer. The Colorectal Cancer Report Summary concluded convincing evidence that red meat, processed meat and ethanol from alcoholic drinks, body fatness and abdominal fatness, are causes of colorectal cancer (WCRF/AICR, 2007). The report furthermore recommends that people should consume less than 500g cooked meat per week (700 to 750g raw) to reduce risk of cancer from red meat. This amount is in line with the South African Food-Based Dietary Guidelines, and limited data available indicate that on average the South African population consume values well below this amount of red meat.

In 1997 the WCRF concluded that red meat *probably* increases risk of cancer, while stating that processed meat and cooking meat at high temperatures *possibly* increases risk. Their report recommended that red meat be limited to 80g per day (WCRF/AICR, 1997), and encouraged relatively low temperatures when cooking red meat.

In 2007, the WCRF (WCRF/AICR, 2007) explored further advancements in science to determine the extent to which food, nutrition and physical activity, modify the risk of cancer. It was concluded that both red meat and processed meat *convincingly* increases risk for colorectal cancer, and red meat possibly increases risk for cancers of the oesophagus, lungs and pancreas. A summary of the strength of the evidence causally linking specific foods and lifestyles to cancer risk are presented in Table 6.2.

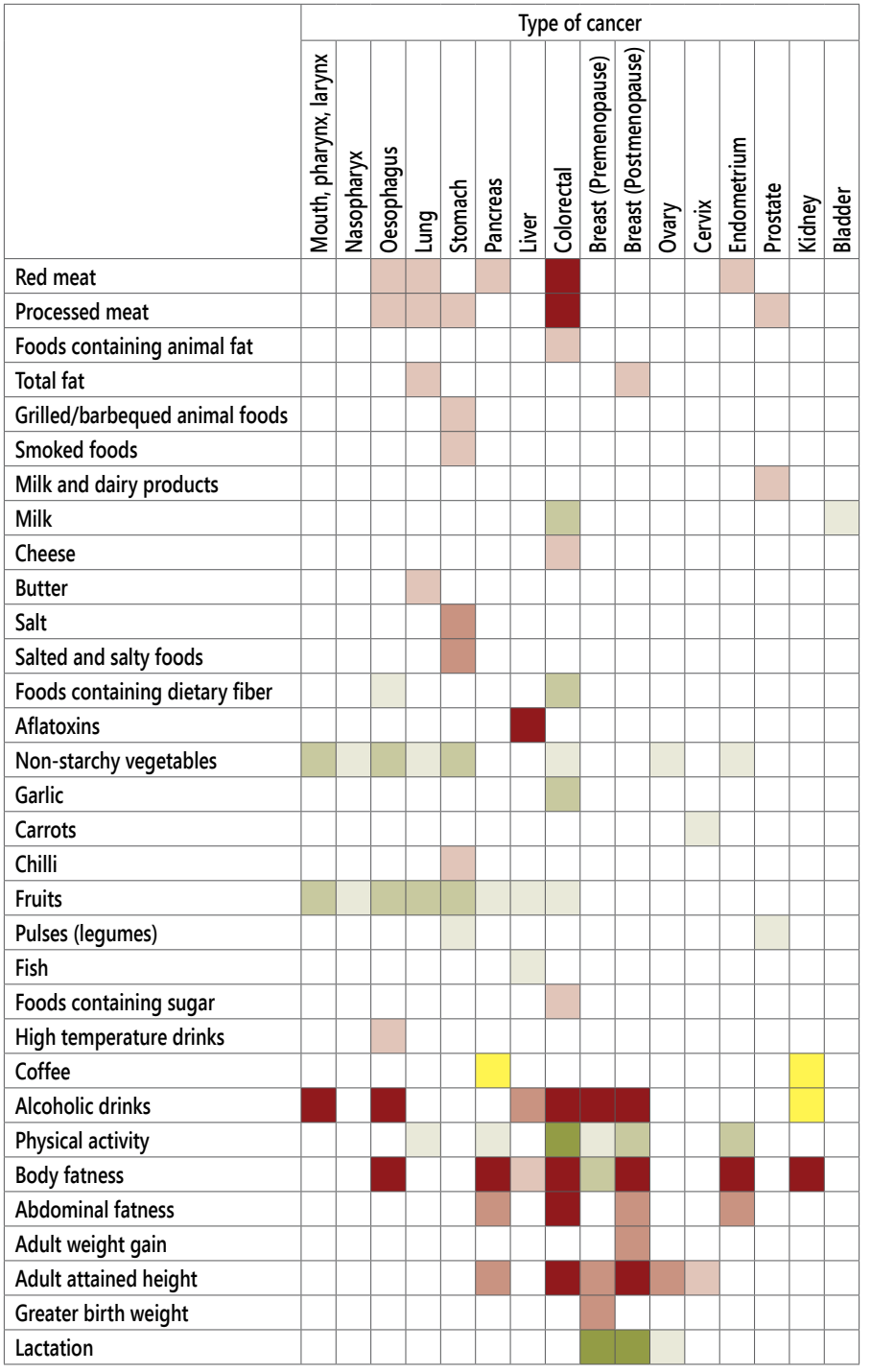
A technical summary of the epidemiological evidence on red and processed meat consumption and cancer (Alexander *et al.*, 2010) evaluated the relationship between red/processed meat intake and cancer in thousands of epidemiologic studies. With critical consideration of the extensive methodological, analytical and biological challenges, they concluded that:

- The totality of the available scientific evidence is not supportive of an independent association between red meat or processed meat and cancer.
- No single epidemiological study was sufficient to make a conclusion of causality.
- Most associations made between consumption and increased risk were weak in magnitude, not statistically significant, zero or inverse.
- Patterns of association varied by gender and anatomic location of tumours.
- Measures of intake and analytical comparisons were variable between studies.

6.4 RECOMMENDATIONS

The recommendations of the World Cancer Research Fund and the American Institute for Cancer Research (2007) were based on convincing judgements, and are proposed to form the basis for public policies and are expected to reduce the incidence of cancer for people, families and communities. In Table 6.3 these recommendations are reported together with justifications, public health goals and personal recommendations. These recommendations also apply to cancer survivors, except in particular situations i.e. if treatment has compromised gastrointestinal function. In addition to these recommendations, it is vital to emphasize the importance of not smoking and avoiding exposure to tobacco smoke, as well as maintaining a healthy body weight (BMI) and exercising. For red meat, the guideline related to animal foods recommends people to **limit intake of red meat to 500g cooked meat per week (700 to 750 raw)** and to avoid processed meat.

Table 6.2 Strength of the evidence causally relating food, nutrition and physical activity with the risk of cancers (Adopted from WCRF/AICR, 2007)



Convincing decreased risk	Convincing increased risk	Substantial effect on risk unlikely
Probable decreased risk	Probable increased risk	
Limited-suggestive decreased risk	Limited-suggestive increased risk	

Table 6.3 Recommendations to reduce the incidence of cancer (Adopted from WCRF/AICR, 2007)

	Justification	Recommendation	Public Health Goals	Personal Recommendations
Body Fatness	Maintenance of healthy body weight throughout life might be one of the most important ways to protect against cancer, along with a number of other common chronic diseases.	**Be within the normal range[1] of body weight**	Median adult body mass index (BMI) to be between 21 and 23. The proportion of the population that is overweight or obese to be no more than the current level, or preferably lower, in 10 years.	Maintain body weight throughout life. Avoid weight gain and increase in weight circumference throughout adulthood.
Physical Activity	Most people living in industrialised and urban settings have habitual levels of activity below levels to which humans are adapted.	**Be physically active as part of everyday life**	The proportion of the population that is sedentary[2] to be halved every 10 years. Average physical activity levels (PALs)[2] to be above 16.	Be moderately physically active, equivalent to brisk walking, for at least 30 minutes every day. As fitness improves, aim for 60 minutes or more of moderate, or for 30 minutes or more of vigorous physical activity every day. Limit sedentary habits such as watching television.
Foods and drink that promote weight gain	Consumption of energy-dense foods and sugary drinks is increasing globally and is probably contributing to the increase in obesity.	**Limit the consumption of energy-dense foods and avoid sugary drinks**	Average energy density of diets to be lowered to 945kj per 100g.[3] Population average consumption of sugary drinks to be halved every 10 years.	Consume energy-dense foods sparingly. Avoid sugary drinks. Consume 'fast-foods'[4] sparingly, if at all.
Plant foods	An integrated approach to the evidence shows that most diets that are protective against cancer are mainly made up from foods of plant origin.	**Eat mostly foods of plant origin**	Population average consumption of non-starchy vegetables and fruits to be at least 600g per day. Relatively unprocessed cereals, pulses (legumes) and other foods that are natural sources of dietary fiber, should contribute to a population average of at least 25g non-starch polysaccharides daily.	Eat at least five portions of a variety of non-starchy vegetables and fruits every day. Eat relatively unprocessed cereals and pulses (legumes) with every meal. Limit refined starchy foods.
Animal foods	An integrated approach to the evidence shows that many foods of animal origin are nourishing and healthy if consumed in modest amounts.	**Limit intake of red meat and avoid processed meat**	Population average of cooked red meat to be no more than 300g a week (400-450g raw), very little if any of which to be processed.	People who eat red meat to consume less than 500g cooked red meat per week (700 – 750g raw), very little if any to be processed.
Alcoholic drinks	The evidence on cancer justifies a recommendation not to drink alcoholic drinks. Other evidence shows that modest amounts of alcoholic drinks are likely to reduce the risk of coronary heart disease.	**Limit alcoholic drinks**	Proportion of the population drinking more than the recommended limits to be reduced by one third every 10 years.[5]	If alcoholic drinks are consumed, limit consumption to no more than two drinks a day for men and one drink a day for women.[5,6]

	Justification	Recommendation	Public Health Goals	Personal Recommendations
Preservation, processing & preparation	The strongest evidence on methods of preservation, processing and preparation shows that salt and salt-preserved foods are probably a cause of stomach cancer, and that foods contaminated with aflatoxins are a cause of liver cancer.	**Limit consumption of salt and avoid mouldy cereals (grains) or pulses (legumes)**	Population average consumption of salt from all sources to be less than 5g (2g sodium) per day. Proportion of the population consuming more than 6g of salt (2.4g sodium) a day to be halved every 10 years. Minimise exposure to aflatoxins from mouldy cereals and pulses (legumes).	Avoid salt-preserved, salted, or salty foods and preserve foods without salt. Limit consumption of processed foods with added salt to ensure an intake of less than 6g (2.4g sodium) a day. Do not eat mouldy cereals (grains) or pulses (legumes)
Dietary Supple-ments	High-dose nutrient supplements can be protective or can cause cancer. Increasing the consumption of beneficial nutrients through food is preferred.	**Aim to meet nutritional needs through the diet alone**[7]	Maximise the proportion of the population achieving nutritional adequacy without dietary supplements.	Dietary supplements are not recommended for cancer prevention.
Breast-feeding	The evidence on cancer, as well as other diseases shows that sustained, exclusive breastfeeding is protective for the mother as well as the child.	**Mothers to breastfeed; children to be breastfed**	The majority of mothers to breastfeed exclusively for 6 months.[8,9]	Aim to breastfeed infants exclusively up to six months and continue with complementary feeding thereafter.
Cancer Survivors	All these recommendations also apply to cancer survivors, unless in specific cases, i.e. if treatment has compromised gastrointestinal function.	**Follow the recommendations for cancer prevention**	All cancer survivors should receive nutritional care from an appropriate trained professional. If able to do so, and unless otherwise advised, aim to follow the recommendations for a balanced diet, healthy weight, and physical activity.[10]	

[1]Normal range refers to appropriate ranges issued by national government or the World Health Organization.
[2]The term 'sedentary' refers to a PAL of 1.4 or less. PAL is a way of representing the average intensity of daily physical activity. PAL is calculated as total energy expenditure as a multiple of basal metabolic rate.
[3]Energy-dense foods are defined as foods with an energy content of more than 945kj per 100g.
[4]The term 'fast-foods' refers to readily available convenience foods that tend to be energy-dense and consumed frequently and in large portions.
[5]Children and pregnant women should not consume alcoholic drinks.
[6]One 'drink' contains about 10 to 15 grams of ethanol.
[7]This may not always be feasible. In some illnesses or dietary inadequacy, supplements may be valuable.
[8]'Exculisvely' means human milk only, with no other food or drink, including water.
[9]In accordance with the UN Global Strategy on Infant and Young Child Feeding.
[10]This recommendation does not apply to those who are undergoing active treatment.

EXPERT OPINION

Dr Carl Albrecht (PhD) is the Head of Research at the Cancer Association of South Africa (CANSA) and the first Cancer Research Advocate in South Africa helping to translate cancer research results into policy.

"CANSA's main message concerning diet and cancer avoidance is to eat and drink moderately using a balanced and varied diet. We also emphasise avoiding carcinogens and emerging carcinogens such as BPA, PAHs, acrylamide, aflatoxin, plasticisers and too much sodium nitrite that can form nitrosoamines. At the same time we recognise that to lower the risk of cancer, our cells must be exposed to natural balances of nutrients that existed when our biochemistry was evolving. An important example is the need for sufficient omega-3 essential oils (ALA, DHA and EPA) compared to a possible overload of omega-6. This particular balance of about two to one for omega-6 to omega-3 also holds for meat. Our dietary vigilance must continue to involve the most crucial aspect of the entire eating exercise, namely our cooking methods, especially of red meat cooked over an open fire. Although this extremely popular pastime may kindle Neolithic nostalgia it is a dangerous exercise because pyrolysis products of meat, such as PHAs, have been linked to prostate, colorectal and pancreatic cancers in epidemiological studies. From this it is clear that the moderate consumption of red meat per se is not the problem. The real problem is what we do to this meat before eating it."

A balanced diet builds upon the foundation of healthful foods from a variety of food groups, including whole grains, fruit, vegetables, dairy products and lean meats. In order to promote a healthy cancer-fighting diet, emphasis should be placed on a varied diet rich in vegetables, fruit and other fibre rich foods in combination with a moderate intake of lean red meat. Caution should be placed on other Westernised lifestyle habits such as the consumption of refined sugars, processed foods, alcohol and smoking.

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CHAPTER 7
RED MEAT AND FAT

WHY IS THIS IMPORTANT?

√ Fats and fatty acids are key nutrients that affect early growth and development and nutrition-related chronic disease later in life.

√ Dietary fats provide the medium for the absorption of fat-soluble vitamins, are a primary contributor to the palatability of food, and are essential to development and survival during the early stages of life from embryonic development and early growth after birth on through infancy and childhood.

√ Omega-3 and omega-6 fatty acids are essential nutrients and may affect the prevalence and severity of cardiovascular disease, diabetes, cancer and age-related functional decline.

CHAPTER AT A GLANCE

√ Not all fats are created equal; some are beneficial to human health.

√ The types of fat in the diet affect the host's blood lipid profile to a greater extent than the amount of cholesterol in the diet.

√ The total fat content of red meat has decreased globally over time due to both farming and retail practices.

√ *Trans fatty* acids (TFAs), specifically industrially produced TFAs, have adverse effects on blood lipid profiles.

√ Observational studies suggest that naturally produced TFAs found in products from ruminant animals (meat and dairy) do not have an adverse effect on health in the quantities usually consumed.

7.1 THE ROLE OF FAT IN NUTRITION AND HEALTH

Since the first Expert Consultation on the Role of Dietary Fats and Oils in Human Nutrition held in Rome from 21 to 30 September 1997 (FAO, 1978), fats have remained one of the most complex and controversial areas of investigation in nutrition science (Nishida & Uauy, 2009). Fats are energy-dense (37 kilojoules per gram), yet the health consequences of dietary fats go well beyond their role as energy sources. The knowledge of the role of particular fatty acids in determining health and nutritional well-being and how they exert these effects has expanded substantially. The recent Expert Consultation on Fats and Fatty Acids in Human Nutrition (FAO, 2010) accentuated that fats and fatty acids should be considered as key nutrients that affect early growth and development and nutrition-related chronic disease later in life.

RECENT SCIENTIFIC EVIDENCE

- √ Several recent studies report no or small association between total dietary fat intake and obesity, weight gain, coronary heart disease and cancer (Field *et al.*, 2007; He *et al.*, 2003; Hu *et al.*, 1997; Koh-Banerjee *et al.*, 2003; Xu *et al.*, 2006, Beresford *et al.*, 2006; Howard *et al.*, 2006; Kushi and Giovannucci, 2002; Prentice *et al.*, 2006; WCRF/AICR, 2007).
- √ Various observational studies in developing and transitional countries suggest that shifting from a lower to a higher percentage of energy from fat has been associated with both lower and higher energy intake and unhealthy weight gain, potentially contributing to the increasing overweight and obesity in these countries (Ghafoorunissa, 1996; Li *et al.*, 2007; Longde, 2005; Popkin *et al.*, 1995).
- √ Low-fat (27–30% of energy), high-carbohydrate diets do not favourably affect serum lipids, fasting serum glucose, fasting serum insulin, or blood pressure, compared with higher fat diets (Appel *et al.*, 2005; Gardner *et al.*, 2007; Schaefer *et al.*, 2005).
- √ A meta-analysis of clinical trials comparing low-fat (<30% of energy) energy-restricted diets to low-carbohydrate (<60 g/d), non-energy-restricted diets, found low-fat diets induced larger reductions in LDL-cholesterol, but did not improve weight loss and increased triglyceride levels and lowered HDL-cholesterol (Nordmann *et al.*, 2006).
- √ Consistent associations have been found between high intakes of specific dietary fats, including PUFAs, and substituting carbohydrates with PUFAs, with lower risk of heart disease (Mozaffarian and Willett,2007; Hu *et al.*, 2001).
- √ Scientific evidence that emerged over the past two decades shows that trans fatty acid consumption has unique adverse effects on serum lipids, including increasing LDL-C, lowering HDL-C, increasing lipoprotein(a), increasing ApoB levels, and decreasing ApoA1 levels (Katan *et al.*, 1994; Mensink and Katan, 1992; Mozaffarian and Clarke, 2009; Mozaffarian *et al.*, 2006).

Progressing evidence

Over time there has been a rapid expansion of the evidence which has resulted in a better understanding of how fats and fatty acids are metabolised and utilised in the body, how they alter cell membrane function and control gene transcription and expression, and how these fatty acids interact with each other (FAO, 2010). In the past 15 years a large number of population-based cohort studies and randomised controlled trials were conducted to determine the impact of fat, and specifically of different types of fatty acids, on human health. As an example, several recent studies found either small or no association between total dietary fat intake and obesity, weight gain, coronary heart disease or cancer risk. Similarly several studies have not found evidence for beneficial effects of following a low-fat diet. Although the beneficial effects of polyunsaturated fatty acids (PUFAs) were known previously, eicosapentaenoic acid (EPA) (C20:5(n-3)) and docosahexaenoic acid (DHA) (C22:6(n-3)) specifically have been identified as having physiological benefits in relation to blood pressure, heart rate, triglycerides, inflammation, endothelial function, as well as a reduced risk of fatal coronary heart disease at a consumption of 250mg/day (FAO, 2010). DHA (C22:6(n-3)) also plays an essential role in the development of the brain and retina during foetal development and the first two years of life (Cetin & Koletzkno, 2008; Helland *et al.*, 2008). A balanced ratio of omega-6 to omega-3 fatty acids has also been recommended for health and has been shown to have anti-inflammatory properties protective against atherogenic changes in vascular endothelial cells (FAO, 2010; De Caterina *et al.*, 2000).

7.2 DIFFERENT TYPES OF FAT

Fats are generally classified or grouped according to the number of double bonds in their chemical structure, i.e. saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA). Food sources of the different fatty acid categories and the level of evidence of consumption on human health are summarized in Table 7.1. In addition to categories of fatty acids eliciting unique effect on human health, individual fatty acids within each of these broad categories may have unique biological properties and health benefits which have only recently been placed high on the agenda for scientific examination.

In most naturally occurring unsaturated fatty acids (MUFAs and PUFAs), the carbon-carbon double bonds are normally in the cis-configuration, apart from selected fatty acids found in meat and milk from ruminant animals with trans-configuration of the double bonds. In the nineteenth century, the process of catalytic hydrogenation was developed for the conversion of liquid unsaturated oils to solid fats (Emken, 1984) which converts many unsaturated double bonds from a cis-configuration to a trans-configuration (Nishida & Uauy, 2009). These trans fatty acids (TFAs) increase the solidity and stability of fat in terms of functional properties, but have also been placed under the spotlight due to evidence suggesting negative effects on human health. As a result TFAs have also recently been highlighted as a noteworthy group of fatty acids which needs to be considered in human nutrition and health.

Table 7.1 Different categories of fatty acids, main food sources and level of evidence of consumption on human health (Adopted from FAO, 2010)

Type	Main food source	Level of evidence
Total fat	All foods containing fats and oils	***Probable evidence*** – No relation between total fat intake and coronary heart disease, fatal coronary heart disease or cancer development.
Saturated fatty acids (SFA)	Mainly animal sources and coconut oil	***Convincing evidence*** – Raises low-density lipoprotein (LDL) and total/high-density lipoprotein (HDL) ratio in comparison to PUFA and MUFA, but no effect on total/HDL ratio in comparison to carbohydrates. ***Possible evidence*** – Increases risk of Type 2 diabetes. ***Insufficient evidence*** – Increased risk of hypertension, body weight and adiposity.
Mono-unsaturated fatty acids (MUFA)	Canola, peanut, and olive oils, avocados, nuts, and seeds such as pumpkin and sesame seeds	***Convincing evidence*** – Lowers LDL and total/HDL ratio when substituted for SFA. ***Possible evidence*** – Decreases risk of metabolic syndrome components. ***Insufficient evidence*** – Effect on diabetes risk, body weight, adiposity, coronary heart disease and cancer.
Poly-unsaturated fatty acids (PUFA)	Sunflower, corn, soybean, flaxseed oils, and also found in foods such as walnuts, flax seeds, fish and meat	***Convincing evidence*** – Essential for human health and development (linoleic acid (LA), alpha-linolenic acid (ALA) ***Convincing evidence*** – Lowers LDL and total/HDL ratio in comparison to SFA. ***Convincing evidence*** – Decreases risk of coronary heart disease when PUFA replaces SFA. ***Possible evidence*** – Decreases risk of metabolic syndrome components. ***Possible evidence*** – Increases lipid peroxidation with high consumption, especially when tocopherol intake is low. ***Insufficient evidence*** – Risk of body weight, adiposity or cancer.
Omega 6 PUFA	Vegetable oils, nuts and meat	***Convincing evidence*** – Essential for human health and development (LA) ***Probable evidence*** – Decreases risk of metabolic syndrome components and diabetes ***Insufficient evidence*** – Risk of body weight, adiposity and cancer
Omega 3 PUFA	EPA and DHA are found in fatty fish such as salmon, tuna, mackerel and sardines ALA is found in canola or soybean oil, walnuts and flaxseed	***Convincing evidence*** – Essential for human health and development (ALA) ***Convincing evidence*** – Decreased risk of fatal coronary heart disease (eicosapentaenoic acid and docosahexaenoic acid) ***Possible evidence*** – Decrease risk of total coronary health disease and stroke
Trans fatty acids (TFA)	Two sources, industrially produced TFAs, e.g. partial hydrogenation of unsaturated oils, and naturally produced TFAs, e.g. products from ruminant animals such as lamb, mutton, beef and dairy.	***Convincing evidence*** – Decreases HDL and increases total/HDL ratio in comparison to SFA, cis MUFA or PUFA ***Probable evidence*** – Increases risk of fatal coronary heart disease and sudden cardiac death, metabolic syndrome and diabetes. ***Insufficient evidence*** – Risk of body weight, adiposity, diabetes and cancer

7.3 RECOMMENDATIONS FOR FAT INTAKE

The recommendations for fat intake reported in this document are based on the latest report of the Expert Consultation on Fats and Fatty Acids in Human Nutrition (FAO, 2010), and places emphasis on the specific fatty acid categories for populations. Although total fat intake should be regulated, emphasis should be placed on choosing and consuming the right types of fat in the diet.

Total fat

Energy balance is critical to maintain a healthy body weight and to prevent weight gain. Convincing evidence shows that this energy balance is independent of macronutrient distribution, i.e. from fat or carbohydrates.

Dietary fat is often restricted in energy-controlled diets as it is the macronutrient that contributes the most to energy intake. However, in populations with inadequate total energy intake, often seen in developing communities in South Africa, dietary fat is an important macronutrient contributing to energy intake at more appropriate levels. The minimum total fat intake for adults is 15% of dietary energy to ensure adequate intake of total energy, essential fatty acids and fat-soluble vitamins. For women of reproductive age and adults with a BMI below 18.5, this minimum is increased to 20% of total dietary energy. The maximum total fat intake recommended for adults is between 30% and 35% of total dietary energy.

Saturated fatty acids

There is convincing evidence that replacing SFAs in the diet with PUFAs decreases the risk of coronary heart disease, yet individual SFAs have different effects on the concentration of plasma lipoprotein, i.e. lauric, myristic and palmitic acids increased LDL cholesterol, whereas stearic acid has no effect.

It is recommended that SFAs should be replaced with PUFAs, and total intake should not exceed 10% of total dietary energy.

Monounsaturated fatty acids

There is convincing evidence that replacing carbohydrates and SFAs in the diet with MUFAs, increases HDL and decreases LDL. The recommendation for MUFAs in the diet is unique in that it is calculated by difference: MUFA = Total fat – SFA – PUFA – TFA, yet it can be up to between 15% and 20% of total dietary energy.

Polyunsaturated fatty acids

There is significant evidence that various PUFAs, specifically linoleic acid (LA) (C18:2(n-6)) and alpha-linolenic acid (ALA) (C18:3(n−3)) are indispensable fatty acids which cannot be synthesized in the human body, but are essential for human health and development. Total PUFA intake is recommended to be a minimum of 6% of total energy intake. The minimum intakes to prevent deficiency symptoms for LA (C18:2(n-6)) and ALA (C18:3(n−3)) are estimated at 2.5% and 0.5% of total energy, respectively.

Omega 3 (n-3) to Omega 6 (n-6) ratio

Various suggestions have been made that a specific ratio of omega-6 to omega-3 is needed, yet the Expert Consultation on Fats and Fatty Acids in Human Nutrition (FAO, 2010) found no rational for a specific recommendation for a specific omega-6 to omega-3 ratio if intakes of omega-6 and omega-3 fatty acids meet the recommendations:

- Omega-6 between 2.5% and 9% of total dietary energy
- Omega-3 between 0.5% and 2% of total dietary energy

Trans fatty acids

There is convincing evidence that TFAs from commercial partially hydrogenated vegetable oils increase the risk of coronary heart disease, diabetes, and metabolic syndrome, etc. It is recommended that the mean population intake should be less than 1% of total dietary energy.

RECOMMENDATIONS

These recommendations are based on the recommendations of the most recent Expert Consultation on Fats and Fatty Acids in Human Nutrition (FAO, 2010) and are expressed as a percentage of total dietary energy.

Adults (Percentage (%) of total dietary energy)

Fatty acid	Acceptable range
Total fat	20-35%
SFA	10%
MUFA	By difference up to 15-20%*
PUFA	6-11%
n-6 PUFA	2.5-9%
n-3 PUFA	0.5-2%
TFA	<1%

Infants (0–24 months) and Children (2–18 years) (Percentage (%) of total dietary energy)

Fatty acid	Age group	Acceptable range
Total fat	0-6 mo	40-60%
	6-24 mo	35%
	2-18 yr	25-35%
SFA	2-18 yr	8%
MUFA	2-18 yr	*
PUFA	6-24 mo	<15%
	2-18 yr	11%
n-6 PUFA Arachidonic acid (AA)	0-6 mo	0.2-0.3%
n-6 PUFA Linoleic acid (LA)	0-24 mo	3.0-4.5%
n-3 PUFA Alpha linolenic acid (ALA)	0-6 mo	0.2-0.3%
	6-24 mo	0.4-0.6%
n-3 PUFA Docosahexaenoic acid (DHA)	0-6 mo	0.1-0.18%
	6-24 mo	10-12mg/kg
n-3 PUFA Eicosapentaenoic acids (EPA)+DHA	2-4 yr	100-150mg
	4-6 yr	150-200mg
	6-10 yr	200-250mg
TFA	2-18 yr	<1%

*MUFA is calculated by difference:
MUFA = Total fat – SFA – PUFA - TFA

HEALTHY FATS AND RED MEAT

Apart from Omega 3 & 6 fatty acids present in red meat, Conjugated Linoleic Acid (CLA), a TFA, found mostly in grass-fed animals, have been proven to deliver numerous health benefits.

√ CLA is a naturally occurring essential fatty acid found in animal products such as lamb and mutton and full fat dairy products.

√ Humans cannot produce CLA, thus we obtain it from food sources.

√ Products obtained from grass-fed animals have the highest concentration of CLA.

√ More than 80 % of lamb and mutton in South Africa are naturally produced, which means these animals graze in open fields.

Health benefits of CLA

√ Adequate intake of naturally occurring CLA was shown to reduce abdominal fat in humans, reduce body fat and increase lean body mass in animal studies.

√ It controls cholesterol and improves blood lipid profiles by increasing high density lipoprotein (HDL), and lowering low density lipoprotein (LDL).

√ It aids in increasing bone density and minimising the risk of developing osteoporosis.

√ Increased intake of CLA has been associated with decreased prevalence of atherosclerosis.

√ It possibly normalises blood glucose, benefiting individuals prone to developing diabetes.

√ It has anti-carcinogenic properties, possibly reducing the risk of developing certain types of cancers, such as prostate and breast cancer.

7.4 TOTAL FAT CONTENT OF RED MEAT

Meat is a valuable food source rich in many of the essential nutrients including protein, iron, zinc, selenium, vitamin B12, Vitamin D and essential omega 3 fatty acids. Although red meat is generally classified as a high protein, iron and fat source, the nutritional composition of foods, like meat, are non-homogenous and ever changing. These changes are the result of various factors including soil and forage composition, environmental factors and post-slaughtering activities such as trimming and cooking methods, in line with results found for South African red meat, including lamb, mutton and beef.

The total fat content of red meat depends upon the breed, feeding regimen, sex and age of the animal at slaughter, the method of butchery and level of trim that is applied to each cut. Globally, the total fat content of meat has consistently decreased (Figure 7.1). From the 1950s to the present day, owing to improved breeding and butchery techniques, the fat content of carcass meat in South Africa has decreased from 32% in 1949 to 18% in 1981 to 13% in 1991 (Schönfeldt, 1998; Klingbiel, 1984; Naude, 1972). Recent projects on the nutrient content of South African red meat (beef, lamb and mutton) have found that the fat content of red meat has decreased on average to less than 15g/100g edible product prior to trimming, and to <10% after trimming of subcutaneous fat. Further removal of visible fat reduces the fat content of South African red meat to <5% on average (Figure 7.2).

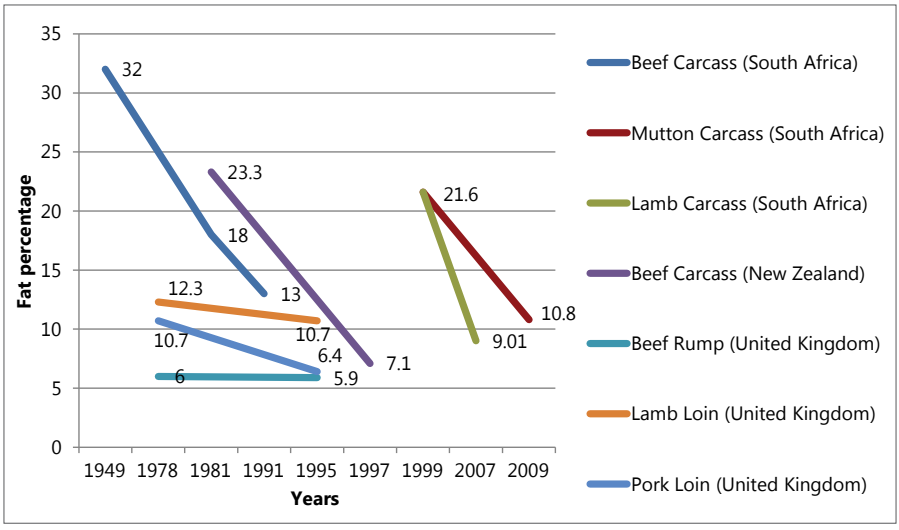


Figure 7.1 Global decreases in fat content of red meat over time

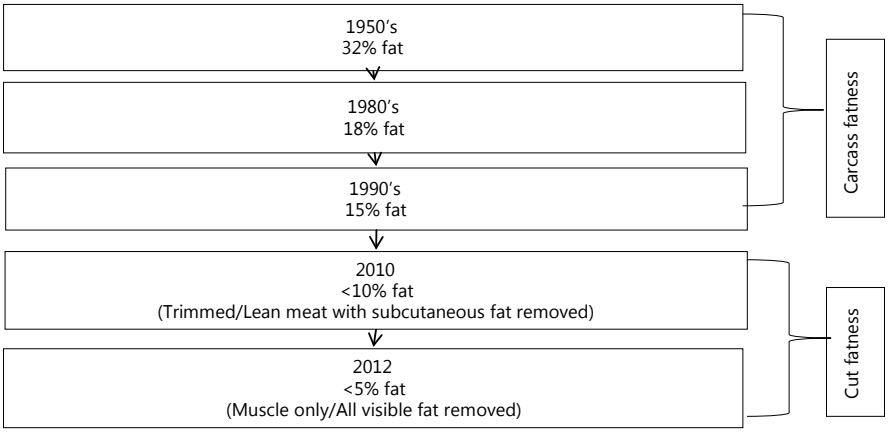


Figure 7.2 Changes in the fat content of South African red meat over time (Sainsbury, 2009; Van Heerden, 2007; Schönfeldt, 1998; Klingbiel, 1984; Naudé, 1972)

THE EFFECT OF TRIMMING

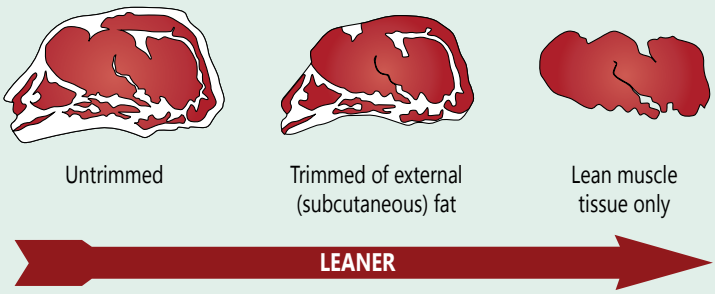
√ Today, many butchers trim the subcutaneous fat layer from the cut before selling it to the consumer.

√ Many consumers trim the subcutaneous fat layer at home prior or after cooking.

√ If consumers choose not to eat any visible fat, only the muscle tissue is consumed.

Similar to the removal of the skin from chicken, removal of the subcutaneous fat layer of meat cuts significantly reduces the fat content of red meat.

Recommendation: Treat subcutaneous fat in the same way as peeling an orange.



Red meat in comparison to other animal foods

Lean red meat like South African lamb and mutton compare favourably to other animal products such as lean chicken (without skin), fish and dairy products. It contains on average similar amounts of total fat to fresh and dark chicken meat without the skin. Instead of promoting the exclusion of red meat from the diet, consumers should be advised on the important effect which trimming has on fat content. Updated nutrient values for lamb and mutton (Chapter 1, page 3) (and soon to be published values for South African beef) provide information on the effect of trimming on fat content and total composition.

Table 7.2 **Fat content of trimmed (lean) and untrimmed animal products (Schönfeldt *et al.*, 2012; Wolmarans *et al.*, 2010; Schönfeldt *et al.*, 1998)**

Meat (100g, cooked)	Fat (g)
Trimmed	
Lamb, leg, roasted, lean	7.7
Lamb, loin, roasted, lean	7.8
Lamb, shoulder, braised, lean	9.9
Mutton, leg, roasted, lean	7.2
Mutton, loin, roasted, lean	9.8
Mutton, shoulder, braised, lean	8.7
Chicken, dark meat, roasted, without skin	9.8
Chicken, dark meat, boiled, without skin	9.7
Chicken, white meat, roasted, without skin	3.6
Chicken, white meat, boiled, without skin	4.1
Pork, loin, braised, lean	8.3
Untrimmed	
Lamb, leg, roasted, untrimmed	11.7
Lamb, loin, roasted, untrimmed	20.9
Lamb, shoulder, braised, untrimmed	15.8
Mutton, leg, roasted, untrimmed	10.1
Mutton, loin, roasted, untrimmed	25.4
Mutton, shoulder, braised, untrimmed	11.3
Beef, rump, roasted, untrimmed	14.4
Beef, prime rib, roasted, untrimmed	18.0
Beef, shoulder, braised, untrimmed	8.2
Chicken, meat and skin, boiled	12.6
Chicken, meat and skin, roasted	13.0
Pork, loin, grilled, untrimmed	13.9
Pork, thick rib/breast, braised, untrimmed	25.4

EXPERT OPINION

Dr Langelihle Simela holds a PhD in animal science, with specialisation in meat science. She has a keen interest in the advancement of the red meat industry, particularly facilitating the participation of smallholder farmers in the sector.

"Meat fat and its quality have probably been the most controversial components of meat in recent years, with opinions ranging from "fat is a totally unacceptable component" to the current opinion that "intake should be regulated and emphasis placed on choosing and consuming the right types of fat". The body of evidence that is consolidated in this chapter will no doubt be a useful background for researchers and a guide to nutritionists, dietitians, industry representatives and consumers of red meat on the present scientific evidence relating to the role and functions of fat and its components, as well as the recommended intake levels."

7.5 RED MEAT AND SATURATED FAT

Despite common reference to animal fats as 'saturated', red meat contains saturated and mono- and polyunsaturated fats**.** Recent studies on the nutrient content have shown that the unsaturated fat content is nearly equal to the saturated fat content (Figure 7.3).

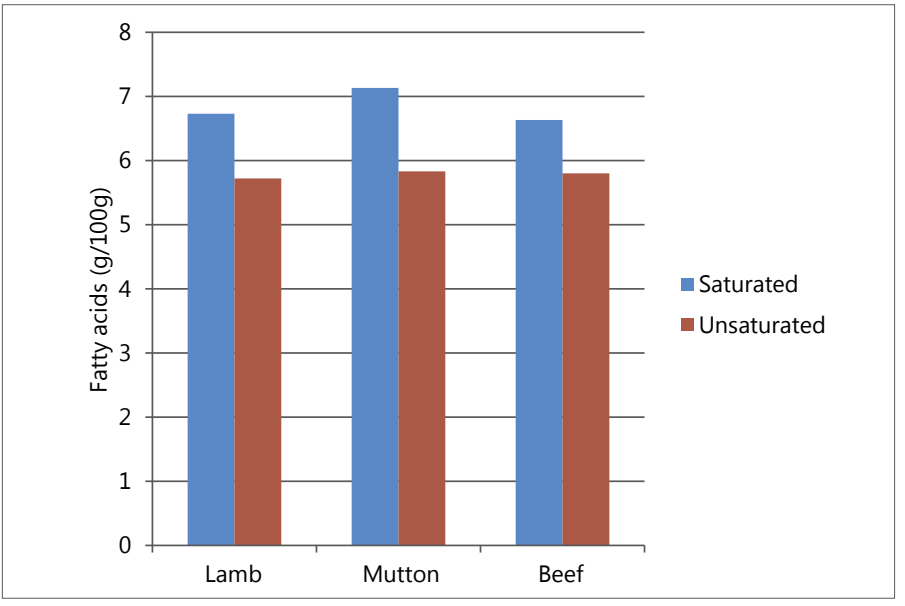


Figure 7.3 Comparison of the saturated and unsaturated fatty acid content of untrimmed South African lamb, mutton and beef (Schönfeldt *et al.*,2012; Schönfeldt & Welgemoed, 1996)

***TRANS* FATTY ACID DEFINITIONS**

Natural TFA:

√ Unsaturated fatty acid with one or more isolated or conjugated double bonds in a trans-confirmation consisting mainly of vaccenic acid [18:1(n-9)] or conjugated linoleic acid (CLA) (a family of isomers from linoleic acid [C18:2(n-6)]).

Industrial produced TFA:

√ A component of partially hydrogenated vegetable oils, which have been highly associated with cholesterol and coronary heart disease.

√ Includes all geometrical isomers of MUFAs with one *trans* double bond, i.e. C14:1, C16:1, C18:1, C20:1, C22:1, and PUFAs with one or more trans double bonds, i.e. C18:2, C18:3, C20:2, C22:2 having non-conjugated, interrupted by at least one methylene group, carbon-carbon double bonds in the *trans* configuration.

Conjugated linoleic acid (CLA):

√ Bacterial metabolites mainly found in animal fats, that comprise a family of positional and geometric isomers of linoleic acid with two conjugated double bonds, of which there are two major forms, i.e. [c9,t11-CLA] and [t10,c12-CLA].

Vaccenic acid:

√ *Trans*-11 vaccenic acid [18:1(n-9)] is a positional and geometric isomer of oleic acid with a single double bond and is the precursor to CLA in humans.

Although fats are grouped according to their number of double bonds, and recommendations are formulated for intake based on these groupings, individual fatty acids may have unique biological properties and health effects. Determining these properties of individual fatty acids has been identified as a research priority high on the global agenda (FAO, 2010). Red meat contains various individual fatty acids, of which the specific profile varies depending on factors such as breed, feeding regime and the proportions of lean meat and fat. In Table 7.3 the cholesterol-raising and cholesterol-lowering fatty acids found in South African lamb, mutton and beef are presented in term of the recent scientific evidence summarised in the Expert Consultation on Fats and Fatty Acids in Human Nutrition (FAO, 2010). South African lamb, mutton and beef contain nearly as much cholesterol lowering fatty acids than cholesterol raising fatty acids.

Table 7.3 Fatty acid content of South African red meat (untrimmed) in relation to effect on plasma-cholesterol levels (Schönfeldt *et al*., 2012; FAO, 2010; Schönfeldt & Welgemoed, 1996)

Fatty Acids	Content (g/100g)		
	Lamb	Mutton	Beef
LDL-cholesterol raising	**4.2**	**3.62**	**3.64**
Lauric acid C12:0	0.08	0.01	ND
Myristic acid C14:0	0.85	0.34	0.37
Palmitic acid C16:0	3.27	3.27	3.27
Cholesterol neutral	**1.91**	**3.01**	**2.99**
Stearic acid C18:0	1.91	3.01	2.99
LDL-cholesterol lowering	**5.22**	**5.40**	**5.4**
Oleic acid C18:1	4.79	4.95	5.12
Linoleic acid (Omega 6) C18:2	0.36	0.29	0.24
Alpha-linolenic acid (Omega 3) C18:3	0.07	0.14	ND
Arachidonic acid C20:4	0.00	0.02	0.04

7.6 RED MEAT AND TRANS FATTY ACIDS

In the past the only TFAs in the human diet were derived from foods obtained from ruminant animals, i.e. meat and dairy. During rumination, gastric bacteria in the gut of cattle and other ruminants convert the cis double bonds of unsaturated fatty acids to the trans position. Ever since the process of catalytic hydrogenation of liquid oils was developed to convert the liquid unsaturated fatty acids to solid fats, the intake of TFA in populations has significantly increased (Nelson *et al.*, 2007). Hydrogenation is a process which converts many cis double bonds to either saturated single bonds (creating SFA), or trans double bonds (creating TFA). Partially hydrogenated oils normally contain more than 20 novel TFA isomers of oleic or linoleic acid, which often comprises 30% to 60% of all fatty acids in the oil (Nishida & Uauy, 2009). There is a growing body of evidence indicating that TFA consumption from partially hydrogenated oils adversely affects cardiovascular risk factors. However, the intake of ruminant TFAs is low in most populations, and there is no conclusive evidence supporting an association with coronary heart disease risk and the amounts of ruminant TFAs usually consumed. Some evidence associates the consumption of certain natural TFAs, e.g. certain conjugated linoleic acid (CLA) isomers, to reduced risk of coronary heart disease and cancers.

Regulating trans fatty acid content in food

In line with global tendencies, the South African Department of Health released the Regulations Relating to Trans-Fat in Foodstuffs (No. R. 127 of the Foodstuffs, Cosmetics and Disinfectants Act, 1972, No. 54 of 1972), on 17 February 2011 which took effect on 31 August 2011. The Regulations prohibit the sale of foodstuffs containing more than 2g of industrially produced TFAs per 100g of oil or fat. Naturally occurring TFAs, normally found in animal products at amounts below the 2g per 100g fat, are not prohibited by the legislation.

United Kingdom: A Case Study

In the United Kingdom (UK) regulating TFA intake from industrially produced foods excluding foods from animal origin, successfully resulted in the reduction of TFA intake of the population to 0.8% of total energy intake. Based on the National Diet and Nutrition Surveys (NDNS 2000/01) it was estimated that approximately 55-65% of total TFA intake in the UK was derived from vegetable oil sources, with the remainder from animal origin. During the intervening years between 1986/87 and 2000/01, there was a considerable decline in the proportion of total TFA derived from fat spreads (SACN, 2007). With respect to the lower income population in the UK, the Low Income Diet and Nutrition Survey (LIDNS) of 2003/5 indicated that within low income individuals with an intake of TFAs greater than 2% of total energy intake, the leading contributors are fat spreads by a great margin (Nelson *et al.*, 2007).

A REVIEW OF THE EVIDENCE

- √ Natural TFAs, at the levels at which they may be consumed in western populations (up to 1.5 % of TEIs), have shown no association with coronary risk (Mozaffarian *et al.* 2006, Willett, 2006).
- √ A prospective Danish cohort found that in 3700 adults monitored for 18 years, ruminant trans-fat intakes were not associated with the risk of occurrence of coronary diseases (Jacobsen *et al.* 2008).
- √ Data from the Transfact study show that ruminant TFA do not alter HDL cholesterol, even at higher intake levels than for those related to spontaneous food intake (Chardigny *et al.* 2008).
- √ Intake may reach an average of 1.1 % of total energy (2.8-4.9 g/day) (Jacobsen *et al.* 2008).
- √ A Canadian intervention study found intakes at ±1.5 % of total energy had no effect on the blood biomarkers for cardiovascular risk (Motard-Bélanger *et al.* 2008).

Fat provides the richest dietary source of energy and supplies essential nutrients such as fat-soluble vitamins and essential fatty acids, but should be consumed in moderation to avoid excessive energy intake which can lead to weight gain. Although lean (trimmed) South African red meat contain less than 10% fat on average, it is recognised that the type of fat rather than the total amount of fat should be considered when making healthy food choices. Red meat is a good source of essential MUFAs, PUFAs and other groups of fatty acids such as CLA which has numerous health benefits.

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CHAPTER 8
RED MEAT AND HYPERTENSION

WHY IS THIS IMPORTANT?

World Health Statistics (World Health Organization (WHO), 2012):

√ There has been a dramatic increase in the conditions that trigger heart disease and chronic illnesses, including hypertension and diabetes, particularly in low and middle-income countries.

√ Hypertension is a high-risk condition and causes 51% of deaths from stroke, and 45% of deaths from coronary heart disease.

√ In 2004 hypertension was responsible for nearly 13% of all deaths globally.

√ Nearly two-thirds of people living with hypertension are from developing countries (WHO, 2011).

South African statistics:

√ In South Africa (SA) 6 million adults suffered from hypertension (BP > 140/90mmHg) in 1998 (SADHS, 1998).

√ Cardiovascular disease was previously ranked as the 2nd highest cause of death in SA (Bradshaw *et al.*, 2000).

√ Hypertension is a costly contributor to Cardiovascular disease (CVD) and has been shown to constitute more than 7.5% of the total health care spend in SA (Seedat & Rayner, 2012).

CHAPTER AT A GLANCE

√ Hypertension is a high-risk condition causing half of deaths from stroke and coronary heart disease.

√ The incidence of hypertension is increasing globally, specifically in developing countries.

√ Lifestyle modifications, including healthier dietary habits, are imperative to improve hypertension.

√ Dietary recommendations include:

- Increase consumption of fruits, vegetables, high-fibre foods and low-fat dairy products.
- Decrease consumption of sodium (salt), fat (saturated - and *trans* fatty acids) and alcohol.

8.1 HYPERTENSION

Blood pressure (BP) refers to a higher than normal force of blood against the artery walls as it circulates through the human body. Hypertension, or high BP, refers to the constant pumping of blood through the vessels with excessive force. As BP rises, the risk for CVD and stroke increases. BP levels are measured as systolic (the pressure in the vessels when the heart beats), and diastolic (the pressure in the vessels when the heart rests between beats); these levels are summarized in Table 8.1.

Table 8.1 Blood pressure levels (WHO, 2011; NIH, 2003)

Level	Systolic	Diastolic
Normal	<120mmHg	<80mmHg
At risk (pre-hypertension)	120-139mmHg	80-89mmHg
High (Stage 1 hypertension)	140-159mmHg	90-99mmHg
High (Stage 2 hypertension)	≥160mmHg	≥100mmHg

BP tends to rise with an increase in age, and behavioural and lifestyle factors influence risk for hypertension, with the risk of CVD beginning at 115/74mmHg, doubling with each increment of 20/10mmHg (NIH, 2003). Excessive consumption of sodium (salt), not consuming adequate amounts of potassium, being overweight, inactive or drinking too much alcohol and smoking have been shown to increase risk of hypertension (WHO, 2011).

Hypertension is considered one of the leading causes of death globally, causing 51% of deaths from stroke and 45% of deaths from coronary heart disease. In spite of the severity with nearly 1 billion people living with hypertension, incidence of hypertension is increasing, specifically in developing countries (WHO, 2012). It is predicted that by 2025, an estimated 1.56 billion people globally will be living with hypertension (WHO, 2011).

Hypertension is called the 'silent killer' as it often displays no warning signs or symptoms and many individuals are unaware that they suffer from hypertension or prehypertension. Hypertension can cause serious damage to health including hardening of the arteries, and decrease in the flow of blood and oxygen to the heart. This reduction in flow can cause angina (chest pains), heart failure or a heart attack. Hypertension can also result in the blocking or bursting of arteries supplying blood and oxygen to the brain, causing stroke.

8.2 HYPERTENSION IN SOUTH AFRICA

The most comprehensive estimates of the prevalence of hypertension in SA were reported by the Demographic and Health Survey (SADHS, 1998). According to this survey 6 million adults suffered from hypertension with BP greater than 140/90mmHg (SADHS, 1998). Connor *et al.* (2005) reported a 55% hypertension prevalence rate in SA adults, with 59% of black African adults, 55% of coloured and Indian adults, and 50% of white adults diagnosed with hypertension. With CVD ranked as one of the greatest contributors to death in the country (Bradshaw *et al.*, 2000), it is no surprise that hypertension has been shown to constitute more than 7.5% of the total health care spend in SA (Seedat & Rayner, 2012).

Transition of households from rural to urban settings, often resulting in the adoption of westernised lifestyle and eating habits, has been reported to be accompanied by an increased incidence of hypertension (Poulter *et al.*, 1990; Van Rooyen *et al.*, 2000; Steyn *et al.*, 2006). These urbanized individuals have been recorded to have higher body weight, and urinary sodium/potassium ratio than their rural counterparts. Other factors often associated with these urbanised subjects include high intakes of saturated fat and sodium, suggesting the significant impact which lifestyle and eating habits have on hypertension risk. Yet, more recent studies are reporting increasing incidence of hypertension in rural areas as well (Steyn *et al.*, 2006).

QUICK FACTS: HYPERTENSION

Hypertension is often called the silent killer as it can be present without symptoms.

Mild symptoms may include:
√ Headaches
√ Nosebleeds
√ Irregular heartbeat
√ Buzzing in the ears

Severe symptoms may include:
√ Weakness
√ Tiredness
√ Nausea & vomiting
√ Confusion & dizziness
√ Anxiety
√ Chest pain
√ Muscle tremors
√ Blurry vision
√ Shortness of breath
√ Palpitations

Causes may include:
√ Age
√ Family history
√ Being overweight
√ Diet with a high fat (SFA & TFA) and salt (sodium) intake
√ Diet low in fruits, vegetables and fibre
√ Diabetes
√ Lack of exercise
√ High intake of alcohol
√ Smoking

(WHO, 2011)

8.3 DIETARY COMPONENTS AND HYPERTENSION

Fats

Dietary fats associated with an increased risk in CVD include trans fatty acids (TFA) and saturated fatty acids (SFA), while polyunsaturated fatty acids (PUFA) are known to be protective. Refer to Chapter 7, page 41 for more information on fatty acids and their role in nutrition and health.

Sodium

Dietary sodium is associated with elevated BP levels, with intakes recommended below 6g per day. Although many individuals report low addition of salt during food preparation and at the table, hidden salt in food products contributes to a significant proportion of dietary sodium intake in South Africa (Carlton *et al.*, 2005). Individuals should be advised to be aware of this fact, and read food labels. From sodium values reported on food labels, salt quantity can be calculated by multiplying sodium content with a factor of 2.5.

Daily salt intakes for South Africans have been recorded at 7.8g/day in the black population, 8.5g/day in the coloured population and 9.5g/day in the white population, all being significantly higher than the recommended 6g/day. Ethnic differences in calcium intake have also been recorded with the black population consuming significantly lower levels than the other population groups. The greatest contributors of sodium intake in South Africa are cereals, and even more specifically breads (Carlton *et al.*, 2005).

Potassium

Adequate consumption of dietary potassium lowers the risk of hypertension and stroke (D'Elia *et al.*, 2011). It has been hypothesised that it is due to this functionality of potassium that populations consuming primitive and vegetarian diets often present low incidence of hypertension and heart disease (Reddy & Katan, 2004). Although a prudent diet high in fruits and vegetables and other foods containing dietary potassium is recommended, there has been no substantial evidence to administer long-term potassium supplementation for hypertension prevention. Table 8.2 presents the sodium (Na) and potassium (K) content of certain foods consumed by many South Africans.

Table 8.2 Sodium (Na) and potassium (K) content of selected South African foods (100g edible portion)# (Schönfeldt *et al*., 2012; Wolmarans *et al*., 2010; Schönfeldt *et al*., 1996)

Food products	Na (mg)	K (mg)
Meat & meat products		
Lamb, trimmed (lean)	71*	288
Lamb, untrimmed	61*	248
Mutton, trimmed (lean)	73*	272
Mutton, untrimmed	65*	243
Beef, untrimmed	80*	282
Chicken, white meat, roasted	48*	269
Chicken, dark meat, roasted	73*	262
Fish, hake, steamed	126*	361
Egg, whole, boiled	126*	98
Vienna	953	101
Sausage, smoked, beef and pork	945	189
Sausage roll, commercial, baked	1044	114
Dairy		
Cheese, cheddar	487	82
Milk, whole, fresh	48	157
Vegetables & fruit		
Broccoli, boiled	4*	121
Carrots, boiled	29*	156
Potato, baked	8*	418
Apple	4	99
Banana	41	206
Peach	4	201
Cereals		
Bread, brown, fortified	648	227
Bread, white, fortified	653	214
Maize, soft, fortified	5*	24
Rice, white	2*	39
Rice, brown	5*	43
Condiments		
Chutney, fruit	811	25
Gravy, brown, powder, prepared with water	417	22
Tomato sauce	582	465
Soup, powder, onion	8957	667
Soup, powder, average, prepared with water	431	64

#Values are reported as per 100g edible portion, portion sizes usually consumed should also be considered when giving dietary advice.
*No salt was added during cooking.

PROPOSED SALT REGULATIONS

Draft regulations aimed at limiting the salt/sodium content of certain processed foodstuffs have been published in the Government Gazette for comment in July 2012 (Notice R533 of Government Gazette 35509 proposed under Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972):

√ Foods included: bread, breakfast cereals, fat and butter spreads, factory butter, savoury snacks, processed meats, raw-meat sausages, dry soup powder, gravy powder and dry flavour mixes/cubes.

√ It includes draft targets for the gradual reduction of salt in the particular food items over a period of 5 years.

"It is the obligation of the Department of Health to improve health and that reducing the sodium content in processed, fast, takeaway, and restaurant food will lead to a healthier population (less high blood pressure, hypertension, heart disease and strokes), and save up to 6,500 lives annually."

– Prof Melvyn Freeman, Cluster Manager of Non-Communicable Diseases, Department of Health.

SNAP-SHOT ON POTASSIUM

- √ Sodium, often a hidden ingredient in foods, increases risk for hypertension.
- √ Potassium, in contrast, is an essential mineral required for heart function, maintenance of blood pressure etc.
- √ There is no recommended daily amount for potassium, yet intakes of 4000mg/day have been recommended.
- √ A potassium intake sufficient to support life can in general be guaranteed by eating a variety of foods.
- √ Potassium is found in vegetables and fruit, red meat and fish.
- √ The best food choices for hypertension include foods high in potassium and low in sodium (Refer to Table 8.2).

8.4 RECOMMENDED LIFESTYLE CHANGES TO IMPROVE HYPERTENSION

The DASH (Dietary Approaches to Stop Hypertension) study proved that non-pharmacological methods can decrease blood pressure equal to the effect of certain medications (Appel *et al.*, 1997). The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of Hypertension (NIH, 2003) recommended weight reduction, the adoption of a DASH eating plan, reducing dietary sodium, increasing physical activity and moderating alcohol consumption. The World Health Organization (WHO) added increasing the consumption of dietary potassium as a possible dietary intervention to decrease risk for hypertension (WHO, 2005).

The South African Hypertension Guidelines 2011 published by the South African Hypertension Society (SAHS) also emphasises that a healthy lifestyle remains the cornerstone of managing hypertension, regardless of the BP level of the individual (Seedat & Rayner, 2012). In addition to decreasing BP, lifestyle changes enhance antihypertensive drug efficiency and decrease total CVD risk. Lifestyle changes recommended by the SAHS are in line with the Strategy of the Department of Health and are summarised in Table 8.3, with certain special considerations for different population groups summarised in Table 8.4.

Table 8.3 Lifestyle modifications for hypertension care recommended by the SAHS (Seedat & Rayner, 2012)

Modification	Recommendation	Approx. Systolic Blood Pressure Reduction
Weight reduction	Maintain normal body weight (BMI: 18.5-24.9) by means of limited kilojoule intake and adequate daily physical activity.	5 to 20mmHg/10kg weight loss
Dietary sodium reduction	Reduce dietary sodium intake to <2.4g sodium per day or 6g sodium chloride (salt).*	2 to 8mmHg
Moderate alcohol consumption	Limit acohol consumption to no more than 2 standard drinks per day for men, and 1 standard drink per day in women.	
Limit total fat intake	Limit total fat intake to between 15% and 30% of total dietary energy, and reduce SFA and TFA intake. Recommended maximum at intake for moderately active adults: • Female normal weight: 70g/day • Female overweight: 50g/day • Male normal weight: 95g/day • Male overweight: 70g/day	
Increase fruit and vegetable consumption	Increase fruits, vegetables, legumes, whole grains and nuts to 5 servings per day.	
Limit free sugars	Reduce free sugars to less than 40g/day (8 level teaspoons).	
Physical activity	Engage regular physical activity for at least 30 minutes per day with a minimum of 150 minutes per week.	4 to 9mmHg
Stop smoking	Stop smoking and avoid the intake of any Nicotine-based products, including snuff.	

*Salt content can be calculated by multiplying sodium content of a product by 2.5

Table 8.4 Special considerations for hypertension in certain populations (Seedat & Rayner, 2012; NIH, 2003)

Population	Special considerations
Black population & Asians	• Black individuals are prone to complications such as stroke, heart and renal failure. • CVD, although emerging in frequency, is less common than in other populations (Seedat & Rayner, 2012). • Compared with Caucasian population, black patients respond poorly to antihypertensive therapy with ACE-inhibitors and β-blockers, but respond well to these in combination with diuretics. Calcium channel blockers (CCBs) show the most consistent response in black hypertensive patients (Brewster *et al.*, 2004).
Asian population	• Asians have a higher prevalence of diabetes mellitus and metabolic syndrome than other population groups (Seedat, 2007; Seedat & Rayner, 2012).
Children & Adolescents	• Hypertension is seldom observed in childhood, and a detailed investigation is recommended to identify underlying secondary cause (Seedat & Rayner, 2012; NIH, 2003). • Hypertension is increasingly linked to obesity in adolescents due to poor dietary habits and lack of physical activity (Seedat & Rayner, 2012).
Women	• The use of oral contraceptives may increase risk of hypertension and is associated with duration of use (NIH, 2003).
Pregnancy	• Hypertensive disease in pregnancy is the leading cause of direct maternal deaths in SA. Pre-eclampsia is a multi-organ disease unique to pregnancy, characterised by the presence of hypertension and proteinuria (Seedat & Rayner, 2012). • Care should be taken when antihypertensive drugs are prescribed to pregnant women. Drugs which are allowed during pregnancy include methyldopa, nifidipine, apresoline and labetalol (Seedat & Rayner, 2012).
Persons living with HIV/AIDS	• Prolonged antiretroviral therapy is associated with a higher prevalence of systolic blood pressure (Seaberg *et al.*, 2003). • Antiretroviral drugs, specifically protease inhibitors and non-nucleoside transcriptase inhibitors, are involved in many drug interactions, and specifically include influencing CCBs. In these cases, frequent BP and dose checks are advised (Seedat & Rayner, 2012).
Elderly	• In adults >50 years, systolic BP greater than 140mmHg is a greater risk for CVD than diastolic BP (NIH, 2003).

THE DIETARY APPROACHES TO STOP HYPERTENSION (DASH) DIET

Overview:

√ Diet developed by the US National Institutes of Health based on scientific research, aimed at lowering blood pressure without medication.

√ Promotes a healthy eating plan along with a reduction of dietary sodium intake.

Evidence:

Numerous studies have published the benefit of the diet on the risk of many diseases in addition to lowering blood pressure, reducing cholesterol, and improve insulin sensitivity, including:

√ CVD (Blumenthal *et al.*, 2010; Levitan *et al.*, 2009)

√ Kidney disease (Steiber *et al.*, 2012; Taylor *et al.*, 2010)

√ Certain types of cancer (Fung *et al.*, 2011; Fung *et al.*, 2010)

√ Diabetes (De Koning *et al.*, 2011)

√ Weight loss (Shenoy *et al.*, 2010)

Recommendations:

√ High intake of fruits and vegetables and low-fat dairy products rich in potassium, magnesium, calcium, and fibre.

√ Low intake of saturated and total fat, cholesterol and sodium.

Further reading:

√ Your guide to lowering blood pressure with DASH. 2006. U.S. Department of Health and Human Services, National Institute of Health. NIH Publication No. 06-4082.

√ http://www.nhlbi.nih.gov/health/public/heart/hbp/dash/new_dash.pdf

8.5 RED MEAT AND HYPERTENSION RISK

The United States Dietary Guidelines Advisory Committee (2010) published a statement that there is no clear association between intake of animal protein products and BP in cohort studies as various studies have shown no association between red meat intake and increased BP (Pitsavos *et al.*, 2006; Wagenmakers *et al.*, 2009).

Although there is convincing evidence that saturated fatty acids (SFA) raises low-density lipoprotein (LDL) and total/ high-density lipoprotein (HDL) ratios in comparison to unsaturated fatty acids, there is insufficient evidence that consumption of SFA increases the risk of hypertension. In fact, recent evidence suggests a greater link between CVD and the consumption of trans fatty acids (TFAs) (created during industrial hydrogenation of vegetable oils), high glycaemic index foods, and dietary salt than between CVD and SFA intake (McNeill & Van Elswyk, 2012; Danaei *et al.*, 2009). More information on the effects of different fatty acids from red meat and other food sources on cholesterol levels and subsequent risk for CVD is presented in Chapter 7, page 39.

Red meat contains inherently very little sodium. Sodium is often added to meat for a variety of reasons, including enhancement of sensory properties (taste), reducing water activity and increasing microbial safety. Many consumers also add salt unconsciously purely out of habit. Consumer benefit associated with the reduction of salt, and particularly added salt, should be emphasised.

Processed meat products can be a significant contributor to dietary salt intake. It has been suggested that the higher sodium levels in processed meats (not fresh or frozen red meat) could be a potential contributor to increased hypertension and CVD risk (McNeill & Van Elswyk, 2012; Micha *et al.*, 2010). It is also suggested that this may explain the disparity in findings related to dietary patterns and risk of CVD. It is strongly recommended that processed meat and unprocessed red meat should be grouped and investigated separately in future research studies.

EXPERT OPINION

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"The DASH diet is a flexible eating plan, one that allows you to incorporate your favorite foods. The 2010 Dietary Guidelines for Americans endorsed the DASH diet as one of the best plans for Americans to follow in meeting these guidelines. The Dietary Guidelines endorse enjoying your food, but eating less of it. Drinking more fat-free and low-fat dairy are recommended, along with making half of your plate fruits and vegetables. Note that the DASH diet emphasizes lean meats. The protein content of the DASH diet was 18% of energy, compared to 15% for the average American and fruit and vegetable diets tested. Over the past century, beef has become leaner due to production and trimming practices resulting in decreases in total and saturated fat."

THE ROLE OF PROTEIN

- √ Clinical trials have shown that protein may decrease risk of hypertension (Appel *et al.*, 2005).
- √ The Omniheart study found that the partial substitution of carbohydrates with protein or MUFAs reduces BP (Appel *et al.*, 2005).
- √ Different types of protein seem to affect BP differently (Wyness *et al.*, 2011).
- √ A meta-analysis of studies showed that an increase in protein in the diet from 15% of daily energy, to 45% of daily energy may lead to a 23% decrease in triglyceride levels (Kirk *et al.*, 2008).

8.6 THE POSITIVE ROLE OF RED MEAT

Evidence supports the inclusion of lean red meat as part of a healthy and balanced diet designed to manage CVD and hypertension (McNeill & Van Elswyk, 2012). The DASH study has demonstrated the potential benefit of the inclusion of lean red meat as part of a low-sodium diet. In an another study, postmenopausal women with high or normal blood pressure were divided into two groups; the one group consumed a low-sodium diet containing 100g cooked lean red meat per day for 14 weeks, the second group consuming a low-sodium high-carbohydrate, low-fat diet. The study found that systolic BP in the group consuming red meat fell by 5.6±1.3mmHg compared to 2.7±1.0mmHg in the group consuming the high-carbohydrate, low-fat diet (Nowson *et al.*, 2009).

In 2012 a rigorously tested randomised controlled trial where a DASH-style diet was followed but included 141g of lean beef per day, instead of the 28.3g/day recommended by the DASH diet, found equal lipoprotein reduction effects from both groups (Rousell *et al.*, 2012), having a positive effect on hypertension.

Lifestyle changes, including healthier dietary habits, are imperative to improve hypertension. Increased consumption of vegetables and fruit, high-fibre foods and low-fat dairy products and decreased consumption of sodium (salt), fat and alcohol are recommended. Research further suggests that fresh lean red meat can be included as part of an anti-hypertensive diet, e.g. a DASH type diet.

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CHAPTER 9

RED MEAT IN A GREEN ENVIRONMENT

WHY IS THIS IMPORTANT?

"Climate change could be the biggest global health threat of the 21st century."

– The Lancet, 2009.

"Climate change is an important threat to food security as agricultural production is critically dependent on local temperature and rainfall" "

– Greenpeace, 2008.

CHAPTER AT A GLANCE

√ As food demand increases, strain is placed on the environment to produce increased volumes of food while natural resources are decreasing.

√ Although agricultural production impacts on the environment, the environment in turn significantly influences agricultural production and, therefore, also food and nutrition security.

√ A healthy sustainable diet:

- includes nutrient dense foods
- promotes biodiversity
- limits food waste

√ Red meat can form part of a sustainable diet.

9.1 TOWARDS A GREEN ENVIRONMENT

In 2011 the world's population reached 7 billion people, and it is projected to grow to more than 9 billion by 2050. A high percentage of the global population will be concentrated in low-income countries (Fan *et al.*, 2012). Emerging middle classes can afford to consume more meat, fruits and vegetables. Food demand will thus increase and it is projected that nearly 80% more meat, 60% more cereals and 30% more roots and tubers will be needed by 2050. As the global consumption of meat, dairy and eggs continues to rise, increasing attention is being paid to the livestock sector's environmental performance. At the 2012 Rio+20 United Nations Conference on Sustainable Development (Brazil 20 to 22 June 2012), governments agreed to make agricultural production more sustainable, and stressed in particular the need to shift to more sustainable livestock production systems.

Environmental responsibility has expanded to include individual actions such as dietary choices, as food demand influences agricultural production. As a result, many campaigns aim to promote diets with the lowest possible environmental impact, yet within the context of human health optimal nutrition cannot be ignored. The focus should be placed on a healthy, environmentally sustainable diet.

9.2 RED MEAT PRODUCTION AND SUSTAINABILITY

There is increased pressure on the global livestock sector to increase production and productivity to meet the rising demand, however, significant focus has also been placed on the effect of production of animal products on the environment. The Food and Agriculture Organization (FAO) published a global report in 2006 entitled Livestock's Long Shadow in which it was reported that the agricultural sector is the largest user of land and water and is responsible for 18% of global greenhouse gas emissions (FAO, 2009). This report is frequently quoted in the press, but it has been criticised as it was suggested that livestock produce more greenhouse gasses than transportation. National reports in general classify agricultural processes at lower levels within the overall carbon portfolios; dwarfed by large transportation- and energy-sector contributions, especially in developed countries (Pitesky *et al.*, 2009).

In the UK the contribution of the livestock sector has been determined at a lower rate of 8% of total greenhouse gas emissions (Millward & Garnett, 2010). In the United States (US) the Inventory of US Greenhouse Gas Emissions and Sinks: 1990 to 2010 (EPA, 2012) found that the agricultural sector (including cultivation and livestock production) accounted for only 6.3% of

total greenhouse gas emissions. A recent report estimated the net contribution of livestock to greenhouse gasses to be only 4.5% (Scholtz *et al.*, 2012). Agricultural activities contribute to emissions of greenhouse gasses through a variety of processes, including enteric fermentation associated with domestic livestock, livestock manure management, rice cultivation, agricultural soil management and burning of agricultural residues. From these processes, agricultural soil management for cultivation of crops (for human or animal consumption) contributed the most to greenhouse gasses (EPA, 2012). Direct livestock emissions (enteric fermentation and manure) contributed to less than 3% of total emissions in the US report (EPA, 2012).

Currently, many different methods are being used to measure and assess the environmental impacts of animal raising, making it difficult to compare results and set priorities for the continuous improvement of environmental performance along production chains. As a result, the FAO has established a multi-stakeholder initiative 'Partnership on the environmental benchmarking of livestock supply chains' through a consultative process, which started in October 2010, between the FAO's Animal Production and Health Division and agriculture and food business representatives. The overarching goal of this initiative is to contribute to improved environmental performance of the livestock sector while considering social and economic viability.

The Partnership promotes an exchange of data and information, technical expertise and research geared towards improving and harmonising the way in which livestock food chains are assessed and monitored. Activities planned for the first three years of the project include establishing science-based methods and guidelines on how to quantify livestock's carbon footprint, creating a database of greenhouse gas emission factors generated for the production of different kinds of animal feed, developing a methodology for measuring other important environmental criteria, such as water consumption and nutrient losses, and biodiversity, and initiating a communication campaign to promote the use of the knowledge obtained (FAO, 2012).

CHALLENGES TO FOOD SECURITY

√ Balancing future demand and supply sustainably.

√ Ensuring that there is adequate stability of food supplies.

√ Achieving global access to food and ending hunger (producing enough food).

√ Managing the contribution of the food system to mitigate climate change.

√ Maintaining biodiversity and ecosystem services while feeding the world.

Foresight: The Future of Food and Farming (2011).

EXPERT OPINION

Prof. Michiel Scholtz is a specialist researcher in applied animal breeding at the ARC and an Extraordinary Professor at the University of the Free State. One of his research interests is reducing the carbon footprint of beef through improved production efficiency.

"Livestock are important to mankind since most of the world's vegetation is rich in fibre and only ruminants can convert this into high quality protein sources for human consumption. In spite of this important role of livestock, it is singled out as a contributor to climate change, although many other sectors are higher contributors. This excellent chapter gives a balanced view on the importance of livestock products in the human diet and their role in climate change. I trust the health professions and consumers will benefit from it."

Red meat production in South Africa (SA)

Although livestock production has its environmental challenges, it can make positive contributions to other aspects of the environment, population health and the economy (Wyness *et al.*, 2011). From a nutritional perspective, people from developing countries, such as SA, who have low energy or protein intakes may in fact benefit nutritionally from increasing their intakes of livestock products.

Animal production can also contribute to economic viability and sustained livelihoods. Although the majority of people in semi-arid regions throughout SA and the rest of the continent sustain themselves primarily by growing crops, this means of food production is not practiced by all. Because of inadequate rainfall and high evaporation rates, average crop yields are often low, and the risk of crop failure is high. Traditionally, inhabitants of such regions rely mostly on domestic grazing animals. In SA this is seen particularly with sheep grazing on semi-arid lands, e.g. the Karoo. Focus should be placed on local breeds that have adapted to the environment and have a higher resistance to pests and disease, while forming part of the local agro-ecosystems. These locally bred animals have a lower carbon and water footprint than many international breeds dominating global livestock production (Cotter & Tirado, 2008).

A HEALTHY AND SUSTAINABLE DIET

- √ Increase nutrient density of the diet through consuming nutrient dense foods and limiting the consumption of empty kilojoule foods.
- √ Promote biodiversity through the consumption of local and indigenous foods.
- √ Decrease food waste, including both the physical wastage of food, and the consumption of foods high in energy but low in essential nutrients.

CLIMATE CHANGE AND PUBLIC HEALTH

Climate change affect s the fundamental requirements for health, including safe drinking water, clean air, sufficient nutritious food, secure shelter etc.

It may furthermore aggravate existing health problems, including:

√ Malnutrition due to impaired agriculture or loss of rural livelihood.

√ Infectious disease, including waterborne-, vector-borne and food-borne diseases.

√ Mental health.

√ Chronic disease.

√ Women's and child health.

√ Occupational health.

√ Violence and injury.

(Myers *et al.*, 2011)

9.3 RED MEAT CONSUMPTION AND SUSTAINABILITY

The question is often asked whether red meat and other animal products can form part of an environmentally friendly diet. The simple answer is "Yes".

Diet-associated greenhouse gasses are positively correlated with the quantity of food and energy consumed (Vieux *et al.*, 2012). Humans need to obtain all the nutrients that are essential for growth and survival from the food they consume. Similar to the case made for many non-communicable diseases, focus should be placed on the quality in addition to the quantity of individual foods. Focusing on nutrient-dense choices (a high amount of nutrients supplied per energy value) within each food group should be more important than eliminating or discriminating against specific food groups.

If a reduction in meat consumption is considered, all potential impacts (both positive and negative) of reduced meat intake in the diet should be taken into account before making recommendations for change. Red meat contains many important nutrients for good health and is an important contributor of nutrients to the South African diet. When meat is reduced in a diet, it is often compensated for by an increase in the consumption of other types of foods.

In terms of environmental impact, a study in France found that when fruits and vegetables were isoenergically (similar energy content) substituted for meat, either null or greater effects on greenhouse gasses were observed as significantly more fruits and vegetables were needed to maintain the energy and nutrient contents of the diet (Vieux *et al.*, 2012). In terms of nutrient adequacy, a 75kg male needs to obtain an average of 0.66g protein per kg bodyweight (±50g protein per day). Consuming 50g dietary protein from lamb or mutton meat would produce 2kg CO2 equivalents during the production process. Obtaining the same amount of protein (50g) from apples for instance, would produce more than double this amount at 4.5kg CO2 equivalents (Dolle, 2012).

Although the underlying causes of under- and over-nutrition extend well beyond consumption of certain types of food, (i.e. animal based foods) the quality of the food source needs to be emphasized once again, this time in the context of environmental sustainability. Sustainable dietary choices should be focused on nutrient density, bioavailability and biodiversity.

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CHAPTER 10

SUMMARY: THE ROLE OF RED MEAT IN A HEALTHY, BALANCED DIET

WHY IS THIS IMPORTANT?

- √ South African red meat is a nutrient dense food, containing less fat and consequently higher concentrations of essential nutrients, than previously thought.
- √ Red meat contains essential bioavailable nutrients, including protein, vitamin A and iron, which are needed to combat the various nutritional deficiencies observed in South Africa.
- √ The South African Food-Based Dietary Guidelines state that ***"Fish, chicken, lean meat or eggs can be eaten daily"***.
- √ Findings of various national intake studies and agricultural production figures indicate that South Africans consume on average less than the recommended 90g cooked red meat per day.
- √ Although lean South African red meat contains less than 10% fat on average, the type of fat in addition to the total amount of fat should be considered when making healthy food choices. Red meat is a good source of essential MUFAs, PUFAs and other groups of fatty acids such as CLA which have numerous health benefits.
- √ Protein promotes healthy weight maintenance and weight loss as part of an energy controlled diet.
- √ In order to promote a healthy cancer-fighting diet, emphasis should be placed on a varied diet rich in vegetables, fruit and other fibre rich foods in combination with a moderate intake of lean red meat.
- √ Research suggests that lean red meat can be included as part of an antihypertensive diet.
- √ Red meat can be included as part of an environmentally sustainable diet which should focus on nutrient dense food choices containing bioavailable nutrients and promoting biodiversity.

Meat is often the most expensive component in the diet and the component which evokes the widest array of comments and international debate. Yet, it should be remembered that meat is very seldom consumed on its own but forms part of a whole meal. The composition of the rest of the meal should not be neglected when healthy food choices are made. Certain nutritional considerations, such as nutrient-density and portion size, should be applied to all foods included in the diet.

10.1 NUTRIENT DENSITY

Nutrient density is defined as the ratio of the nutrient content (in grams) to the total energy content (in kilojoules) of a specific food product. The more nutrients present and the fewer the kilojoules, the higher the nutrient density. The term 'nutrient-rich foods' is commonly used as a synonym for nutrient-dense.

Red meats (lamb, mutton, beef and veal) play a key role in a balanced diet by providing nourishing nutrients. A serving of lean red meat provides more than 7 nutrients in significant amounts which are important to human health and development. A 90g edible portion of lean South African lamb or mutton, i.e. the meat from about two lamb chops, contribute to nearly half of an adult's Recommended Dietary Allowance (RDA) for protein, more than 30% of the RDA for zinc and it contributes significantly to the intake of other essential vitamins and minerals including iron and magnesium, as well as the B-vitamins.

TAKE HOME MESSAGES

Cutting down on fat

South African lamb and mutton on average contains less than 10% fat and can be included as part of a well-balanced diet. When buying meat, the type, cut and intended cooking method can make a big difference.

√ Ask your butcher for a lean cut or select a meat cut with little visible fat.

√ Trim the excess visible fat off the meat before cooking.

√ Use a tomato based basting sauce.

√ Grill meat instead of frying.

√ Avoid adding extra fat or oil while preparing meat.

√ Roast meat on a metal rack above a roasting tin, so that the fat can drip off.

Cooking meat safely

√ Processed meat products, such as sausages, burgers, kebabs and rolled joints need to be cooked until the juices run clear and they are not pink or red anymore.

√ Whole cuts of lamb, mutton and beef can be consumed when they are still pink or rare.

√ Avoid excessive exposure to smoke and open flame.

Storing meat safely

√ Store raw meat in sealed containers on the bottom shelf of the fridge, so that it cannot touch or drip onto other food.

√ Keep cooked and raw meat separately, e.g. don't place your cooked meat in the same container which it was marinated in.

√ When storing cooked meat, cool it as quickly as possible after cooking, and put it in the fridge or freezer.

Thawing raw meat

√ Defrost meat in the microwave if you intend cooking it as soon as it is defrosted.

√ If you have time, thaw frozen meat in the fridge to prevent it from getting too warm.

√ When thawing raw meat keep it in a sealed container on the bottom shelf of the fridge, so that it cannot touch or drip onto other food.

√ If you defrost raw meat and then cook it properly, you can freeze it again.

√ Do not reheat meat more than once.

FINAL COMMENT:
THE COMPLEXITY OF RED MEAT IN NUTRITION EPIDEMIOLOGY

How red meat is defined, quantified, and/or analysed may have a significant impact on the link between its consumption, and Non-Communicable Disease (NCD) risk.

The lack of a consistent and adequate description of red meat is a significant limitation to evidence on the link between red meat and cancer.

√ No universal definition for red meat exists, only recommendations.

√ Many studies evaluate the link between red and/or processed meat and cancer.

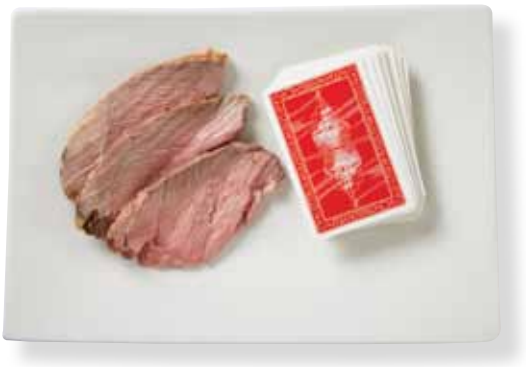
As examples, in three cohort studies, red meat was defined as:

√ Beef, pork, or lamb as a main dish in one study.

√ Beef, pork and a variety of processed red meat items in the second.

√ In the third study, red meat was not defined at all.

√ It is hypothesised that there is a greater link between high salt processed meats and cancer, than between unprocessed red meat and cancer.



10.2 PORTION SIZE

Apart from deciding what and when to eat, another important decision is how much to eat. Many health conscious consumers are perfectly capable of making healthy food choices for three wholesome meals per day, yet many people struggle with portion sizes. Most of the time we unknowingly eat portions that are too large and this contributes to an increased risk of overweight and obesity.

Over-sized portions of food have become the norm in many households. The portions sizes of take-aways, soft drinks and meals served at restaurants, have increased over the last 20 years, often as a result of the increased demand for value-for-money. Unfortunately, portion sizes which were once considered far too big to consume in one sitting, are now considered normal. Larger portions contain more kilojoules, and often the result is growing waistlines.

Consuming three regular meals per day has also changed to constant grazing, with individuals often losing track of what they are consuming throughout the day and over consuming food.

What is a healthy portion of lean meat?

The South African Food-Based Dietary Guidelines recommends up to 560g lean red meat per week, between 80g and 90g per day. This is in line with the average consumption statistics available for South Africans. However, it is well known that this range differs significantly from person to person.

Cooking losses in meat are on average between 20 to 30%, dependent on cut composition (meat, bone and fat ratio), temperature of the heat source, internal temperature of cooked meat, adding of condiments, etc. This means that an 80g cooked lean meat portion is roughly equivalent to 100g raw lean meat.

As a guide, a portion of red meat is equivalent to the size of a pack of cards or the palm of your hand.

A healthy, balanced diet builds upon the foundation of the right amounts of nutrient-dense foods from a variety of food groups, including lean meat, whole grains, vegetables, fruit and dairy products.

List of experts that contributed

Beulah Pretorius (page 22)
Carl Albrecht (page 38)
Catherine Champagne (page 58)
Ingrid van Heerden (page 16)
Langelihle Simela (page 47)
Michiel Scholtz (page 64)
Nelia Steyn (page 10)
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