AVOCADOS: CONSUMER BELIEFS AND EFFECT ON WEIGHT LOSS AND MARKERS OF CARDIOVASCULAR HEALTH

Z. PIETERSE Hons. B.Sc.

Dissertation submitted for the degree Magister Scientiae in Nutrition at the Potchefstroomse Universiteit vir Christelike Hoër Onderwys

Supervisor: Prof. W. Oosthuizen

Assistant Supervisor: Prof. JC Jerling

Potchefstroom

2003

Potchefstroomse Universiteit
vir Christelike Hoer Onderwys

ACKNOWLEDGEMENTS

To God my Heavenly Father, all my gratefulness for filling my life with so many blessings and opportunities and for guiding me in writing this dissertation.

I would like to express my sincere gratitude to the following people who contributed to make this dissertation possible.

- Prof. Welma Oosthuizen, my promotor, for her brilliant guidance, support and encouragement.
- Prof. Johann Jerling, my co-promotor, for his motivation, guidance and valuable contributions.
- Prof. Salome Kruger and Dr. Grieta Hanekom, for their assistance and contribution in the study.
- Dr. Marius Smith from the Medical Research Council of South Africa for analysing the plasma fatty acids.
- Dr. Alta Schutte for the arterial compliance measurements.
- Sr. Chrissie Lessing for the outstanding role she played in the recruitment, handling and organisation of the subjects and the drawing of blood.
- Jane Badham from JB Consultancy for her role in the designing of the consumer questionnaires and for liasing with the South African Avocado Growers Association and MARKINOR.
- All the consumers and subjects who took part in this study.
- The postgraduate students for their assistance in the collection of dietary and anthropometric data.
- The South African Avocado Growers Association and the South African Government's Technology and Human Resources for Industry Programme for funding this study.
- Prof. SW Vorster and Mrs. C Van der Walt for the language editing of this dissertation.
- To all my family, friends, colleagues and fellow students for their support.
- To my beloved fiancé, for his support and understanding.
- Lastly, to my loving parents, for all the opportunities they gave me and their continuous encouragement, love and support.

AFRIKAANSE TITEL

Avokado's: Verbruikershouding en effek op gewigsverlies en merkers van kardiovaskulêre gesondheid.

OPSOMMING

Motivering

Die doelwit van die Suid Afrikaanse Avokado Kwekers Vereniging (SAAKV) is om die aanvraag na avokado's te verhoog deur middel van advertensie, promosie of enige ander manier wat deur die Vereniging goed gevind word. Voordat 'n produk aangemoedig en geadverteer kan word, is verbruikersnavorsing noodsaaklik om die verbruiker se houding en gevoel ten opsigte van 'n produk te bepaal. Hierdie bevindinge moet dan opgevolg word deur wetenskaplike studies, gemik op spesifieke probleme en teikengroepe, om wetenskaplike bewyse te verkry. Min verbruikersnavorsing is tot dusver op avokado's gedoen, en studies wat die gesondheidseffekte van avokado's ondersoek is beperk, en beskikbare literatuur is slegs gefokus op die cholesterol-verlagende effekte van avokado's.

Doelwitte

Eerstens is die doelwit om die opvattings en houding van die Suid-Afrikaanse verbruiker teenoor avokado's en gesondheid te ondersoek; om die effek van geslag, ouderdom, ras of lewenstandaard op die verbruiker se houding teenoor avokado's te bepaal.

Tweedens is die doelwit om te bewys dat avokado's nie vetmakend is nie en in verslankingsdiëte ingesluit kan word; om die effek van avokado's, 'n ryk bron van mono-onversadigde vetsure, as deel van 'n verslankingsdieet op gewigsverlies, serumlipiede, fibrinogeen en vaskulêre funksie in oorgewig- en obese proefpersone te ondersoek.

Metodes

- **Verbruikerstudie:** Een duisend nege honderd sewe en negentig Suid-Afrikaanse individue, ewekansig geselekteer uit metropolitaanse gebiede in Suid Afrika, het aan hierdie studie deelgeneem. Data is geweeg ten opsigte van geslag, ouderdom en rasseverspreiding om die volwasse metropolitaanse populasie te reflekteer. Die totale populasie (10 695 000) was verteenwoordigend van beide geslagte (5 423 000 mans en 5 272 000 vroue) en hoof rassegroepe (2 615 000 blankes, 6 252 000 swartes, 1 255 000 kleurlinge en 573 000 Indiërs) van verskillende ouderdomsgroepe en lewenstandaarde. Die vraelyste, bestaande uit 17 voedselverwante vrae, is deur 'n multidissiplinêre span opgestel waarvan een oor die houding teenoor avokado's gehandel het. Opgeleide veldwerkers het persoonlike onderhoude met

verbruikers gevoer. Die marknavorsingsmaatskappy, MARKINOR, was gekontrakteer om die data in te samel. Kwantitatiewe data is statisties ontleed om die relevante beskrywende statistiek, oorkruis-tabellering en statistiese toetse te verkry.

- **Dieetintervensiestudie:** Een en sestig vry-lewende oorgewig vrywilligers met 'n gemiddelde (standaard afwyking) liggaamsmassa-indeks (LMI) van 32 (3.9) kg/m^2 het in hierdie ewekansig geselekteerde, gekontroleerde parallelle studie deelgeneem. Die proefpersone is afgepaar volgens geslag, LMI en ouderdom, en ewekansig aan twee groepe toegeken. Die eksperimentele groep het 200 g avocado (1 avocado) per dag ingeneem wat 30 g van hul dieetvet vervang het, terwyl die kontrolegroep geen avokado's tydens hul verslankingsdieet vir ses weke ingeneem het nie. Die diëte was isokalories en die totale energie het bestaan uit 30% vet, 55% koolhidrate en 15% proteïene. 'n Sewe-dag maaltydplan is aan albei groepe gegee op grond van hul energiebehoeftes. Antropometrie, fisiese aktiwiteit, dieetinnames, bloeddruk en arteriële meegewendheid is aan die begin en einde van die studie met behulp van standaard metodes bepaal. Vastende bloedmonsters is verkry aan die begin en einde van die studie.

Resultate

- **Verbruikerstudie:** Daar is geen prakties betekenisvolle verskille in die verbruikers se response ten opsigte van geslag of ouderdom gevind nie. Prakties betekenisvolle verskille is wel tussen verskillende rassegroepe en LSM (Lewenstandaard Meting)-groepe vir sommige veranderlikes gevind. Die algehele respons van verbruikers ten opsigte van die effek van avokado's op gesondheid, gesondheid van die hart, gesondheid van kinders en die gesondheidseffekte geassosieer met die vetinhoud van avokado's was baie positief. Ongeveer die helfte van die verbruikers is nog steeds nie oortuig nie of onseker van die cholesterolinhoud van avokado's, terwyl 47% van die verbruikers nog steeds glo dat avokado's vet maak. Meer as 80% van die verbruikers stem saam dat avokado's 'n goeie bron is van vitamiene en minerale, en 76% sien avokado's as 'n goeie bron van vesel. Ongeveer 70% van die verbruikers stem saam dat avokado's goed is vir sportmanne en –vroue. Avokado's word deur 49% van die verbruikers beskou as 'n vrug wat seksuele funksionering bevorder.
- **Dieetintervensiestudie:** Die inskiklikheid van avokado-inname in die eksperimentele groep is bepaal as 94.6%. Antropometriese bepalings (liggaamsmassa, LMI en liggaamsvetpersentasie) het in albei groepe gedurende die studie betekenisvol verlaag, en die verskil was dieselfede in beide groepe. Serumlipiede (totale cholesterol, laedigtheidslipoproteïencholesterol (LDL-C), hoëdigtheidslipoproteïencholesterol (HDL-C) en trigliseriede), fibrinogeen, bloeddruk en arteriële meegewendheid het nie betekenisvol binne of tussen die twee groepe verander nie.

Gevolgtrekkings

- **Verbruikerstudie:** Daar bestaan nog steeds 'n paar mites en wanopvattings by sommige verbruikers aangaande avokado's, veral ten opsigte van seksuele funksionering, cholesterolinhoud en die vetmakende eienskappe van avokado's. Die landbou-industrie kan hierdie resultate gebruik om verskillende bemarkingsveldtogte, gefokus op spesifieke teikengroepe, te beplan ten einde wanopvattings rakende avokado's te verander en die positiewe voedingswaarde van avokado's oor te dra.
- **Dieetintervensiestudie:** Die inname van 200 g avokado per dag, as deel van 'n verslankingsdieet, benadeel nie gewigsverlies wanneer dit 30 g dieetvet vervang nie. Gewigsverlies of avokado-inname het nie die serumlipiedvlakke, plasma fibrinogeen, bloeddruk of arteriële meegewendheid beïnvloed nie.

Sleutelterme: Avokado's; verbruiker; houding; opvattings; gesondheid; mono-onversadigde vetsure; gewigsverlies; obesiteit;serumlipiede; vaskulêre funksie; fibrinogeen.

SUMMARY

Motivation

The objective of the South African Avocado Growers Association (SAAGA) is to increase the demand of avocados by advertising, promoting and other means deemed fit by them. In order to promote and advertise a product, consumer research has to be done to determine the consumers' attitudes towards and beliefs concerning the product. These findings then need to be followed up by scientific studies, targeted at specific problems and target groups to yield scientific evidence. Little consumer research has been done on avocados and studies investigating the health effects of avocados are limited, with available literature only focussing on the cholesterol lowering effect of avocados.

Objectives

Firstly, the objective is to investigate the beliefs and attitudes of the South African consumer towards avocados and health; to determine whether gender, age group, race or living standard influence the consumers beliefs towards avocados.

Secondly, the objective is to dispel the myth that avocados are fattening and should therefore be avoided in energy restricted diets; to examine the effects of avocados, a rich source of mono-unsaturated fatty acids, as part of an energy restricted diet on weight loss, serum lipids, fibrinogen and vascular function in overweight and obese subjects.

Methods

- **Consumer study:** One thousand nine hundred and ninety-seven South African individuals, randomly selected from metropolitan areas in South Africa, participated in this survey. Data were weighed to reflect the adult metropolitan population based on gender, age and race distribution. The total population (10 695 000) was representative of both genders (5 423 000 men and 5 272 000 women) and major race groups (2 615 000 whites, 6 252 000 blacks, 1 255 000 coloureds and 573 000 Indians) from different age groups and living standards. The questionnaires were designed by a multidisciplinary team and consisted of seventeen food-related questionnaires, of which one questioned the beliefs regarding avocados. Trained field workers administrated questionnaires by conducting face-to-face interviews with consumers. The market research company, MARKINOR, was contracted to collect the data. Quantitative data was statistically analysed in order to generate the relevant descriptive statistics, cross tabulations and statistical tests.

- **Dietary intervention study:** Sixty one free-living volunteers (13 men; 48 women), with a mean (standard deviation) body mass index (BMI) of 32 (3.9) kg/m^2, participated in this randomised, controlled parallel study. The subjects were paired according to gender, BMI and age and randomly assigned to one of two groups. The experimental group consumed 200 g of avocado (1 avocado) per day, substituting 30 g of other mixed dietary fats, and the control group excluded avocado from their energy restricted diet for six weeks. Seven-day isoenergetic menu plans were given according to mean energy requirements of both genders to provide 30% fat, 55% carbohydrates and 15% protein of total energy intake. Anthropometric measurements, physical activity, dietary intakes, blood pressure and arterial compliance were measured with standard methods at the beginning and end of the intervention. Fasting blood samples were drawn at the beginning and end of the intervention period.

Results

- **Consumer study:** There were no practical significant differences in the consumers responses in terms of gender or age. Practical significant differences were found between different race and LSM (Living Standard Measure) groups for some variables. The overall response of consumers towards the effect of avocados on health, heart health, children's health and the health effects associated with the fat content of avocados were very positive. However, almost half the consumers are still not convinced of or are uncertain as to the cholesterol content of avocados, while 47% of the consumers still believe that avocados are fattening. More than 80% of the consumers agreed that avocados are a good source of vitamins and minerals, and 76% consider avocados to be a good source of fibre. Almost 70% of the consumers agreed that avocados are good for sportsmen and –women. Avocados were seen by 49% of the consumers to be an aphrodisiac.
- **Dietary intervention study:** Fifty-five subjects completed the study. Compliance with avocado intake in the experimental group was 94.6%. Anthropometric measurements (weight, body mass index and percentage body fat) decreased significantly in both groups during the study ($p<0.001$), and the change was similar in both groups. Serum lipid levels (total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol and triglycerides), fibrinogen, blood pressure and arterial compliance did not change significantly within or between the two groups.

Conclusions

- **Consumer study:** There are still a few myths and misconceptions that exist among some consumers regarding avocados, especially with regard to sexual functioning, cholesterol content, and fattening effect of avocados. The agricultural industry can use these results to plan different marketing campaigns focused on certain target groups to change the misperceptions concerning avocados and convey the positive nutritional value of avocados.
- **Dietary intervention study:** The consumption of 200 g avocado per day, within an energy restricted diet, does not compromise weight loss when substituted for 30 g of mixed dietary fat. The serum lipid levels, plasma fibrinogen, arterial compliance, as well as systolic and diastolic blood pressure were not affected by weight loss or avocado intake.

Key words: avocados; consumer; belief; attitude; health; monounsaturated fatty acids; weight loss; obesity; serum lipids; vascular function; fibrinogen.

CONTENTS

LIST OF ABBREVIATIONS

%E	Percentage of total energy
ADA	American Dietetic Association
ANOVA	One-way analysis of variance
BHT	Butylated hydroxytoluene
BMI	Body mass index
BMR	Basal metabolic rate
BP	Blood pressure
CHD	Coronary heart disease
CHO	Carbohydrates
CI	Confidence intervals
CV	Coefficient of variance
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
DRI	Dietary reference intakes
EI	Energy intake
FDA	Food and Drug Administration
HDL-C	High-density lipoprotein cholesterol
HWC	High waist circumference
kJ	Kilojoules
LDL	Low-density lipoproteins
LDL-C	Low-density lipoprotein cholesterol
LSM	Living Standard Measure
MUFA	Monounsaturated fatty acids
NIDDM	Non-independent diabetes mellitus
PU for CHE	Potchefstroom University for Christian Higher Education
PUFA	Polyunsaturated fatty acids
SAARF	South African Advertising Research Foundation
SBP	Systolic blood pressure
SD	Standard deviation
SFA	Saturated fatty acids
SMC	Smooth muscle cell
TC	Total cholesterol
TFA	Trans fatty acids
TG	Triglycerides
USDA	United States Department of Agriculture
VLDL	Very low-density lipoproteins

CHAPTER 1

PREFACE

CHAPTER 1

PREFACE

1. AIMS AND OBJECTIVES

The aims and objectives of this dissertation were:

1.1 **Main aim**: To investigate the beliefs and attitudes of the South African consumer towards avocado and health.

Objectives: To determine whether gender, age group, race or living standard influence the consumers beliefs towards avocados.

1.2 **Main aim**: To determine if an increased consumption of avocado would compromise weight loss when consumed as part of an energy restricted diet. Another aim was to investigate the effects of avocados, as part of an energy restricted diet, on serum lipids, plasma fibrinogen and vascular function in obese subjects.

Objectives: To investigate the effects of avocados as part of an energy restricted diet on:

- Anthropometric variables: Body weight, body mass index (BMI) and percentage body fat
- Serum lipids: Total serum cholesterol (TC), triglicerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C)
- Plasma fibrinogen
- Vascular function: Systolic blood pressure (SBP), diastolic blood pressure (DBP) and arterial compliance.

2. STRUCTURE OF THIS DISSERTATION

This dissertation is presented in article format. The experimental work consisted of two studies, of which the first was in the field of consumer sciences and the second in the field of clinical nutrition. Following this preface chapter, Chapter 2 consists of a published review paper entitled "Avocados (monounsaturated fatty acids), weight loss and serum lipids" (published in The Specialist Forum, April 2003) that will serve as an introductory chapter. Chapter 3 consists of a manuscript on the South African consumers' beliefs regarding avocados and health (prepared for submission to the International Journal of Consumer Studies). The questionnaire used in this study is presented as Addendum A at the end of this dissertation. In Chapter 4, the effects of avocados, as part of an energy restricted diet, on weight loss, serum lipids, fibrinogen and vascular function are

investigated in obese subjects (submitted for publication in Nutrition: The International Journal of Applied and Basic Nutritional Sciences). The seven day menu plan, 24h-dietary recall form, physical activity questionnaire and calendar with important dates (e.g. when blood will be taken, etc.) used in this study are presented in Addenda B, C, D and E, respectively. In Chapter 5, a general discussion and summary of all the results are provided, conclusions are drawn and recommendations are made. The relevant references of Chapter 2, 3 and 4 are provided at the end of each chapter according to the authors' instructions of the specific journal to which the manuscripts were submitted or being prepared for.

3. AUTHORS CONTRIBUTIONS

The two studies reported in this dissertation were planned and executed by a team of researchers. The contribution of each of the researchers is given in Tables 1.1 and 1.2. Also included in this section is a statement from the co-authors confirming their individual role in each study and given their permission that the two articles may form part of this dissertation.

Table 1.1 Consumer beliefs, avocados and health

Name	Role in the study
Miss Z Pieterse (Hons. B.Sc Nutrition)	Responsible for literature searches and statistical analysis. Main author of the paper.
Prof. W Oosthuizen PhD (Nutritionist)	Supervisor. Critically revised paper.
Prof. JC Jerling Ph.D (Nutritionist)	Co-supervisor. Critically revised paper.
Me. J. Badham (Dietician)	Responsible for designing of questionnaires in co-operation with business partners and liasing with the market research company, MARKINOR.

I declare that I have approved the above-mentioned article, that my role in the study, as indicated above, is representative of my actual contribution and that I hereby give my consent that it may be published as part of the M.Sc. dissertation of Miss Z Pieterse.

Prof. JC Jerling

Prof. W Oosthuizen

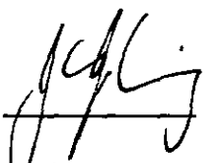
Me. J. Badham

Table 1.2 Avocados, weight loss and markers of cardiovascular health

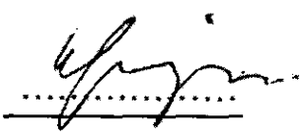
Name	Role in the study
Miss. Z Pieterse (Hons. B.Sc Nutrition)	Responsible, together with JC Jerling and W Oosthuizen for the design, planning, execution and documentation of the study. Responsible for literature searches, nutrient and laboratory analyses and processing of data. Main author of the paper.
Prof. W Oosthuizen Ph.D (Nutritionist)	All aspects considering the design, planning, approval of final protocol, funding, execution and documentation of the study. Study leader.
Prof. JC Jerling Ph.D (Nutritionist)	All aspects considering the design, planning, approval of final protocol, funding, execution and documentation of the study. Statistical analysis.
Dr. HS Kruger Ph.D (Dietitian and Pharmacist)	Involved in the standardisation of anthropometric measurements, and all aspects considering the execution and documentation of study.
Dr. SM Hanekom Ph.D (Dietitian)	Designing of the menu plans and reviewing of nutrient analysis.
Dr. CM Smuts (Nutritionist)	Analysis of plasma fatty acids.
Dr. AE Schutte PhD (Physiologist)	Blood pressure and arterial compliance measurements.

The following is a statement from the co-authors confirming their individual role in each study and given their permission that the article may form part of this dissertation.

I declare that I have approved the above-mentioned article, that my role in the study, as indicated above, is representative of my actual contribution and that I hereby give my consent that it may be published as part of the M.Sc. dissertation of Miss Z Pieterse.

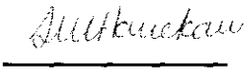


Prof. JC Jerling

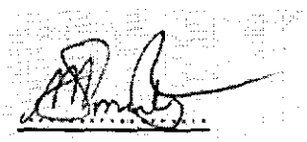


Prof. W Oosthuizen

Prof. HS Kruger



Dr. SM Hanekom



Dr. CM Smuts

Dr. AE Schutte

CHAPTER 2

AVOCADOS (MONOUNSATURATED FATTY ACIDS), WEIGHT LOSS AND SERUM LIPIDS

Zelda Pieterse, Johann C. Jerling, Welma Oosthuizen

Potchefstroom Institute of Nutrition, Potchefstroom University for Christian Higher Education, Potchefstroom, South Africa.

The Specialist Forum, published in April 2003

ABSTRACT

The consumption of diets enriched with monounsaturated fatty acids have been related to a lower rate of coronary heart disease, mainly due to their positive effects on serum lipids. The avocado is a fruit rich in monounsaturated fatty acids and other nutrients, offering protection against coronary heart disease. This article will review the scientific evidence on avocados, and their impact on weight loss and serum lipids.

INTRODUCTION

There is epidemiological evidence that increasing dietary monounsaturated fatty acids (MUFA) may decrease the risk of coronary heart disease (CHD). Moreover, evidence from controlled clinical studies has shown that a diet high in MUFA favourably affects a number of risk factors for CHD, including plasma lipids and lipoproteins, factors related to thrombogenesis, *in vitro* low density lipoprotein (LDL) oxidative susceptibility (compared to polyunsaturated fatty acids), and insulin sensitivity.[1] This article will focus on the effects of MUFA on plasma lipids.

Elevated blood concentrations of total cholesterol or LDL cholesterol (LDL-C) increase the risk of cardiovascular disease (CVD), whereas higher concentrations of high-density lipoprotein cholesterol (HDL-C) decrease risk. Elevated concentrations of circulating triglycerides (TG) have also been shown to be an independent risk factor for CVD.[2] In comparison with a diet high in saturated fatty acids (SFA), a high MUFA diet decreases LDL-C and TG levels and increases HDL-C levels.[1,3]

Avocados are a rich food source of MUFA, with a MUFA content of 15.63 g per 100 g of avocado.[4] The MUFA, oleic acid (C18:1), is the most prevalent MUFA in the diet, and contributes to 58.6% of the total fatty acids content found in avocados.[5] The high concentration of MUFA (oleic acid) in avocado suggests that a diet rich in avocado may have beneficial effects on blood lipids, and could play a significant role in protecting against the development of CHD.[6]

The first study concerning the health benefits of avocados was published in 1960, investigating the cholesterol-lowering effect of avocados.[7] This study stimulated new research on avocados, resulting in the publication of six other studies on the lipid-lowering effect of avocados.[6,8-12]

HEALTH PROFILE OF THE AVOCADO

Avocados meet the definition of a functional food as outlined by the American Dietetic Association (ADA) Position Statement in that they provide health benefits beyond basic nutrition.[13] The avocado is a nutrient dense, cholesterol-free fruit, which is low in sodium and can be considered to be a source of fibre. The nutritional information of avocados is given in *Table 1*.

Table 1 Nutritional information of avocados (per 100g edible portion)

	Amount	
	South African[4,5]	USDA[16]
Energy (kJ)	1021	741
Protein (g)	1.7	2.11
Carbohydrates (g)	1.9	6.91
Fibre (g)	5.3	4.9
Fat (g)	23.5	17.33
Monounsaturated fatty acids (g)	15.63	11.21
Polyunsaturated fatty acids (g)	3.04	2.041
Saturated fatty acids (g)	4.82	2.59
Cholesterol (g)	0	0
Vitamin A (RE) (µg)	61	61
Vitamin C (mg)	14	7.9
Vitamin E (mg)	1	1.34
Thiamine (mg)	0.04	0.108
Riboflavin (mg)	0.03	0.122
Niacin (mg)	1.6	1.921
Folate (µg)	29	66
Magnesium (mg)	31	41
Iron (mg)	0.4	1.18
Potassium (mg)	583	634
Lutein (µg)	169	-
Beta-Sitosterol (mg)[17]	76	

USDA: United States Department of Agriculture

New research from the University of California, Los Angeles, indicates that California avocados have nearly twice as much vitamin E as previously reported, making avocados the highest fruit source of this powerful antioxidant.[14] Love and Sayed have also identified avocados as a food that may protect against disease, due to its vitamin E content.[15]

According to the vegetable and fruit composition tables of South African food, avocados are the forth-highest fruit source of lutein among fruit.[4] Lutein is a carotenoid which improves visual

performance in patients with age-related cataracts as demonstrated by Olmedilla *et al* in a two year double-blind, placebo-controlled pilot study, where patients consumed 15mg of lutein three times a week.[18] Olmedilla *et al* summarised that similar results were also previously reported by other authors.[18]

The avocado provides more beta-sitosterol than any other fruit with known value.[19] Beta-sitosterol is the most abundant phytosterol found in avocados and function as an anticholesterolemic agent.[17] On a gram-per-gram basis, avocados contain more than for times the beta-sitosterol of oranges, which have previously been reported as the richest known fruit source of beta-sitosterol.[19]

AVOCADOS AND WEIGHT LOSS

Obesity is considered a risk factor for the development chronic diseases. A 20% increase in body weight substantially increases the risk for hypertension, coronary artery disease, lipid disorders, and non-insulin-dependent diabetes mellitus.[20] The prevalence of obesity is common among South African women, ranging from 23.8% to 59.4%, with the highest prevalence among black women.[21]

In the public's mind, the word "dietary fat" has become synonymous with obesity and heart disease, whereas the words "low fat" and "fat-free" have become synonymous with heart health. Compelling evidence, however, indicates the greater importance of types of fat, rather than total amount of fat with respect to risk of CHD.[22] A very low-fat diet (10%E), high in carbohydrates, will, however, not necessarily prevent the development of obesity and may even have other negative effects, such as decreased HDL-C and increased TG, as well as insulin resistance (glucose intolerance). A moderate-fat diet (30%E) with a low SFA (<10%E) and high MUFA has the most beneficial effect on lipid profiles and is also associated with a lower body mass.[21]

Avocados are, when compared to other fruit, high in fat (17.33-23.5g/100g)[4,16] and are seen by many consumers to be fattening, and therefore excluded in energy restricted diets.

In a recent study conducted by the Potchefstroom Institute of Nutrition at the Potchefstroom University, the effects of avocado within an energy restricted diet on weight loss and serum lipids were investigated in overweight and obese subjects, using a controlled parallel intervention study. Intervention studies are experimental studies in which an exposure (avocado intake) is given to a group of people over a certain time period, and the effect/outcome (e.g. weight loss, serum lipids) compared to a control group, which did not receive the treatment. In this study fifty-five free-living volunteers (11 men, 44 women), with a body mass index of between 27 and 44 kg/m^2, were paired and randomly assigned to one of two groups. The experimental group consumed 200g of avocado (1 avocado) per day, substituting 30g of other dietary fats, and the control group excluded avocado from their energy restricted diet for six weeks. Seven-day isocaloric menu plans were given

according to energy requirements of both groups to provide 30% fat, 55% carbohydrates and 15% protein of total energy.[23]

There were significant reductions in body weight in both groups during the study. The weight lost by the experimental and control group was similar and was accompanied by significant reductions in body mass index and percentage body fat. The study concluded that the consumption of 200g avocado per day, within an energy restricted diet, did not compromise weight loss when substituted for 30g of dietary fat.[23]

The study thus proves that avocados are not more fattening than other fat sources. The inclusion of avocados in energy restricted diets will probably also increase the palatability of the diet and promote dietary compliance. The total amount of fat in avocados is lower when compared to other dietary sources *(Table 2)*. Avocados can therefore be a healthy substitute for butter/margarine, cheese, cream cheese – on bread, toast, crackers – as well as a healthy substitute for commonly used ingredients in dips.[24]

AVOCADOS, MUFA AND SERUM LIPIDS

A fatty acid is an organic acid – a chain of carbon atoms with hydrogen atoms attached – that has an acid group (-COOH) at one end and a methyl group (-CH3) at the other end. Unsaturated fatty acids lack hydrogen atoms and have at least one double bond between carbon atoms. MUFA lacks two hydrogen atoms and has one double bond between carbon atoms.[24] The richest sources of MUFA in the diet are vegetable oils, especially olives and olive oil, canola oil, avocados and nuts (*Table 3*).

Studies investigating the lipid-lowering effects of avocados as MUFA source are limited. The primary food source of MUFA that has been used in studies is olive oil, with only seven studies published where avocados were used as main MUFA.[6-12] Five of the seven studies published are, however, poorly designed because of a lack of an appropriate control group, and will therefore not be discussed.[6,7,8,9,12]

In a well-designed randomised parallel controlled study, Lopez-Ledesma *et al*, investigated the effects of a MUFA (avocado) rich diet in 37 adult patients with mild hypercholesterolemia (15 of them with hypertriglyceridemia), and 30 healthy patients.[11] Patients were randomly assigned to receive either a high MUFA diet or an isocaloric control diet for a period of seven days, while being hospitalised. They found a significant decline in total cholesterol and LDL-C concentration with no change in HDL-C in healthy and hypercholesterolemic subjects, as well as a significant decline in TG levels in moderately hypercholesterolemic patients, either with hypertriglyceridemia (combined

Table 2 Comparison of high-fat dietary sources[4,5]

	Avocado		Margarine (Brick/Hard)		Margarine (Med fat, spread)		Mayonnaise		Cream (Canned)		Cream Cheese		Cheese (Cheddar)	
	Per 100g	Per 30g serving	Per 100g	Per 5g serving	Per 100g	Per 5g serving	Per 100g	Per 5g serving	Per 100g	Per 15g serving	Per 100g	Per 20g serving	Per 100g	Per 30g serving
Kilojoules (kJ)	1021	309	2975	149	1882	94	2165	108	905	135	1466	293	1646	499
Fat (g)	23.5	7.1	80	4	50.5	2.53	54	2.7	21	3.1	34.9	6.98	32.3	9.8
SFA (g)	4.82	1.46	14.3	0.72	9.87	0.49	6.84	0.34	13.1	1.96	22.0	4.4	18.4	5.6
MUFA (g)	15.6	4.7	35.7	1.79	12.1	0.61	10.0	0.5	6.05	0.9	9.84	1.97	8.1	2.5
PUFA (g)	3.04	0.92	26.2	1.31	26.3	1.32	34.6	14.6	0.78	0.12	1.27	0.25	0.75	0.23
Cholesterol (g)	0	0	0	0	0	0	28	1.4	44	6.6	110	22	115	34.8

SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids

Table 3 Dietary sources high in MUFA (100g portion) [4,5]

Dietary source	Kilojoules (kJ)	Total fat (g)	MUFA (g)
Vegetable oil			
Canola	3700	100	58.9
Olive	3699	100	73.7
Sunflower	3699	100	18.57
Avocado[16]	884	100	70.55
Peanut	3700	100	40.84
Nuts and seeds			
Almonds	2451	52.5	34.11
Cashews	2402	46.4	27.32
Hazel	2643	62.6	49.09
Macadamia	2936	73.7	58.17
Pecans	2792	67.6	42.16
Peanuts	2431	49.3	24.46
Fruit			
Avocado	1021	23.5	15.63
Olives	517	10.7	7.89

MUFA: Monounsaturated fatty acids.

hyperlipidemia) or with normal serum TG levels.[11] The short intervention period of only seven days is, however, a limitation of the study. The controlled feeding on the other hand provides strength to the study.

Carranza *et al* showed improvement in lipid levels, when investigating the effects of avocado on the level of blood lipids in 8 patients with phenotype II and 8 patients with phenotype IV dyslipidemias.[10] Patients were assigned to either a diet rich in MUFA using avocado as their major source, or a low-saturated fat diet without avocado. Diets were of 4 weeks duration and they were assigned in a crossover design, with their three daily meals eaten at their clinical unit. Total cholesterol and LDL-C decreased significantly in patients with phenotype II dyslipidemia. A significant increase was also seen in HDL-C in both phenotype II and IV dyslipidemia patients. Carranza *et al* concluded that avocados are an excellent source of MUFA in diets designed to treat

hypercholesterolemia with some advantages over low-fat diets with a greater amount of carbohydrates.[10] This study also used controlled feeding, which strengthens the study, but the small sample size used is, however, a limitation.

The study by Pieterse *et al*, however, found no significant changes in plasma lipid levels when investigating the effects of avocado within an energy restricted diet on weight loss and serum lipids in overweight and obese subjects.[23] This could be due to the normal to borderline high serum lipid levels of the subjects, in contrast to the dyslipidemic patients used in the previous studies. The good initial MUFA intake (10% of total energy intake) of the subjects recorded at baseline, could also be a possible explanation for the lack of effect.

There is thus scientific evidence suggesting a lipid-lowering effect when consuming high MUFA diets enriched with avocados, especially in hypercholesterolemic patients.

LIPID-LOWERING MECHANISMS OF AVOCADOS

Interest in the lipid-lowering effect of avocados has primarily been stimulated by the high MUFA content of avocados. Data also suggest that the phytosterols found in avocados could contribute to their lipid-lowering effect.

Effect of MUFA

Kinetic studies have previously demonstrated that plasma LDL concentrations are dependent on the production rate of small, very low-density lipoproteins (VLDL). This suggests that the hypocholesterolaemic effect of MUFA may be due to an alternation of $VLDL_2$ particle production rates, but not the larger triacylglycerol-rich $VLDL_1$ particles, as plasma triacylglycerol levels were found to be unaffected by MUFA. A study by Sanderson and co workers suggested that the LDL-lowering effect of increasing dietary MUFA is mediated either by an upregulation of LDL clearance or by reduced conversion of intermediate-density lipoprotein into LDL. Thus, MUFA did not change triacylglycerol, but decreased LDL-cholesterol.[25]

In addition to the lowering of LDL-C by high MUFA diets, studies also found decreases in plasma TG levels with a high MUFA diet, suggesting a triacylglycerol-lowering effect by MUFA. The underlying mechanism for the hypotriacylglycerolemic effect of MUFA is not clear.[26] However, McNamara proposed two complementary mechanisms that may be involved: (1) changes in the composition of VLDL (2) changes in the expressed activities of the enzymes and proteins involved in intravascular processing and catabolism of VLDL, both of which would decrease plasma triacylglycerol concentrations.[27] Additional studies are, however, needed to clarify the mechanism or mechanisms by which MUFA elicit a triacylglycerol-lowering effect.[26]

Effect of phytosterols

Recently, analysis of avocados has provided new information showing that this fruit is a significant source of dietary phytosterols.[17] Plant sterols (phytosterols) are found in vegetable oils, seeds, nuts and some vegetables and fruit. Phytosterols are the plant analogues of cholesterol and are effective in reducing serum cholesterol levels without causing serious side effects.[28] On average, a 13% reduction in LDL and a 10% reduction in total cholesterol concentrations were found by Moghadasian and Frohlich in a review of 16 published studies, using various phytosterol mixtures (1-6 g/day). Neither HDL cholesterol or triglyseride levels are found to be significantly affected by dietary phytosterols.[28] The mechanism for the serum cholesterol-lowering effect of phytosterols involves inhibition of intestinal cholesterol absorption and decreased hepatic cholesterol synthesis.[17] In the light of the fairly high doses phytosterols necessary to significantly reduce cholesterol it is unclear what the overall impact of the phytosterols in avocados might be.

CONCLUSION

CHD is one of the leading causes of mortality and morbidity in South Africa.[29] It is accepted that diet, *inter alia,* through its effects on lipid metabolism and antioxidant properties, plays an important role in the primary and secondary prevention of CVD.[30]

There is consistent evidence showing a lipid-lowering effect of diets high in MUFA. A MUFA-enriched diet also does not compromise weight loss. Although the existing scientific evidence on avocados is limited, the high MUFA content and nutrient density of the avocado, suggests a beneficial effect on the lipid and nutrient profile, and should be considered as part of a dietary strategy to protect against the development of CHD.

REFERENCES

1. Kris-Etherton PM. Monounsaturated fatty acids and risk of cardiovascular disease. *Circulation* 1999;100:1253-1258.

2. Feldman EB. Assorted monounsaturated fatty acids promote healthy hearts. *Am J Clin Nutr 1999;70:953-954.*

3. Van Horn L, Ernst N. A summary of the science supporting the new National Cholesterol Education Program dietary recommendations: What dieticians should know. *J Am Diet Assoc* 2001;101(10):1148-1154.

4. Kruger M, Sayed M, Langenhoven ML, Holling F. Composition of South African Foods: Vegetables and fruit. Supplement to the MRC Food composition tables 1991. 1st ed. Tygerberg: Medical Research Council, 1998.

5. Kruger M, Langenhoven M, Faber M. Fatty acid and amino acid composition tables. Supplement to the MRC food composition tables. Parow: National Research Programme for Nutritional Intervention Medical Research Council, 1991.

6. Colquhoun DM, Moores D, Somerset SM, Humphries JA. Comparison of the effects on ipoproteins and apolipoproteins of a diet high in monounsaturated fatty acids, enriched with avocado, and a high-carbohydrate diet. *Am J Clin Nutr* 1992;56:671-677.

7. Grant WC. Influence of avocados on serum cholesterol. *Proc. Soc. Exp Biol Med* 1960;104:45-47.

8. Alvizouri-Muñoz M, Carranza-Madrigal J, Herrera-Abarca JE, Chavez-Carbajal F, Amezcua-Gastelum JL. Effects of avocado as a source of monounsaturated fatty acids on plasma lipid levels. *Arch Med Res* 1992;23(4):163-167.

9. Lerman-Garber I, Ichazo-Cerro S, Zamora-González J, Cardososaldaña GG, Posadas-Romero C. Effects of a high-monounsaturated fat diet enriched with avocado in NIDDM patients. *Diabetes care* 1994;17(4):311-315.

10. Carranza J, Alvizouri M, Alvarado MR, Chávez F, Gómez M, Herrera JE. Effects of avocado on the level of blood lipids in patients with phenotype II and IV dyslipidemias. *Arch Inst Cardiol Mex* 1995;65(4):342-348.

11. Lopez-Ledesma R, Frati-Munari AC, Hernandez-Dominguez BC, Cervantes-Montalvo S, Hernandez-Luna MH, Juarez C, Moran-Lira S. Monounsaturated fatty acid (avocado) rich diet for mild hypercholesterolemia. *Arch Med Res* 1996;27(4):519-523.

12. Carranza-Madrigal J, Herrera-Abarca JE, Alvizouri-Muñoz M, Alvarado-Jimenez MR, Chavez-Carbajal F. Effects of a vegetarian diet vs. a vegetarian diet enriched with avocado in hypercholesterolemic patients. *Arch Med Res* 1997;28(4):537-541.

13. Position of the American Dietetic Association: Functional foods. *J Am Diet Assoc.* 1999;99:1278-1285.

14. Hispanic Online. The amazing avocado. [Web:] http://hispaniconline.com/lstyles/food&rest/avocado.html [Date of access: 1 Feb. 2003]

15. Love P, Sayed N. Eat plenty of vegetables and fruits everyday. South African Food-Based Dietary Guidelines. *SAJCN* 2001;14(3)Suppl:S24-S32.

16. USDA National Nutrient Database for Standard Reference. United States Department of Agriculture Web site. Release 15. August 2002. [Web:] http://www.nal.usda.gov/fnic/cgi-bin/list_nut.pl [Date of access: 3 Mar. 2003].

17. Duester KC. Avocado fruit is a rich source of beta-sitosterol. *J Am Diet Assoc* 2001;101(4):404-405.

18. Olmedilla B, Grando F, Blanco I, Vaquero M. Lutein, but not α-tocopherol, supplementation improves visual function in patients with age-related cataracts: a 2-y double-blind, placebo-controlled pilot study. *Nutr* 2003;19:21-24.

19. Weihrauch JL, Gardner JM. Sterol content of foods of plant origin. *J Am Diet Assoc* 1987;73:39-47.

20. Laquatra I. Nutrition for weight management. In *Krause's food, nutrition & diet therapy,* 10th ed. LK Mahan & S Escott-Stump, pp 486-515. Philadelphia: W.B. Saunders, 2000.

21. Wolmarans P, Oostuizen W. Eat fat sparingly – implications for health and disease. South African Food-Based Dietary Guidelines. *SAJCN* 2001;14(3)Suppl:S48-S54.

22. Hu FB, Manson JE, Willett WC. Types of dietary fat and risk of coronary heart disease: critical review. *J Am Coll Nutr* 2001;20(1):5-19.

23. Pieterse Z, Jerling JC, Oostuizen W, Kruger HS, Hanekom SM, Smuts CM, Lessing MC, Schutte A. 2002. The effect of avocados within an energy restricted diet on weight loss and serum lipids in obese subjects. Potchefstroom: PU for CHE. (Thesis – Honns.Sc) 18p.

24. Whitney EN, Cataldo CB, Rolfes SR. Understanding normal and clinical nutrition. 5th ed. Belmont: Wadsworth, 1998.

25. Sanderson P, Gill JMR, Packard CJ, Sanders TAB, Vessby B, Williams CM. UK food standards agency cis-monounsaturated fatty acid workshop report. *BJN* 2002;88:99-104.

26. Kris-Etherton PM, Pearson TA, Wan Y, Hargrove RL, Moriarty K, Fishell V. High-monounsaturated fatty acid diets lower both plasma cholesterol and triacylglycerol concentrations. *Am J Clin Nutr* 1999;70:1009-1015.

27. McNamara DJ. Dietary fatty acids, lipoproteins, and cardiovascular disease. *Adv Food Nutr Res* 1992;36:253-351.

28. Moghadasian MH, Frohlich JJ. Effects of dietary phytosterols on cholesterol metabolism and atherosclerosis: Clinical and experimental evidence. *Am J Med* 1999;107:588-594.

29. Bradshow D, Bourne D, Schneider M, Sayed R. Mortality patterns of chronic diseases of lifestyle in South Africa. In: *Chronic Diseases of Lifestyle in South Africa.* Fourie J, Steyn K,.pp 5-36. Cape Town: Medical Research Council, 1995.

30. Vorster HH, Cummingss JH, Jerling JC. Diet and haemostatic processes. *Nutrition research reviews* 1997;10:115-135.

CHAPTER 3

THE BELIEFS OF SOUTH AFRICAN CONSUMERS REGARDING AVOCADOS AND HEALTH

Z Pieterse[1] Hons.BSc, W Oosthuizen[1] PhD, JC Jerling[1] PhD, J Badham RD[2]

[1]Potchefstroom Institute of Nutrition, Potchefstroom University for Christian Higher Education, Potchefstroom, South Africa.

[2]JB Consultancy, Johannesburg, South Africa.

Prepared for submission to the *International Journal of Consumer Studies.*

SUMMARY

Objectives: Firstly the objective was to investigate the beliefs and attitudes of the South African consumer towards avocados and health. Secondly the objective was to determine whether gender, age group, race or living standard influence the consumers' beliefs towards avocados.

Methodology: One thousand nine hundred and ninety-seven South African individuals, randomly selected from metropolitan areas in South Africa, participated in this survey. Data were weighed to reflect the adult metropolitan population based on gender, age and race distribution. The total population (10 695 000) was representative of both genders (5 423 000 men and 5 272 000 women) and major race groups (2 615 000 whites, 6 252 000 blacks, 1 255 000 coloureds and 573 000 Indians) from different age groups and living standards. The questionnaires were designed by a multidisciplinary team and consisted of seventeen food-related questionnaires, of which one questioned the beliefs regarding avocados. Trained field workers administrated questionnaires by conducting face-to-face interviews with consumers. The market research company, MARKINOR, was contracted to collect the data. Quantitative data was statistically analysed in order to generate the relevant descriptive statistics, cross tabulations and statistical tests.

Results: There were no practical significant differences in the consumers responses in terms of gender or age. Practical significant differences were found between different race and LSM (Living Standard Measure) groups for some variables. The overall response of consumers towards the effect of avocados on health, heart health, children's health and the health effects associated with the fat content of avocados were very positive. However, almost half the consumers are still not convinced of or are uncertain as to the cholesterol content of avocados, while 47% of the consumers still believe that avocados are fattening. More than 80% of the consumers agreed that avocados are a good source of vitamins and minerals, and 76% consider avocados to be a good source of fibre. Almost 70% of the consumers agreed that avocados are good for sportsmen and –women. Avocados were seen by 49% of the consumers to be an aphrodisiac.

Conclusion: There are still a few myths and misconceptions that exist among some consumers regarding avocados, especially with regard to sexual functioning, cholesterol content, and fattening effect of avocados. The agricultural industry can use these results to plan different marketing campaigns focused on certain target groups to change the misperceptions concerning avocados and convey the positive nutritional value of avocados.

Keywords: Avocados; consumer; belief; attitude; health.

Short title: Consumer beliefs, avocados and health

INTRODUCTION

In a report on South African food consumption studies undertaken amongst different population groups from 1983 to 2000,[1] avocados were found to be one of fourteen raw fruits (excluding wild fruit) commonly consumed by more than 3% of South African adults (>10 years), as reported in 4 of the 8 surveys included. The percentage intake of the groups consuming avocados and average gram per person per day (g/person/d) of those consuming the fruit were 4.2% (73.7); 16.2% (35.1), 71.9% (25.7) and 5.8% (63.8) in the respective studies. The per capita (average portion) consumption was also calculated (gram per person per day), which was 3.1, 5.7, 18.5 and 3.7 g/person/day. The per capita consumption is always less than the average portion consumed since it is the total amount consumed divided by the total population. In one of the studies, the Dikgale study, conducted on adults in the Northern Province, avocados were found to be the fruit most frequently consumed, and one of a total of only 28 different food items consumed by this study population.[1] The avocado is also ranked 14th among the most frequently consumed raw fruits in the United States.[2]

Avocados are one of three fruit and vegetables that carries the heart Mark of the South African Heart Foundation to be eaten as part of the heart foundation eating plan. The Heart Mark is a guideline and incentive for shoppers to instantly identify healthy products on the shelf. These products are low in cholesterol, low in saturated fat, low in salt and high in fibre (where applicable).[3] Avocados were also listed in the new USDA Dietary Guidelines for Americans as an unsaturated fat that can be included in a healthy diet.[4]

Avocados were previously excluded from the products included in the 5 A day program of the UK Department of Health due to its fat content, but a review of the scientific evidence on avocados showed that the monounsaturated fat found in the fruit has health benefits and is associated with lower risk of heart disease, and is therefore now included in this program.[5,6]

It is unfortunate for both avocado growers and the consumer public that weight-conscious people often shun the avocado because of the mistaken idea that eating it will tend to increase one's weight. Contributing to this misconception is the public's tendency to accept the oversimplification that "if it tastes rich, it's bad for you;" what's "good" for us is supposed to be only the less appealing foods such as carrots, lettuce, and spinach.[7]

In 1992 the California Avocado Commission conducted a national consumer market research study among American consumers. In general, when asking respondents about their attitudes towards avocados, they indicated that they see avocados as having a pleasant taste, being very nutritional and being versatile. The Commission is constantly at work setting the record straight on the myths and misconceptions consumers have concerning the fruit, especially revolving around cholesterol and fat content.[8]

The "Monthly Ag Briefs", published by the Hawaii Department of Agriculture, have recently reported that a change in consumer attitudes towards the health value of avocado has helped boost the consumption of the fruit. They also state that, in the past, the attitude was that avocados were fattening and did not contain significant amounts of nutrients, but that recent research by nutritionists have found plenty of health benefits in avocados.[9]

This study is the first consumer study to examine the beliefs of South African consumers towards avocados and will focus on the influence of gender, age, race and living standards on the consumers' responses towards avocados.

METHODS

Subjects

In 2002 one thousand nine hundred and ninety-seven South African individuals, randomly selected from metropolitan areas in South Africa, participated in this survey. Data were weighed to reflect the adult metropolitan population based on gender, age and race distribution and resulted in a total population of 10 695 000. The total population was representative of both genders (5 423 000 men and 5 272 000 women) and major race groups (2 615 000 whites, 6 252 000 blacks, 1 255 000 coloureds and 573 000 Indians) from different age groups and living standards.

Questionnaires

The questionnaires were designed by a multidisciplinary team consisting of researchers and business partners. Trained field workers administrated questionnaires by conducting face-to-face interviews with consumers. The market research company, MARKINOR, was contracted to collect the data. Seventeen food-related questionnaires were developed, of which one questioned the beliefs regarding avocados using the following fourteen statements (Addendum I):

1. Avocados are good for your health
2. Avocados are good for children
3. Avocados are fattening
4. Avocados contain fat and so are bad for you
5. Avocados are good for sportsmen/women
6. Avocados contain good fat but you must not eat too many
7. Avocados contain good fat, therefore you can eat them
8. Avocados are a good source of fibre
9. Avocados contain cholesterol and so are bad for you
10. Avocados are bad for your heart
11. Avocados contain fat, but can still be eaten as part of a healthy diet
12. Avocados are bad for you
13. Avocados are a good source of vitamins and minerals
14. Avocados improve sexual functioning

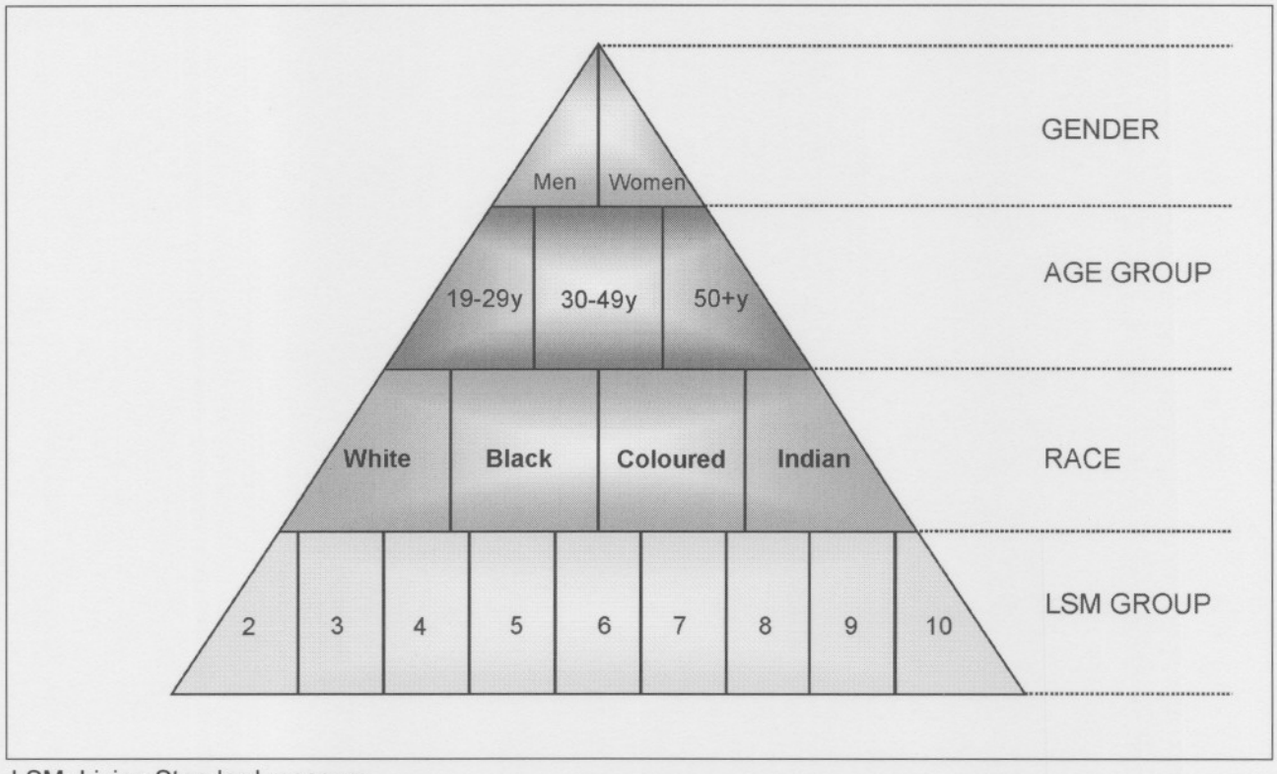
Respondents were asked to rate each of the above statements on how strongly they agree with them on a scale of 5 to 1, as illustrated in Table I.

Table I Five point response scale

Response	Scale
STRONGLY AGREE	5
AGREE	4
NEITHER AGREE NOR DISAGREE	3
DISAGREE	2
STRONGLY DISAGREE	1

The variables that were investigated for each of the statements in the questionnaire were gender, age, race and Living Standard Measure (LSM). The variables were subdivided into groups as illustrated in Figure I.

Figure I Variables and subgroups



LSM: Living Standard measure

The South African Advertising Research Foundations' (SAARF) classification to group people according to their living standards using criteria such as degree of urbanisation and ownership of cars and major appliances was used. The SAARF LSM divided the population into ten groups, from 1 at the bottom end, to 10 at the top.[10] There are no people in LSM group 1 living in metropolitan areas, and are therefore not included in this report.

Statistical analysis

The quantified data produced from questionnaires were analysed using the computer software package Statistica®. Firstly, an item analysis was done to decide whether items can be grouped, and factor analyses to make groups based on statistical calculations and also to check whether together they measure a single dimension. Item analysis was done by calculating the Cronbach's Alpha. The Cronbach's Alpha was 0.72 indicating that the group of items (statements) included could be used as a whole.

Secondly, cross tabulations were carried out for gender, race, age group and LSM group to examine frequencies of observations that belong to specific combinations of categories on more than one variable, allowing the identification of relationships between the cross tabulated variables. Cross tabulations were also used to describe the consumer characteristics. Thirdly, descriptive statistics were done to calculate the means and standard deviation (SD) of variables and subgroups for each statement.

Fourthly, one-way analysis of variance (ANOVA) (*F*-test) was performed to test for significant differences between means of variables. After obtaining statistically significant *F*-test from the ANOVA, post hoc comparisons were done to determine which means contributed to the effect, thus, which groups were particularly different from each other. The unequal N HSD post hoc test was used to determine the significant differences between group means.

Lastly, practical significance was determined for the variables where statistically significant differences were found with ANOVA. The practical significance between means was tested by using Tukey's multiple comparison test.[11] When a practical significant difference with a value of >0.14 was found, further calculations were made to determine between which groups the practical significance existed. This calculation yielded a d-value of which the effect size could be interpreted as follows[12]: small effect d=0.3-0.49; medium effect d=0.5-0.79; large effect d>0.8.

RESULTS

Although statistical analyses were performed on the 5 point response scale, results given as percentages will be reported using a three response scale, namely: "agree", "neither agree nor disagree" and "disagree", which were obtained by combining "strongly agree" with "agree", and "strongly disagree" with "disagree". Only practical significant differences of statistically significant results will be reported.

The consumers' characteristics are presented in Table II. Figure II represents the percentage, mean and standard deviation (± SD) response of the total group of consumers to the 14 statements. In Table III the respective mean response of the different variables and subgroups are given for each statement. The Appendix at the end of the chapter consists of figures of the percentage response for each statement, according to gender, age, race and LSM group.

Table II **Consumer characteristics**

	Total group		Gender		Race			
Variables	**Number**	**Percentage**	**Men**	**Women**	**White**	**Black**	**Coloured**	**Indian**
Gender								
Men	5 423 000	50.7 %						
Women	5 272 000	49.3 %						
Age group								
16-29 years	4 126 000	38.6 %	2200 000	1926 000	712 000	2700 000	498 000	216 000
30-49 years	4 346 000	40.6 %	2141 000	2205 000	1007 000	2591 000	537 000	211 000
50+ years	2 223 000	20.8 %	1082 000	1141 000	896 000	961 000	220 000	146 000
Race								
White	2 615 000	24.5 %	1295 000	1320 000				
Black	6 252 000	58.5 %	3261 000	2991 000				
Coloured	1 255 000	11.7 %	588 000	667 000				
Indian	573 000	5.36 %	279 000	294 000				
LSM group								
LSM 2	408 000	3.81 %	177 000	231 000	0	408 000	0	0
LSM 3	671 000	6.27 %	364 000	307 000	4 000	661 000	6 000	0
LSM 4	1 346 000	12.6 %	649 000	697 000	0	1328 000	14 000	4 000
LSM 5	2 336 000	21.8 %	1230 000	1106 000	20 000	2084 000	200 000	32 000
LSM 6	1 967 000	18.4 %	1129 000	838 000	112 000	1314 000	431 000	110 000
LSM 7	849 000	7.94 %	360 000	489 000	214 000	317 000	174 000	144 000
LSM 8	799 000	7.47 %	387 000	412 000	316 000	123 000	244 000	116 000
LSM 9	994 000	9.29 %	487 000	507 000	762 000	17 000	130 000	85 000
LSM 10	1 325 000	12.4 %	640 000	685 000	1187 000	0	56 000	82 000

LSM: Living standard measure

Avocados and health

The relationship between avocados and health was explored by means of a number of statements covering overall health, heart health, children's health and health effects associated with the fat content of avocados.

Responses to the first statement, "Avocados are good for your health", were positive, with 90% of the consumers agreeing with this statement (mean = 4.4). There was no practical significant difference in the response between gender and the different age groups, but there was, however, a small practical significance in the response between Indians (mean = 4.1) versus blacks (mean = 4.4). Blacks and coloureds tend to agree most with this statement (mean 4.4). A large differentiation was found between the responses of the different LSM groups, with the response ranging from 4.3 to 4.7 on the 5 point response scale. A small practical significance was observed between LSM group 2 (mean = 4.7) and LSM 4-8 (mean = 4.3-4.4), while a medium practical significance was found between LSM group 2 (mean = 4.7) and LSM 3, 9-10 (mean = 4.2-4.3).

Almost two-thirds (64%) of the consumers disagreed with the statement, "Avocados are bad for your heart" (mean = 2.4), with no practical significant differences between the attitudes of men and women, race, age or LSM groups.

When respondents were asked to respond to the statement "Avocados are bad for you", 80% responded negatively to this statement (mean = 2). From a practical point of view, the response of men and women, the different LSM groups as well as the different age groups did not differ practically significantly. There was a small practical significant difference in the responses between whites (mean = 1.8) and blacks (mean = 2.1), with whites disagreeing most with this statement.

The statement, "Avocados are good for children", was asked to test the consumers' beliefs regarding the role of avocados in children's health. Consumers responded positively to this statement, with 84% agreeing that avocados are good for children (mean = 4.1). The response was similar in all groups.

Consumers responded negatively to the statement "Avocados contain fat and so are bad for you" (mean = 2.4). Sixty-six percent of the consumers disagreed with this statement. There was a small practical significant difference in the response between LSM 2 (mean = 2.4) and LSM 3 (mean = 2.7). The responses of men and women and the different race and age groups were the same.

Consumers also had to respond to the following statement "Avocados contain fat, but can still be eaten as part of a healthy diet". A positive response was found among 76% consumers (mean = 3.9) with regard to this statement. Male and female consumers of different race, age and LSM group exhibited a similar attitude towards this statement.

The responses of consumers to the statements, "Avocados contain good fat but you must not eat too many" and "Avocados contain good fat, therefore you can eat them" were, respectively, 60% (mean = 3.5) and 71% positive (mean = 3.5). No practical significant differences were found between consumers' responses in terms of gender, race, LSM and age group to either of the statements.

The following statement was asked with regard to the cholesterol content of avocados: "Avocados contain cholesterol and so are bad for you". More than half the consumers (56%) disagreed with this statement (mean = 2.5), with a small practical significant difference between the response of whites (mean = 2.4) and Indians (mean = 2.7), with whites more likely to disagree than Indians.

Figure II Consumers attitude towards avocados

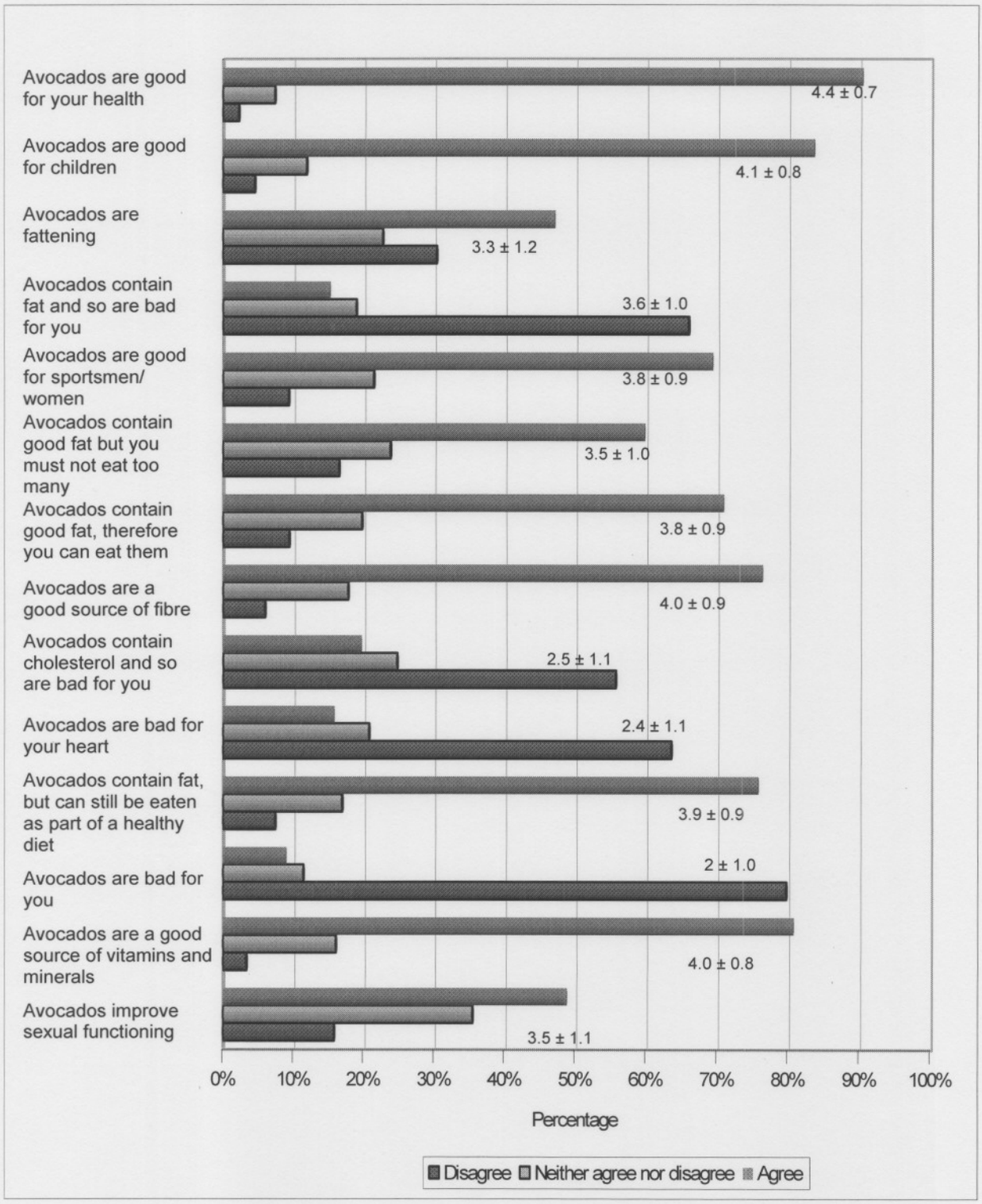


Table 2 Consumers attitude towards avocados according to the different variables and subgroups

Variable	Good for your health	Good for children	Fattening	Contain fat and so are bad for you	Good for sportsmen/ women	Contain good fat but you must not eat too many	Contain good fat, therefore you can eat them	Good source of fibre	Contain cholesterol and so are bad for you	Bad for your heart	Contain fat, but can still be eaten as part of a healthy diet	Bad for you	Good source of vitamins and minerals	Improve sexual functioning
Gender														
Male	4.36	4.14	3.20	2.26	3.87	3.48	3.82	3.95	2.44	2.29	3.86	1.87	4.01	3.50
Female	4.36	4.16	3.32	2.50	3.78	3.61	3.75	3.95	2.65	2.46	3.91	2.09	4.06	3.43
Race														
White	4.28	4.23	3.00[a]	2.20	3.88	3.58	3.77	3.78	2.36[a]	2.20	3.90	1.78[a]	4.00	2.93
Black	4.42[a]	4.11	3.43[a]	2.50	3.77	3.54	3.82	4.00	2.65	2.47	3.90	2.10[a]	4.03	3.68[ab]
Coloured	4.42	4.23	3.12	2.24	3.98	3.51	3.77	4.08	2.42	2.29	3.93	1.80	4.15	3.38[b]
Indian	4.06[a]	4.02	2.97	2.28	3.82	3.52	3.46	3.97	2.68[a]	2.49	3.53	1.96	4.06	2.75[a]
Age														
16-29	4.74	4.50	3.26	2.42	4.14	3.77	4.19	4.43	2.60	2.46	4.32	2.04	4.50	3.70
30-49	4.80	4.62	3.29	2.37	4.23	3.92	4.26	4.43	2.55	2.32	4.42	1.93	4.57	3.75
50+	4.73	4.66	3.20	2.34	4.25	3.94	4.24	4.33	2.45	2.35	4.37	1.95	4.58	3.35
LSM group														
LSM 2	4.66[bcdefghi]	4.25	3.49	2.38[a]	3.96[a]	3.85	3.92	4.35[abcdefgh]	2.63	2.48	4.13	2.12	4.11	3.92[cdefgh]
LSM 3	4.25[b]	3.86	3.29	2.69[a]	3.41[a]	3.42	3.70	3.72[a]	2.80	2.66	3.71	2.26	3.81	3.54[cijkl]
LSM 4	4.41[c]	4.17	3.48	2.49	3.83	3.58	3.77	4.02[bi]	2.70	2.61	3.82	2.13	3.98	3.62[mnop]
LSM 5	4.42[d]	4.13	3.32	2.55	3.79	3.46	3.85	4.02[cj]	2.69	2.50	3.86	2.12	4.03	3.73[qrst]
LSM 6	4.39[e]	4.14	3.32	2.30	3.89	3.50	3.83	4.00[dk]	2.43	2.21	3.98	1.84	4.09	3.54[duvwx]
LSM 7	4.34[f]	4.19	3.21	2.25	3.85	3.65	3.76	4.01[el]	2.46	2.37	3.94	2.01	4.11	3.18[eimqu]
LSM 8	4.32[g]	4.18	3.11	2.23	3.79	3.50	3.70	4.00[fm]	2.50	2.34	3.78	1.85	4.03	3.18[fjnrv]
LSM 9	4.29[h]	4.23	3.15	2.22	3.92	3.62	3.75	3.80[g]	2.40	2.16	3.96	1.72	4.09	2.91[gkosw]
LSM 10	4.24[i]	4.17	3.00	2.27	3.86	3.60	3.70	3.74[hijklm]	2.40	2.26	3.85	1.85	4.02	3.00[hlptx]

Means for each separate statement and group with similar symbol, differed significantly from each other, with practical significance d=0.3-0.49 (small); d=0.5-0.79 (medium); d>0.8 (large) (Cohen, 1988). Only practical significant differences of statistically significant results are given.

Avocados' effect on body weight

Almost half the consumers (47%) agreed with the statement that avocados are fattening (mean = 3.3). A small practical significant difference was observed between the responses of whites (mean = 3.0) and blacks (mean = 3.4), with blacks agreeing most with the statement, followed by coloureds (mean = 3.1). Whites and Indians were dubious in their response, by neither agreeing nor disagreeing with the statement (mean = 3.0). No practical significant differences were found between the responses of men and women, LSM or age groups. However, all the LSM groups agreed with this statement (mean > 3.0), except LSM group 10 whose response was dubious (mean = 3.0). This could be due to the fact that LSM group 10 consists of mainly whites and Indians (and a few coloureds), who responded dubiously.

Although 90% of the consumers agreed that avocados are good for your health, 47% of those consumers still believe avocados to be fattening (mean = 3.2). Forty-nine percent (49%) of the consumers agreeing with the statements "Avocados contain fat, but can still be eaten as part of a healthy diet" and "Avocados contain good fat, therefore you can eat them", also believe that avocados are fattening (mean = 3.3).

Nutrient content

The knowledge of the consumer with regard to the nutrient content of avocados was also questioned. Consumers seem to be aware of the fact that avocados are very nutrient dense, as seen by their positive response to the statement "Avocados are a good source of vitamins and minerals", with 81% agreeing (mean = 4). The responses of the different groups were similar.

A similar picture emerged when consumers were asked about the fibre content of avocados using the statement "Avocados are a good source of fibre". Seventy-six percent of the consumers agreed that avocados are a good source of fibre (mean = 4). The only practical significant difference in response was between some of the LSM groups. A small practical significant difference was found between LSM group 2 (mean = 4.4) and 4-8 (mean = 4.0); and LSM group 4-8 (mean = 4) and 10 (mean = 3.7), while a medium practical significant difference was observed between LSM group 2 (mean = 4.4) and groups 3, 9-10 (mean = 3.7-3.8).

Sport performance

Consumers' attitudes towards avocados and sport performance were positive when the following statement was asked: "Avocados are good for sportsmen/women". Sixty-nine percent of the consumers agreed with this statement (mean = 3.8), with the only difference in response found between LSM groups 2 (mean = 4.0) and 3 (mean = 3.4), which was of medium practical significance. Consumers in LSM group 3 were the least likely to agree with the statement.

Sexual functioning

The statement, "Avocados improve sexual functioning", led to the most interesting and profound practical significant differences in the consumers' responses, particularly in race and the LSM groups. Overall, forty-nine percent of the consumers agreed with this statement (mean = 3.5), with no difference in response between men and women and the different age groups.

With regard to response between race groups, blacks tended to agree most with this statement (mean = 3.7), with a large practical significant difference compared to Indians, who disagreed with the statement. The response of blacks (mean = 3.7) also showed a medium practical significant difference when compared to the response of coloureds (mean = 3.4). Indians (mean = 2.8) disagreed more than whites (mean = 2.9) with this statement.

The response of consumers according to their respective LSM groups varied between a mean of 3.7 and 4.4 on the 5-point response scale, with the response of LSM group 2 being the highest. Small practical significances were found between LSM groups 2 and 3, 6 and between LSM groups 3-4, 6 and 7, 8. Medium practical significant differences were observed between LSM groups 2, 5 and 7,8; and LSM groups 3-6 and 9, 10. Lastly, large practical significant differences were found between LSM groups 2 and 9, 10 as well as LSM groups 3 and 10. The positive response of the LSM groups tended to decrease with an increase in LSM group from LSM 2 to 10.

DISCUSSION

Fourteen statements were included in this study to analyse consumers' views and beliefs regarding the relationship between avocados and health. None of the statements produced practical significant gender or age differences in the consumers' responses. Practical significant differences in the responses between race and LSM groups were noted for some variables. Due to the fact that some LSM groups were representative of only one (LSM 2), two (LSM 3) or three race groups, the distribution of the race groups in the various LSM groups could have influenced the response and associated differences between LSM groups.

Avocados and health

The overall response of consumers towards the effect of avocados on health was very positive. Most consumers believe avocados to be a healthy fruit that can be included in a healthy diet for both adults and children. They also belief that avocados contain good fat and are aware of the fact that they must not overindulge on avocados. The only concern is that although avocados contain no cholesterol, almost half of the consumers are still not convinced of or uncertain about the cholesterol content of avocados.

Avocados contain high amounts of the so-called "good" fat, more commonly known as monounsaturated fatty acid (15.63 g/100g avocado).[13] According to Wolmarans and Oosthuizen,[14] the type of dietary fat plays an important role in the development of coronary heart disease (CHD).

The consumption of diets enriched in monounsaturated fat has been related to a lower rate of CHD, by favouring a number of risk factors for CHD including plasma lipids and lipoproteins, blood pressure, endothelial function and haemostatic parameters.[15,16] Although experimental studies on the health benefits of avocados are limited with somewhat controversial results, there is scientific evidence suggesting a beneficial role of avocado-enriched diets on lipids, especially in hypercholesterolemic patients. Avocados are therefore a healthy fruit choice to include as part of a heart healthy diet.

The effect of avocados on body weight

Although almost half of the consumers believe that avocados are fattening, blacks and coloureds agreed more than whites and Indians with this statement. Whites and Indians seem to be uncertain whether avocados are fattening or not. Results of analyses done on consumers who agreed that avocados are healthy showed that almost half still consider avocados as being fattening.

A recent study by Pieterse *et al.*,[17] who examined the effect of avocados within an energy restricted diet on weight loss in overweight subjects, concluded that the daily consumption of 200 g of avocado (1 average avocado) for 6 weeks, does not compromise weight loss when substituted for 30 g of dietary fat. There is thus scientific evidence dispelling the myth that avocados are fattening. Avocados can therefore be eaten as part of a healthy diet, whether you want to lose weight or not.

Nutrient content

Almost all consumers agreed that avocados are a good source of vitamins and minerals. Avocados contain 22 different vitamins and minerals, and are probably the best fruit source of Vitamin E, niacin (vitamin B3), pantothenic acid, biotin, phosphor, magnesium, zinc, potassium and copper, as well as one of the five best fruit sources of riboflavin (vitamin B2), vitamin B6, folic acid, calcium, iron, selenium, sodium, chloride and manganese per 100 g edible portion, when compared to other fruit most commonly consumed by South Africans (bananas, apples, peaches, grapes, pears, oranges, apricots, loquats, litchi's, guavas, mangos pineapples, strawberries).[1]

In a meta-analysis of cohort studies, a fourfold increase in fruit and doubling of vegetable consumption was associated with a decrease in the risk of heart disease,[18] which, according to Love and Sayed,[19] was attributed to the combined effect of potassium (lowers blood pressure), folate (reduces plasma homocysteine), and fibre in fruits and vegetables. Avocados contain high amounts of all three these nutrients, therefore emphasising the importance and role of avocados in a healthy diet. Love and Sayed[19] also identified the vitamin E content of avocados (1 mg/100 g) as a nutrient that offers protection against disease.

The current dietary reference intakes (DRI) of fibre for men and women ages 19 to 50, are 38 g/day and 25 g/day, respectively.[20] According to a review of the nutritional status of South Africans, the daily dietary fibre intakes of South Africans vary between 16.6 and 29.8 g for men and 13.1 and 26 g for women aged 25 to 64.9 years, with the highest intakes among urban black men and white women.[21] According to the reference tables compiled by Vorster *et al.*,[21] white and rural black women were the only groups who met the recommended dietary reference intake for fibre. In comparison with the other fourteen most commonly consumed raw fruits in South Africa, avocados have the second highest fibre content, containing 5.3 g fibre per 100 g of avocado.[13] The consumption of one avocado (~200g) provides 28% and 42% of the daily DRI for fibre for men and women respectively. Avocados are thus a healthy fruit source of fibre, which can be included in diets to achieve adequate fibre intakes.

Sport performance

Consumers agreed that avocados are good for sportsmen and -women, and thus sport performance, despite the relatively high fat content of avocados.

Fat is important in the diets of athletes as it provides energy, fat-soluble vitamins, and essential fatty acids.[22] Fat is the fuel best suited for low to moderate activity because of its extensive availability in adipose stores. A diet containing 25% to 30% of the total daily kilojoule intake from fat is recommended. Severe fat restriction (<15% of energy intake) might limit performance by hindering intramuscular triglyseride storage, which provides a significant proportion of energy at all intensities of exercise.[23]

Avocados also contain antioxidant vitamins (vitamin C, vitamin E, and β-carotene), which play an important role in sports performance. Exercise results in an increase in the oxidative processes in the muscle, leading to increased generation of lipid peroxides and free radicals. Antioxidant vitamins, particularly vitamin C, vitamin E, and β-carotene, neutralize these free radicals, and might play a role in enhancing recovery from exercise and maintaining optimal immune response.[23]

Sexual functioning

According to the results, avocados are seen as an aphrodisiac by blacks and coloureds. An aphrodisiac is a food, drink, drug, scent, or device that, promoters claim, can arouse or increase sexual desire, or libido. A broader definition includes products that improve sexual performance. This belief could have originated from the many ancient people who believed in the "law of similarity", reasoning that an object resembling genitalia may possess sexual powers.[24] The Aztecs called the avocado tree "Ahuacuatl" which, translated, means 'testicle tree' because the ancients thought the fruit hanging in pairs on the tree resembled the male's testicles.[25]

According to the Food and Drug Administration (FDA), the reputed sexual effects of so-called aphrodisiacs are based on folklore, not on fact.[24] Although the ancient Aztecs certainly thought

that avocados improve sexual performance, the effects of avocados on the human libido has yet to be scientifically proven.

CONCLUSION

This study has brought new insight into the South African consumers' attitude towards avocados that was previously unknown. There are still a few myths and misconceptions that exist in some groups regarding avocados, especially concerning the aphrodisiac properties of avocados. The beliefs that avocados are fattening and contain cholesterol are still present in almost half the consumers.

The various media have a tremendous effect on the food intakes and beliefs of consumers. The industry could therefore use this tool together with these results to change the misperceptions concerning avocados and convey the positive nutritional value of avocados, in order to get the right health messages through to the consumer.

ACKNOWLEDGEMENTS

The authors wish to thank Sylvia Jones from MARKINOR for the collection of data and the South African Avocado Growers Association (SAAGA) and the South African Government's Technology and Human Resources for Industry Programme (THRIP) for partial financial support of the study.

REFERENCES

1. Nel JH, Steyn NP. 2002. Report on South African food consumption studies undertaken amongst different population groups (1983-2000): average intakes of foods most commonly consumed. [Web:] http://doh.gov.za/docs/reports/2002/food/
2. United States Food and Drug Administration. 2003. Food labelling. Specific nutrition labelling requirements and guidelines: Identification of the 20 most frequently consumed raw fruit, vegetables and fish in the United States. Code of Federal regulations. Title 21(2), Part 101;C:101.44. [Web:] http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr
3. Heart Foundation of South Africa. 2003. The Heart Mark. [Web:] http://www.heartfoundation.co.za/h_mark.php
4. United States Department of Agriculture. 2000. Nutrition and your health: Dietary guidelines for Americans. 5th edition. Home and Garden Bulletin. 232:1-44.
5. UK Department of Health. 2003. 5 A Day [Web:] http://www.doh.gov.uk/fiveaday/
6. Karst T. 2003. Avocados receive nod for 5 a day. The Packer. November 21.
7. Bergh B. 1992. Nutritious value of avocado. California Avocado Society Yearbook. 76:123-135.
8. Affleck M. 1992. The United States avocado market. Proceedings of Second World Congress. 643-645.
9. Hawaii Department of Agriculture. 2003. Avocado attitudes shift with newfound focus on fruit's health benefits. Monthly Ag Briefs. June [Web:] http://www.hawaiiag.org/hdoa/add_md.htm
10. Haupt P. 2003. The SAARF universal living standards measure (SU-LSM^{TM}) – 12 years of continuous development. [Web:] http://www.saarf.co.za/lsm-article.htm
11. Steyn HS. 2000. Practical significance of the difference in means. Journal of Industrial Psychology 26(3):1-3.
12. Cohen J. 1988. Statistical power analysis for the behavioural sciences. 2nd ed. 567p. Hillsdale: Erlbaum.
13. Kruger M, Sayed M, Langenhoven ML, Holling F. 1998. Composition of South African Foods: Vegetables and fruit. Supplement to the MRC Food composition tables 1991. 1st ed. 160p. Medical Research Council: Tygerberg.
14. Wolmarans P, Oosthuizen W. 2001. South African Food-Based Dietary Guidelines: Eat fats sparingly – implications for health and disease. South African Journal of Clinical Nutrition 14(3):S48-S54, September.

15. Pérez-Jiménez F, López-Miranda J, Mata P. 2002. Protective effect of dietary monounsaturated fat on arteriosclerosis: beyond cholesterol. Atherosclerosis. 163:385-398.

16. Kris-Etherton PM. 1999. Monounsaturated fatty acids and risk of cardiovascular disease. Circulation. 100:1253-1258.

17. Pieterse Z, Jerling JC, Oosthuizen W, Kruger HS, Hanekom SM, Smuts CM, Lessing MC, Schutte AE. 2002. The effect of avocados within an energy restricted diet on weight loss and serum lipids in obese subjects. Thesis – Honns.Sc. 18p. PU for CHE: Potchefstroom.

18. Law M, Morris J. 1998. By how much does fruit and vegetable consumption reduce the risk of ischaemic heart disease. European Journal of Clinical Nutrition. 52:549-556.

19. Love P, Sayed N. 2001. South African Food-Based Dietary Guidelines: Eat plenty of vegetables and fruits every day. South African Journal of Clinical Nutrition. 14(3):S24-S31, September.

20. The Nutrition Information Centre at the University of Stellenbosch. 2003. DRIs: Dietary Reference Intakes. 120p.

21. Vorster HH, Oosthuizen W, Jerling JC, Veldman FJ, Burger HM. 1997. The nutritional status of South Africans: A review from the literature from 1975-1996. Part 2 of 2. HST: Durban.

22. American Dietetic Association. 2000. Nutrition and athletic performance – position statement. Journal of the American Dietetic Association. 100:1543-1556.

23. Mahan LK, Escott-Stump. Krause's food, nutrition & diet therapy: Nutrition for health and fitness. : 9th ed. 1194p. Saunders: Philadelphia.

24. Nordenberg T. 1996. Looking for a libido lift? The facts about aphrodisiacs. FDA Consumer. Jan-Feb.

25. Kertesz V. 2003. Aphrodisiacs. [Web:] http://www.lifenetwork.ca/features/top10/topten15.asp.

APPENDIX

CHAPTER 4

SUBSTITUTION OF HIGH MUFA AVOCADO FOR MIXED DIETARY FATS DURING AN ENERGY RESTRICTED DIET: EFFECTS ON WEIGHT LOSS, SERUM LIPIDS, FIBRINOGEN AND VASCULAR FUNCTION

Z Pieterse[1] Hons.BSc, JC Jerling[1] PhD, W Oosthuizen[1] PhD, HS Kruger[1] PhD, SM Hanekom[1] PhD, CM Smuts[2] PhD, AE Schutte[3] PhD

[1]Potchefstroom Institute of Nutrition, Potchefstroom University for Christian Higher Education, Potchefstroom, South Africa.

[2]Nutritional Intervention Research Unit, Tygerberg, South Africa.

[3]Department of Physiology, Potchefstroom University for Christian Higher Education, Potchefstroom, South Africa.

Nutrition: The International Journal of Applied and Basic Nutritional Sciences, submitted in October 2003.

ABSTRACT

Objective: Firstly, to dispel the myth that avocados are fattening and should therefore be avoided in energy restricted diets. Secondly, to examine the effects of avocados, a rich source of mono-unsaturated fatty acids, as part of an energy restricted diet on weight loss, serum lipids, fibrinogen and vascular function in overweight and obese subjects.

Methodology: Sixty one free-living volunteers (13 men; 48 women), with a mean (standard deviation) body mass index (BMI) of 32 (3.9) kg/m^2, participated in this randomised, controlled parallel study. The subjects were paired according to gender, BMI and age and randomly assigned to one of two groups. The experimental group consumed 200 g of avocado (1 avocado) per day, substituting 30 g of other mixed dietary fats, and the control group excluded avocado from their energy restricted diet for six weeks. Seven-day isoenergetic menu plans were given according to mean energy requirements of both genders to provide 30% fat, 55% carbohydrates and 15% protein of total energy intake. Anthropometric measurements, physical activity, dietary intakes, blood pressure and arterial compliance were measured with standard methods at the beginning and end of the intervention. Fasting blood samples were drawn at the beginning and end of the intervention period.

Results: Fifty-five subjects completed the study. Compliance to avocado intake in the experimental group was 94.6%. Anthropometric measurements (weight, body mass index and percentage body fat) decreased significantly in both groups during the study ($p<0.001$), and the change was similar in both groups. Serum lipid levels (total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol and triglycerides), fibrinogen, blood pressure and arterial compliance did not change significantly within or between the two groups.

Conclusion: The consumption of 200 g avocado per day, within an energy restricted diet, does not compromise weight loss when substituted for 30 g of mixed dietary fat. The serum lipid levels, plasma fibrinogen, arterial compliance, as well as systolic and diastolic blood pressure were not affected by weight loss or avocado intake.

Research support: This study was supported by the South African Avocado Growers Association and the South African Government's Technology and Human Resources for Industry Programme (THRIP).

Running head: Avocados, weight loss and markers of cardiovascular health

Key words: Avocados; monounsaturated fatty acids; weight loss; obesity; serum lipids; vascular function; fibrinogen.

INTRODUCTION

Almost half of South African consumers (47%) believe avocados to be fattening, probably because of its high fat content, and should therefore be excluded in energy restricted diets.[1] Avocados are, when compared to other fruit, high in fat (15.3-17.33 g/100g),[2,3] but is a rich food source of monounsaturated fatty acids (MUFA) (9.61-11.2 g/100g avocado).[2,3] The MUFA, oleic acid, contributes 58.6% - 64.7% of the total fatty acids found in avocados.[3,4]

According to Ellis et al.,[5] studies in animals suggest that the type of dietary oil may alter body composition and adiposity. Diets high in polyunsaturated and monounsaturated fatty acids promote reduced fat accumulation compared to diets high in saturated fatty acids. A study by Ellis et al.[5] found that canola oil (62% MUFA) promotes less fat deposition (lower fat cell size and fat cell number) compared to corn oil (61% polyunsaturated fatty acids (PUFA)) when growing female rats were fed high fat diets (40% of energy) for 8 weeks.

Preliminary data from Piers et al.[6] has, for the first time, demonstrated significantly greater postprandial fat oxidation rates in healthy normal weight to mildly obese men fed a high-fat (43% of energy) MUFA (virgin olive oil) breakfast meal as compared to an isocaloric saturated fatty acids (SFA) (cream) breakfast meal. In addition, the MUFA breakfast was associated with a significantly greater thermic effect in the high waist circumference (HWC ≥ 99 cm) subjects by about 55 kJ/5h, increasing potentially to 220 kJ/day for an individual with a total energy intake of 10 MJ/day. The impact of these differences in substrate oxidation rates and thermogenesis on body weight and composition in the long term, remain to be determined. If these were to be sustained over time, then simply changing the source of dietary fat might encourage some body fat loss, even on a relatively high-fat diet.[6]

A recent study by Colette et al.[7] investigated the effects of dietary MUFA on weight loss, serum lipid concentrations and other cardiovascular risk factors in overweight subjects during a short period (8 weeks) of active weight loss. Results from the study showed that reduction in energy intake had the same effect on body weight loss when MUFA fats were substituted for carbohydrates (CHO) without changing the concentrations of SFA and PUFA. The MUFA-rich diet, predominantly enriched with olive oil and avocado, showed better effects on serum triglicerides (TG) than the CHO-rich diet.[7]

Results of a review of 18 well-controlled studies by Kris-Etherton et al.[8] found that high-MUFA, low-SFA diets are equally as effective as low-fat, low-SFA, high-CHO diets in reducing total and low-density lipoprotein cholesterol (LDL-C) and have the added benefits of a greater magnitude of TG lowering and maintaining high-density lipoprotein cholesterol (HDL-C) levels. MUFA also lower total cholesterol levels when compared to SFA.[9] The high concentration of MUFA in avocado

suggests that a diet rich in avocado will have beneficial effects on blood lipids[10], thereby protecting against the development of coronary heart disease (CHD).

Most of the studies done on MUFA, however, have been limited to the use of olive oil as the main MUFA source. The first study concerning the cholesterol-lowering effect of avocados was published in 1960.[11] Six studies have since been published, using avocado as the main source of MUFA[10,12-16] These studies showed inconsistent results with respect to the effect of avocado on serum lipid levels. Differences in experimental design, type of diet and heterogeneity of the subjects studied make comparison of these studies difficult.

Other non-lipidaemic effects could be involved in the protective effect of the MUFA diet. One of these involves a hypotensive effect, similar to that observed with the intake of other unsaturated fat enriched diets. Some findings suggest that MUFA may modulate atherogenesis by affecting the different components and function of the endothelium. Dietary MUFA also decreases prothrombotic environment, modifying both coagulation and fibrinolysis.[17] Colette et al.[7] also suggest a protective effect of oleic acid on oxidative stress and smooth muscular cell (SMC) proliferation, two other important cardiovascular risk factors. These findings suggest that high-MUFA diets may confer benefits on CVD risk factors beyond those associated with plasma lipids and lipoproteins.[9]

The aim of this study was to investigate the effects of avocados as part of an energy restricted diet on weight loss, serum lipids, fibrinogen and vascular function in free-living overweight and obese subjects, using a single blind randomised controlled parallel intervention study.

METHODS

Subjects

The study was approved by the Ethics Committee of the Potchefstroom University for Christian Higher Education (PU for CHE) and an informed consent form was signed by each participant. Sixty-one free-living overweight and obese volunteers (13 men; 48 women) from the Lipid Clinic of the PU for CHE participated in this study. The exclusion criteria for selection of subjects were: body mass index (BMI) < 27 kg/m^2, diabetes or other chronic diseases (except hypertension), pregnant or lactating women. Fifty-five subjects completed the study.

The subjects' ages ranged from 21 to 57 years, with a mean (standard deviation (SD)) age of 40.8 (8.94) years. At entry, subjects had a mean BMI of 31.9 (3.9) kg/m^2, TC of 5.21 (1.17) mmol/L, LDL-C of 3.45 (1.12) mmol/L, HDL-C of 1.10 (0.34) mmol/L and TG of 1.73 (2.03) mmol/L.

Eleven subjects (4 experimental; 7 control) had a TC:HDL ratio equal to or greater than 6.4 and 5.6 for men and women respectively at baseline.[18] The rest of the subjects were normolipidemic at

baseline. Six subjects (4 experimental; 2 control) used hipolipidaemic agents (statins) and thirteen subjects used anti-hypertensive medication during the intervention period.

Four subjects were classified with high-normal hypertension (SBP of 130-139 mmHg); three with stage 1 hypertension (SBP of 140-159 mmHg) and one with stage 2 hypertension (SBP of 160-179 mmHg).[18]

The baseline means of the other variables were as follows: fibrinogen of 4.36 (1.26) g/L, systolic blood pressure (SBP) of 120 (15.6) mmHg, diastolic blood pressure (DBP) of 71 (8.2) mmHg and arterial compliance of 2.40 (0.53) ml/mmHg.

Study design

This study was done under free living conditions using a single blind randomised, controlled parallel study design. The subjects were paired according to gender, BMI and age and then randomly assigned to one of two groups, an experimental group (n=31) or control group (n=30).

Results of prescribed mean energy intake calculated using the Harris and Benedict formula in combination with a recommended formula to estimate energy requirements of the obese,[19] were 8000 kJ and 7000 kJ for men and women respectively.

Diets for both groups were isoenergetic and provided 30% of total energy intake as fat, 55% as carbohydrates, and 15% of energy as protein. The experimental group included 200 g of avocado (1 avocado) per day, substituting 30 g of other mixed fat sources, and the control group excluded avocado from their energy restricted diet for six weeks. Dietary cholesterol intake was less than 300 mg per day in both groups.

Two separate seven-day menu plans were given to both groups, consisting of three main meals with two in-between meals, with given portion sizes. All aspects of the menu-plan were explained to the subjects as a group and individually.

The subjects visited the Lipid Clinic on a weekly basis to monitor compliance and to motivate subjects, and for the experimental group to receive their avocados. Subjects were asked to maintain their alcohol consumption and physical activity patterns throughout the study.

Dietary assessment

Dietary intakes were estimated using a 24-hour recall questionnaire at the beginning and at the end of the intervention. The computer program, Foodfinder 2, which is based on the South African food composition tables,[2] was used to analyse the nutrient content of the diet. Subjects were interviewed to determine their avocado consumption.

The reported dietary energy intake of each subject was used to determine the nature of underreporting/validity of dietary assessment in both groups at baseline. Underreporting was ascertained by comparing individually reported energy intake (EI) expressed as a multiple of the basal metabolic rate, as estimated from mean reported weight and height using the Schofield equations (BMR_{est}), with the individually calculated physical activity level. Subjects were classified as under-reporters (EI:BMR<0.76), acceptable reporters (EI:BMR 0.76-1.24) and over-reporters (EI:BMR>1.24) according to their EI:BMR ratio.[20]

Clinical assessment

Anthropometric measurements and physical activity were measured at the beginning and end of the intervention. The anthropometric measurements were done by grades I and II internationally accredited anthropometrists using calibrated equipment. Anthropometric measurements included body weight, height and waist circumferences. Circumferences were measured with the cross-hand technique using a steel tape (Lufkin, Cooper Tools, Apex, NC). Height and weight were measured respectively with a stadiometer and a Precision Health (A&D Company, Tokyo Japan) electronic scale, and BMI (kg/m^2) was calculated.

Percentage body fat was determined using formulas based on height, weight and waist circumference[21,22] for obese men and women. Heyward and Stolarczyk[23] recommend using these fat-specific anthropometric equations, instead of the skinfold method to asses the body composition of obese subjects due to various factors that limit the accuracy and precision of skinfold measurements of obese subjects.

Physical activity information was obtained by means of a validated quantitative questionnaire measuring physical activity index, based on the Baecke physical activity questionnaire.[24] The questionnaire, adapted by Kruger et al.,[25] categorises physical activity in three different physical activity index levels, namely low (1.00-3.33), moderate (3.34-6.67) and high (>6.67) physical activity.

Blood pressure (BP) and arterial compliance were measured at baseline and end, using a Finometer (Biomedical Instrumentation, Amsterdam).[26,27] After a period of 10 minutes, resting BP values were obtained. Blood pressure was regarded to be resting when the SBP did not change with more than 10 mmHg during the last minute of this period, otherwise the resting period was extended. The resting BP was then recorded continuously for 1 minute. The data was digitised for further analysis with the Fast Modelflo software.[28] In this way the SBP and DBP, as well as the arterial compliance, were obtained. The vascular unloading technique of Penáz together with the Physiocal criteria of Wesseling provided reliable, non-invasive and continuous estimates of blood pressure.[27]

Blood samples

Blood samples were taken at the beginning and end of the intervention period. The subjects were required to fast overnight (12h). Venous blood samples were collected using a 21-gauge scalp infusion set. Samples were drawn with minimal stasis between 07:00 and 10:00 to avoid effects of diurnal variation. Clotted and citrated blood were centrifuged for 15 minutes at 2000g to yield serum for the measurements of lipids and plasma for fatty acids and fibrinogen respectively. Aliquots of serum and plasma were stored at -82°C until the analysis was performed.

Experimental methods

The fatty acids composition of total plasma lipids was measured to monitor compliance (coefficient of variance (CV) = 4.3%). Plasma was thawed and extracted with chloroform/methanol (2:1; v/v) according to a modified method of Folch et al.[29] All the extraction solvents contained 0.01% butylated hydroxytoluene (BHT) as an antioxidant. Heptadecanoic acid (C17:0) was used as internal standard to quantify the individual fatty acids. Total lipids were analysed for fatty acid composition as described previously.[30]

TC concentrations (CV = 1.73%), HDL-C (CV = 3.86%) and TG (CV = 0.93%) were measured on a Vitros DT60 II Chemistry System with Vitros reagents and controls. Serum LDL-C was calculated using the Friedewald formula (LDL-C (mmol/L) = TC-TG/2.2 – HDL).

Plasma fibrinogen was measured with a modified method of Clauss, using the ACL-200 automated coagulation analyser and reagents from Instrumentation Laboratories (IL) Milan, Italy.

Avocado fatty acid analysis

The fatty acid composition of the avocados was measured by gas chromatography (BÜCHI-Caviezel® Method, AOAC® Peer-verified method PVM 4)[31] in 3 samples of pulp from three randomly selected avocados at weeks 1, 3 and 6.

The results of the fatty acid analysis performed on the avocados used in this study showed a similar composition to that shown in the MRC food composition tables.[2,4] Avocado samples were found to have a mean fat content of 17.76%, mean MUFA content of 9.9 g/100g avocado with the proportion of oleic acid being 47.48% of the total fatty acid (Table I).

Statistical analysis

The computer software package Statistica® was used for the statistical analysis of the data. The statistician was blind to the treatments of the subjects. The variables were tested for normality using the Shapiro Wilk's test and descriptive statistics were done. Data that were normally

distributed are expressed as mean [95% confidence intervals (CI)]. Data that are not normally distributed are expressed as median [25, 75 percentiles]. Significant changes within groups, from baseline to end, were determined by using the t-test for dependent samples for parametric data and the Sign test for non-parametric data. Differences between the two groups were determined by using the t-test for independent samples for parametric data and the Mann-Whitney U test for non-parametric data. A P-value of less than or equal to 0.05 was regarded as being statistically significant.

There were no differences in the weight loss between men and women and they were therefore not analysed as separate groups.

Table I

Avocado-composition data			
	Mean of 3 samples of pulp*	South African (Langenhoven *et al*, 1991)	US Department of Agriculture (USDA, 2002)
Total fat (g/100g sample)	17.76	15.3	17.33
MUFA (g/100g sample)	9.90	9.61	11.21
% Palmitoleic acid (C16:1)	10.65	-	3.19
% Oleic acid (C18:1)	47.48	-	61.5
PUFA (g/100g sample)	2.56	1.96	2.04
% Linoleic acid (C18:2)	14.64	-	11.1
% Linolenic acid (C18:3)	1.29	-	0.66
SFA (g/100g sample)	4.25	2.44	2.59
% Palmitic acid (C16:0)	16.79	-	14.9
% Stearic acid (C18:0)	0.63	-	0.08

MUFA: Monounsaturated fatty acid; PUFA: Polyunsaturated fatty acid, SFA: Saturated fatty acid; %: Percentage of total fatty acids; *: Analysed using gas chromatography

RESULTS

Six subjects dropped out from the study during the intervention period – three from each group. One subject had an emergency appendix operation; one subject did not follow the dietary intervention correctly; four subjects voluntarily abandoned the study because they had difficulty complying with the intervention. The compliance with avocado intake in the experimental group was 94.6%.

The mean physical activity index of the whole group was 2.93 at baseline, indicating a low level of activity (physical activity index = 1.00-3.33). There were no significant differences between the groups in changes in physical activity during the study (p=0.123). A significant decrease in physical activity index was, however, seen from baseline to end (p=0.013) in the experimental group. The small change in physical activity index is not of any clinical significance, because the group's baseline and end values remained in the low physical activity category (physical activity index = 1.00-3.33).

The nature of underreporting was determined at baseline in both groups and individually. The experimental group had a mean EI:BMR ratio (SD) of 0.79 (0.29), classifying them as acceptable reporters, while the control group had a mean EI:BMR ratio (SD) of 0.71 (0.19), classifying them as under-reporters. At the individual level, both groups had 15 under-reporters (EI:BMR<0.76) and 12 acceptable reporters (EI:BMR 0.76-1.24), and the experimental group had one over-reporter (EI:BMR>1.24). The mean EI:BMR ratio (SD) of both groups was 0.75 (0.25), classifying the subjects as under-reporters.

Dietary intake

Total energy, protein, carbohydrate, fat and cholesterol intake did not differ significantly between the groups at baseline. Table II shows that energy intake decreased significantly (p=0.039) and nonsignificantly (p=0.073) in the control and experimental groups respectively. There were no significant differences between the groups in the changes in the mean percentage energy from protein or carbohydrate during the study. A significant increase, however, was seen in the percentage energy from carbohydrate in the control group from baseline to end. This increase can be ascribed to the decrease in the percentage energy from fat from baseline to end. The only macronutrient that changed significantly between the two groups was the percentage energy from fat. The percentage energy from fat increased slightly with 2.8% in the experimental group, while a 9.7% decrease was found in the control group. The cholesterol intake of both groups decreased significantly from baseline to end and could possible be due to a decrease in the intake of meat, and therefore animal fat, and the fact that no eggs were included in their menu plan. The reported dietary intakes of the different fatty acids are also shown in Table II. The experimental group had a significantly higher intake of trans fatty acids (TFA) (p=0.015) and oleic acid (C18:1) (percentage of total fatty acids) (p=0.022) at baseline, as well as significantly lower intakes in the percentage energy from PUFA (p=0.024) compared to the control group.

As expected, the introduction of avocados in the diet of the experimental group caused a significant increase in the percentage energy from MUFA, especially the main MUFA, oleic acid (C18:1). Although the percentage of energy from MUFA and oleic acid (C18:1) in the control group

Table II

Changes in dietary intake during intervention								
		Experimental (n=28)			Control (n=27)			p-value between groups
		Mean	95% CI	p-value*	Mean	95% CI	p-value*	
Energy (kJ)	B	6973	6059, 7888	0.073	6152	5326, 6977	0.039	
	E	6231	5650, 6812		5357	4783, 5931		
	Δ	-742	-1559, 74.7		-795	-1547,-42.6		0.923
Protein (% TE)	B	16.1	14.4, 17.9	0.881	17.7	15.7, 19.6	0.861	
	E	15.9	14.6, 17.3		17.9	16.6, 19.1		
	Δ	-0.18	-2.59, 2.23		0.18	-1.90, 2.30		0.819
SFA (% TE)	B	11.0	9.26, 12.7	0.018	10.6	8.80, 12.3	0.084	
	E	7.98	6.93, 9.03		8.20	6.50, 9.88		
	Δ	-3.00	-4.85,-1.15		-2.36	-5.10, 0.43		0.863
PUFA (% TE)	B	6.34	5.32, 7.36	0.018	8.68	6.80, 10.5	0.008	
	E	4.84	4.20, 5.48		5.51	4.25, 6.77		
	Δ	-1.50	-2.71,-0.28		-3.17	-5.42, 0.91		0.181
Cholesterol (mg)	B	208	143, 273	0.002	197	141, 253	0.019	
	E	112	88.1, 136		132	96.2, 167		
	Δ	-96.0	-165,-27.0		-65.6	-128,-3.13		0.505

		Experimental (n=28)			Control (n=27)			p-value between groups
		Median	25-75% Percentile	p-value*	Median	25-75% Percentile	p-value*	
CHO (% TE)	B	45.1	39.5, 51.7	0.089	45.6	38.0, 51.7	0.007	
	E	46.8	43.8, 50.3		50.7	41.6, 57.7		
	Δ	1.99	-1.89, 7.68		4.67	1.08, 12.8		0.157
Fat (% TE)	B	31.6	26.7, 36.6	0.186	31.9	24.8, 39.8	0.124	
	E	34.0	30.3, 37.0		22.2	16.9, 34.7		
	Δ	2.83	-4.70, 8.23		-9.70	-19.5, 4.50		0.040
MUFA (% TE)	B	9.85	8.32, 12.1	0.038	9.47	7.86, 12.0	0.054	
	E	10.6	8.30, 14.3		10.2	6.43, 16.0		
	Δ	1.30	-0.78, 2.74		0.80	-0.78, 3.76		0.662
C18:1 (% FA)	B	30.4	24.4, 33.7	<0.001	26.0	20.9, 30.9	0.441	
	E	47.7	42.7, 49.7		27.9	22.1, 33.4		
	Δ	15.8	10.6, 21.7		1.96	-4.78, 6.47		0.001
TFA (g)	B	1.66	0.81, 2.90	0.001	0.54	0.20, 1.69	1.000	
	E	0.52	0.15, 0.95		0.69	0.41, 1.27		
	Δ	-1.40	-2.29, -0.41		-0.08	-1.00, 0.69		0.002

B: Baseline; E: End; Δ: Change from baseline to end; SFA: Saturated fatty acid; PUFA: Polyunsaturated fatty acid CHO: Carbohydrates; MUFA: Mono-unsaturated fatty acid; TFA: Trans fatty acid; % TE: Percentage of total energy; % FA: Percentage of total fatty acids; *: p-values between baseline and end

also tended to increase from baseline to end, the increase in the experimental group was significantly greater than in the control group.

The percentage energy from SFA decreased significantly in the experimental group (p=0.018) and nonsignificantly in the control group (p=0.084) from baseline to end (Table II). The decrease in energy from SFA can probably be explained by the decreased intake of meat and animal fat. A significant decrease in the percentage energy intake from PUFA was found in both the experimental and control group.

The consumption of avocado by the experimental group replaced almost all the other fat sources high in PUFA, especially vegetable oils. The intake of TFA in the experimental group decreased significantly, possibly due to the replacement of margarine by avocados. The fact that the percentage of energy from PUFA decreased significantly in the control group, probably indicates that they decreased their fat intake from vegetable oils, but still consumed fat sources such as margarine because their total amount of TFA intake stayed more or less the same. The change in TFA intake in the experimental group was also significantly different from the change in the control group.

Anthropometry

There were no significant differences in anthropometric measurements at baseline. Table III shows that there were significant reductions in body weight, percentage body fat and BMI in both groups after 6 weeks, and that the changes were similar in both groups. The mean 2.13 kg lost by the experimental group, did not differ significantly from the 2.65 kg lost by the control group.

Plasma fatty acids

The changes in plasma fatty acids during the experimental period are shown in Table IV. Changes in plasma fatty acids between the two groups did not differ significantly. The percentage plasma stearic acid (C18:0) was significantly higher in the experimental group at baseline, compared to the control group (p=0.043). The percentage plasma oleic acid (C18:1n-9) increased significantly from baseline to end with the consumption of avocado in the experimental group, confirming the good compliance with avocado intake. A decrease was seen in the percentage myristic acid (C14:0) from baseline to end in both groups, but was only significant in the experimental group.

Table III

Changes in anthropometric measurements during intervention									
		Experimental (n=28)			Control (n=27)			p-value between groups	
		Mean	95% CI	p-value	Mean	95% CI	p-value		
Weight (kg)	B	91.3	86.2, 96.5	<0.001	91.2	85.7, 96.6	<0.001		
	E	89.2	84.1, 94.4		88.5	83.4, 93.6			
	Δ	-2.13	-2.82, -1.43		-2.65	-3.40, -1.90		0.291	
		Median	25-75% Percentile	p-value	Median	25-75% Percentile	p-value	p-value between groups	
BMI (kg/m^2)	B	31.6	29.4, 34.9	<0.001	30.9	28.9, 33.6	<0.001		
	E	30.8	28.9, 33.9		29.9	27.8, 32.9			
	Δ	-0.80	-1.10, -0.45		-0.80	-1.20, -0.50		0.561	
Body fat (%)	B	43.5	42.3, 45.8	<0.001	44.0	42.1, 45.7	<0.001		
	E	42.5	41.3, 44.6		43.0	41.0, 44.1			
	Δ	-0.98	-1.40, -0.57		-1.17	-1.60, -1.04		0.066	

B: Baseline; E: End; Δ: Change from baseline to end; BMI: Body mass index.

Table IV

Changes in plasma fatty acids during intervention									
% of total fatty acids		Experimental (n=28)			Control (n=27)			p-value between groups	
		Mean	95% CI	p-value*	Mean	95% CI	p-value*		
C14:0	B	0.53	0.45, 0.60	0.005	0.50	0.40, 0.60	0.056		
	E	0.37	0.28, 0.45		0.39	0.33, 0.44			
	Δ	-0.16	-0.26, -0.05		-0.11	-0.23, -0.00		0.576	
C18:1 (n-9)	B	9.59	9.20, 9.97	0.046	9.76	9.14, 10.4	0.625		
	E	10.0	9.63, 10.4		9.64	9.17, 10.1			
	Δ	0.45	0.01, 0.89		-0.12	-0.63, 0.39		0.088	
C18:3 (n-3)	B	0.07	0.06, 0.08	0.421	0.08	0.01, 0.14	0.500		
	E	0.06	0.05, 0.07		0.06	0.05, 0.06			
	Δ	-0.01	-0.02, 0.01		-0.02	-0.08, 0.04		0.622	

B: Baseline; E: End; Δ: Change from baseline to end; *: p-value between baseline and end

Table IV (cont.)

Changes in plasma fatty acids during intervention								
% of total fatty acids		Experimental (n=28)			Control (n=27)			p-value between groups
		Median	25-75% Percentile	p-value*	Median	25-75% Percentile	p-value*	
C16:0	B	28.3	27.0, 29.1	0.441	28.5	27.0, 29.8	0.700	
	E	27.7	26.4, 30.8		28.6	27.5, 29.8		
	Δ	-0.88	-1.80, 1.92		0.89	-0.93, 2.14		0.174
C18:0	B	15.5	14.0, 16.3	0.689	14.7	13.7, 15.3	0.170	
	E	14.8	13.4, 15.8		14.1	13.4, 14.8		
	Δ	-0.37	-1.21, 0.47		-0.46	-1.26, 0.57		0.634
C18:2 (n-6)	B	21.6	18.9, 22.9	0.700	21.2	19.5, 22.5	0.700	
	E	21.7	19.6, 23.0		20.6	19.5, 23.9		
	Δ	0.19	-1.92, 1.73		-0.17	-1.92, 1.35		0.622

B: Baseline; E: End; Δ: Change from baseline to end; *: p-value between baseline and end

Serum lipids

Table V summarises the changes in serum lipid profiles during the experimental period. There were no significant differences in serum lipid levels between the two groups at baseline. Changes from baseline to end in serum TC, LDL-C, TG and HDL-C did not differ significantly in either group. The changes in serum lipid levels (TC, HDL-C, LDL-C or TG) were also not significantly different between the two groups.

Fibrinogen and vascular parameters

Plasma fibrinogen, arterial compliance, as well as SBP and DBP did not differ significantly between the two groups at baseline. There were no significant changes in plasma fibrinogen, arterial compliance, SBP or DBP during the intervention (Table VI).

Table V

Changes in serum lipid levels during intervention								
		Experimental (n=28)			Control (n=27)			p-value between groups
		Mean	95% CI	p-value*	Mean	95% CI	p-value*	
TC (mmol/L)	B	5.26	4.75, 5.77	0.973	5.16	4.75, 5.57	0.466	
	E	5.29	4.75, 5.82		5.26	4.84, 5.68		
	Δ	0.03	-0.42, 0.48		0.01	-0.17, 0.37		0.784
	%Δ	2.69	-7.08, 12.4		2.58	-2.55, 7.70		
LDL-C (mmol/L)	B	3.43	2.92, 3.95	0.963	3.47	3.08, 3.86	0.255	
	E	3.39	2.86, 3.92		3.58	3.21, 3.95		
	Δ	-0.04	-0.40, 0.47		0.11	-0.15, 0.37		0.759
	%Δ	5.65	-9.82, 21.1		5.57	-2.00, 13.1		
HDL-C (mmol/L)	B	1.12	0.95, 1.27	0.971	1.10	0.98, 1.21	0.779	
	E	1.07	0.95, 1.20		1.10	0.98, 1.22		
	Δ	-0.01	-0.13, 0.10		0.00	-0.07, 0.07		0.836
	%Δ	1.70	-6.94, 10.3		0.53	-6.33, 7.40		
TG (mmol/L)	B	2.13	1.09, 3.18	0.943	1.31	0.97, 1.65	0.995	
	E	1.88	1.26, 2.49		1.28	0.95, 1.61		
	Δ	-0.26	-1.05, 0.53		-0.03	-0.26, 0.20		0.576
	%Δ	10.5	-7.77, 28.7		13.0	-8.08, 34.1		

B: Baseline; E: End; Δ: Change from baseline to end; %Δ: Percentage change from baseline to end; TC: Total cholesterol; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; TG: triglyceride; *: p-value between baseline and end

Table VI

Changes in fibrinogen and vascular parameters during intervention								
		Experimental (n=28)			Control (n=27)			
		Mean	95% CI	p-value*	Mean	95% CI	p-value*	p-value between groups
Fibrinogen (g/L)	B	4.45	3.89, 5.00	0.625	4.27	3.83, 4.72	0.760	
	E	4.41	3.89, 4.92		4.31	3.89, 4.72		
	Δ	-0.14	-0.70, 0.43		0.06	-0.32, 0.44		0.566
Arterial compliance (ml/mmHg)	B	2.36	2.16, 2.56	0.211	2.44	2.22, 2.66	0.252	
	E	2.44	2.22, 2.65		2.50	2.27, 2.74		
	Δ	0.08	-0.05, 0.21		0.07	-0.06, 0.19		0.892
Systolic BP (mmHg)	B	119	113, 125	0.778	121	115, 127	0.570	
	E	118	111, 125		120	112, 129		
	Δ	-0.73	-6.83, 5.38		-0.66	-6.28, 4.97		0.986
Diastolic BP (mmHg)	B	70.2	66.4, 74.1	0.136	72.5	70.2, 74.8	0.078	
	E	67.5	63.0, 71.9		69.6	65.6, 73.7		
	Δ	-2.77	-6.47, 0.93		-3.07	-6.52, 0.37		0.904

BP: Blood Pressure; B: Baseline; E: End; Δ: Change from baseline to end; *: p-value between baseline and end

DISCUSSION

The validity of measures of dietary intake is difficult to assess because all methods rely on information given by the subjects, which might not be correct.[32] Underestimation of energy intake is related to obesity and affects the relation of macronutrients in the reported diet.[33] The tendency of obese subjects to underreport their energy intakes can be seen in the low energy intakes reported at baseline (Table II), and their mean EI:BMR ratio (SD) of 0.75 (0.25), that classifies the subjects as under-reporters, indicating dietary reports of poor validity. The energy intakes can therefore probably not be accepted as a true reflection of their actual dietary intakes.

The total percentage energy intake from fat differed significantly between the two groups (Table II). The reason for this difference could be the fact that the experimental group's fat intake was mainly from avocados, which has a high fat content. The control group, however, could possibly have cut down on their dietary fat intake, because of the general belief that "dietary fats make you fat".

The significant increase in plasma oleic acid levels in the experimental group with avocado intake confirms good compliance with the intervention (Table II). It also seems that the amount of avocado consumed by the experimental group provided sufficient amounts of oleic acid to effectively increase blood levels of oleic acid (C18:1).

The inclusion of avocados in an energy restricted diet did not compromise the weight lost in the experimental group. The changes in body weight of the two groups were similar, despite the significant reduction in fat intake seen only in the control group.

In these subjects with initial high intakes of MUFA and normal to borderline high mean cholesterol levels, additional MUFA intake or weight loss had no effect on serum TC, LDL-C, TG or HDL-C lipid levels. Two randomised crossover studies on avocados showed improvement in lipid levels when compared to high-CHO diets, namely: decreased TC and LDL-C in healthy subjects[10] and decreased TG in non-independent diabetes mellitus (NIDDM) patients.[13] Carranza-Madrigal et al.[16] showed a decrease in LDL-C compared to control values, but also a decrease in HDL-C in dyslipidemic patients following a vegetarian diet enriched with avocado.

In a well designed randomised parallel controlled study, Lopez-Ledesma et al.,[15] investigated the effects of a MUFA (avocado) rich diet in 37 adult patients with mild hypercholesterolemia (TC=5.4-9.3 mmol/L), 15 of them with hypertriglyceridemia (TG=2.3-4.8 mmol/L), and 30 healthy patients. Patients were randomly assigned to receive either a high MUFA diet or an isoenergetic control diet for a period of seven days while being hospitalised. They found a significant decline in TC and LDL-C concentration with no change in HDL-C in healthy and hypercholesterolemic subjects, as well as a significant decline in TG levels in moderately hypercholesterolemic patients, either with hypertriglyceridemia (combined hyperlipidemia) or with normal serum TG levels.

Carranza et al.[14] also showed improvement in lipid levels when investigating the effects of avocado on the level of blood lipids in 8 patients with phenotype II and 8 patients with phenotype IV dyslipidemia. Patients were assigned to either a diet rich in MUFA using avocado as their major source, or a low-saturated fat diet without avocados. Diets were of 4 weeks duration and they were assigned in a crossover design, with their three daily meals eaten at the clinical unit. Total cholesterol and LDL-C decreased significantly in patients with phenotype II dyslipidemia. A significant increase was also seen in HDL-C in both phenotype II and IV dyslipidemic patients.

In contrast to the studies mentioned above, a study by Alvizouri-Muñoz et al.[12] found no significant changes in any plasma lipid levels compared to control values in healthy subjects. The present study does not confirm the positive effects of avocado as MUFA source on serum lipids found by previous studies. This could be due to the normal to borderline high mean serum lipid levels and good initial MUFA intake (10% of total energy intake) of the subjects (Table II).

Studies investigating the effects of a high MUFA diet on haemostatic factors found no effect on plasma fibrinogen levels in healthy subjects,[34] NIDDM subjects[35] or subjects with impaired glucose tolerance.[36] Vorster et al., [37] however, observed an increase in plasma fibrinogen in obese subjects losing weight, while Alonso et al.[38] found a 16.2% decrease in plasma fibrinogen levels after a modest (7.3%) reduction in weight after 12 weeks. Marckmann et al.[39] also found sustained improvement in plasma fibrinogen levels (lowering of 6%) after major weight loss (average of 13.6 kg) in obese subjects. The small percentage of weight lost in this study, 2.3% and 3% of initial body weight in the experimental and control group respectively, as well as the shorter intervention period (6 weeks), could be possible explanations for the unchanged plasma fibrinogen levels found in this study (Table VI).

A study by Resnick and Lester,[40] investigating the effect of modest weight loss on arterial compliance in hypertensive subjects, concluded that modest weight loss (5 kg) in essential hypertension increased arterial compliance significantly. The subjects' mean blood pressure in the present study was, however, normal, which could explain the lack of effect on arterial compliance.

Clinical intervention trials have consistently shown the blood pressure-lowering effect of even modest reduction in weight in persons who are hypertensive and those who are normotensive.[41] The hypotensive effects of isoenergetic substitution of SFA for MUFA have also been confirmed in studies among healthy subjects.[17] This study has, however, failed to show any hypotensive effect after significant weight loss or MUFA intake. The wide range in age of the subjects (21-57 years) might have concealed the blood pressure lowering effects which usually occur in the older subjects.

SUMMARY

This study dispels the myth that avocados are fattening and should not be included in an energy restricted diet. Neither weight loss nor avocado (MUFA) intake had an effect on serum lipid levels, plasma fibrinogen, arterial compliance, SBP or DBP.

ACKNOWLEDGEMENTS

The authors wish to thank Sister Chrissie Lessing for the outstanding role she played in handling and organising the subjects and drawing blood. We also want to thank the South African Avocado Growers Association and the South African Government's Technology and Human Resources for Industry Programme for funding this study. We would like to acknowledge the role of Jane Badham in liasing with the South African Avocado Growers Association. Special thanks to all the subjects who took part in the study.

REFERENCES

1. Pieterse Z. Avocados: Consumer beliefs and effects on weight loss and markers of cardiovascular health. Potchefstroom: PU for CHE. (Dissertation – M.Sc.), 2003.

2. Langenhoven ML, Kruger M, Gouws E, Faber M. *MRC Food composition tables.* 3rd ed. Parow: Medical Research Council, 1991:245 p.

3. United States Department of Agriculture, Agricultural Research Service: Nutrient Database for Standard Reference, Release 15; 2002. Accessed March 3, 2003. Available at: http://www.nal.usda.gov/fnic/foodcomp

4. Kruger M, Langenhoven M, Faber M. Fatty acid and amino acid composition tables. Supplement to MRC food composition tables. Parow: Medical Research Council, 1991:205 p.

5. Ellis J, Lake A, Hoover-Plow J. Monounsaturated canola oil reduces fat deposition in growing female rats fed a high or low fat diet. Nutr Res 2002;22:609-621.

6. Piers LS, Walker KZ, Stoney RM, Soares MJ, O'Dea K. The influence of dietary fat on postprandial fat oxidation rates: monounsaturated (olive oil) vs saturated fat (cream). Int J Obes 2002;26:814-821.

7. Colette C, Percheron C, Pares-Herbute N et al. Exchanging carbohydrates for monounsaturated fats in energy-restricted diets: effects on metabolic profile and other cardiovascular risk factors. Int J Obes 2003;27:648-656.

8. Kris-Etherton PM, Zhao G, Pelkman CL, Fishell VK, Coval SM. Beneficial effects of a diet high in monounsaturated fatty acids on risk factors for cardiovascular disease. Nutr Clin Care 2000;3:153-162.

9. Kris-Etherton PM. Monounsaturated fatty acids and risk of cardiovascular disease. Circulation 1999;100:1253-1258.

10. Colquhoun DM, Moores D, Somerset SM, Humphries JA. Comparison of the effects on lipoproteins and apolipoproteins of a diet high in monounsaturated fatty acids, enriched with avocado, and a high-carbohydrate diet. Am J Clin Nutr 1992;56:671-677.

11. Grant WC. Influence of avocados on serum cholesterol. Proc Soc Exp Biol Med 1960;104:45-47.

12. Alvizouri-Muñoz M, Carranza-Madrigal J, Herrera-Abarca JE, Chavez-Carbajal F, Amezcua-Gastelum JL. Effects of avocado as a source of monounsaturated fatty acids on plasma lipid levels. Arch Med Res 1992;23(4):163-167.

13. Lerman-Garber I, Ichazo-Cerro S, Zamora-González J, Cardososaldaña GG, Posadas-Romero C. Effects of a high-monounsaturated fat diet enriched with avocado in NIDDM patients. Diabetes care 1994;17(4):311-315.

14. Carranza J, Alvizouri M, Alvarado MR, Chávez F, Gómez M, Herrera JE. Effects off avocado on the level of blood lipids in patients with phenotype II and IV dyslipidemias. Arch Inst Cardiol Mex 1995;65(4):342-348.

15. Lopez-Ledesma R, Frati-Munari AC, Hernandez-Dominguez BC, et al. Monounsaturated fatty acid (avocado) rich diet for mild hypercholesterolemia. Arch Med Res 1996;27(4):519-523.

16. Carranza-Madrigal J, Herrera-Abarca JE, Alvizouri-Muñoz M, Alvarado-Jimenez MR, Chavez-Carbajal F. Effects of a vegetarian diet vs. a vegetarian diet enriched with avocado in hypercholesterolemic patients. Arch Med Res 1997;28(4):537-541.

17. Pérez-Jiménez F, López-Miranda J, Mata P. Protective effect of dietary monounsaturated fat on arteriosclerosis: beyond cholesterol. Atherosclerosis 2002;163:385-398.

18. Krummel D (2000): Nutrition in Cardiovascular Disease. In: Mahan LK& Escott-Stump S, eds. *Krause's food, nutrition & diet therapy*, 10th ed. Philadelphia: W.B. Saunders, 2000: 558-595.

19. Johnson RK. Energy. In: Mahan LK& Escott-Stump S, eds. *Krause's food, nutrition & diet therapy*, 10th ed. Philadelphia: W.B. Saunders, 2000:19-30.

20. Black AE. The sensitivity and specificity of the Goldberg cut-off for EI:BMR for identifying diet reports of poor validity. EJCN 2000;54:395-404.

21. Weltman A, Levine S, Seip RL, Tran ZV. Accurate assessment of body composition in obese females. Am J Clin Nutr 1988;48:1179-1183.

22. Weltman A, Seip RL, Tran, ZV. Practical assessment of body composition in adult obese males. Human biology 1987;59:523-535.

23. Heyward VH, Stolarczyk LM. *Applied body composition assessment.* Human Kinetics: USA. 1996:221p.

24. Baecke JAH, Burema J, Frijiers JER. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. Am J Clin Nutr 1982;36:936-942.

25. Kruger HS, Venter CS, Steyn HS. A standardised physical activity questionnaire for a population in transition: the THUSA study. AJPHERD 2000;6:54-64.

26. Wesseling KH, Settels JJ, De Wit B. The measurement of continuous finger arterial pressure noninvasively in stationary subjects. In: Schmidt TH, Dembroski TM & Blümchen G, eds. *Biological Factors in Cardiovascular Disease*, Berlin: Springer, 1986:355-375.

27. Silke B, McAuley D. Accuracy and precision of blood pressure determination with the Finapres: an overview using re-sampling statistics. J Hum Hypertens 1998: 12:403-409.

28. Wesseling KH, Jansen JRC, Settels JJ, Schreuder JJ. Computation of aortic flow from pressure in humans using a nonlinear, three-element model. J Appl Physiol 1993;75:2566-2673.

29. Folch J, Lees M, Sloane-Stanley GH. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 1957;226:497-509.

30. Van Jaarsveld PJ, Smuts CM, Tichelaar HY, Kruger M, Benadé AJS. Effect of palm oil on plasma lipoprotein concentrations and plasma low-density lipoprotein composition in non-human primates. Int J Food Sci Nutr 2000;51:S21-S30.

31. AOAC® Peer-verified method PVM 4: Determination of total fat in foods and feeds byt the Caviezel method, based on gas chromotographic technique. AOAC International publications; 1997. Available at: http://www.aoac.org/pubs/PVMs/fetfat.htm

32. Lafay L, Basdevant A, Charles MA, et al. Determinants and nature of dietary underreporting in a free-living population: the Fleurbaix Laventie Ville Santé (FLVS) study. Int J Obes 1997;21:567-573.

33. Voss S, Kroke A, Klipstein-Grobush K, Boeing H. Is macronutrient composition of dietary intake data affected by underreporting? Results from the EPIC-Potsdam Study. European Prospective Investigation into Cancer and Nutrition. Eur J Clin Nutr 1998;52(2):119-126.

34. Lopez-Segura F, Velasco F, Lopez-Miranda J, et al. Monounsaturated fatty acid-enriched diet decreases plasma plasminogen activator inhibitor type 1. Arterioscler Thromb Vasc Biol 1996;16(1):82-88.

35. Rasmussen O, Thomsen C, Ingerslev J, Hermansen K. Decrease in von Willebrand factor levels after a high-monounsaturated-fat diet in non-insulin-dependent diabetic subjects. Metabolism 1994;43(11):1406-1409.

36. Niskanen L, Schwab US, Sarkkinen ES, Krusius T, Vahtera E, Uusitupa MI. Effects of dietary fat modification on fibrinogen, factor VII, and plasminogen activator inhibitor-1 activity in subjects with impaired glucose tolerance. Metabolism 1997;46(6):666-672.

37. Vorster HH, Badenhorst C, Barnard HC, Walker ARP, Kruger MM, Van Jaarsveld P. Effects of weight reduction on plasma fibrinogen levels and other metabolic variables in obese women. S Afr J Clin Nutr 1989;2(2):8-15.

38. Alonso R, Uribe C, Astudillo J, et al. Relation of weight loss to change in some cardiovascular risk factors (CVRF) in overweight healthy men. Atherosclerosis 1997;134(1-2):318-319.

39. Marckmann P, Toubro S, Astrup A. Sustained improvement in blood lipids, coagulation, and fibrinolysis after major weight loss in obese subjects. Eur J Clin Nutr 1998:52:329-333.

40. Resnick LM, Lester MH. Effect of modest weight loss on arterial compliance in essential hypertension. AJH 2001;14(4):A124.

41. McCarron DA, Reusser ME. Body weight and blood pressure regulation. Am J Clin Nutr 1996:63(Suppl):423S-425S.

CHAPTER 5

GENERAL SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 5

GENERAL SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1. INTRODUCTION

In this final chapter, a summary of the main findings from the two studies reported in this dissertation will be given. As the results of each study are discussed, interpreted, elucidated and compared to the relevant literature in the preceding chapters, only general conclusions will subsequently be made. This will be followed by general recommendations regarding this study, as well as recommendations to the food industry and health professionals as deduced from these findings.

2. SUMMARY OF MAIN FINDINGS

2.1 Consumer beliefs, avocados and health

- South African consumers gender or age did not influence their responses towards the relationship between avocados and health. The race and living standard of consumers did, however, influence their response to some of the statements regarding avocados.
- Blacks agreed more strongly than Indians that avocados are good for you, and agreed that avocados are fattening, while whites responded dubiously. Black people agreed more strongly than coloureds that avocados have aphrodisiac properties, and differed in response compared to Indians, who disagreed. Whites on the other hand were more likely to disagree that avocados contain cholesterol and so are bad for you than Indians, and disagreed more than blacks that avocados are bad for you.
- With regard to the difference in response in the various LSM groups, LSM group 2 agreed more strongly than all the other groups that avocados are good for your health and are a good source of fibre. LSM group 2 also disagreed more than LSM group 3 that avocados contain fat and so are bad for you, while LSM 3 agreed more strongly that avocados are good for sportsmen/women compared to LSM group 2. The response to avocados as a good source of fibre, also led to differences in the response between LSM group 10 and LSM groups 4-8, with LSM group 10 agreeing less. LSM group 2 agreed the most that avocados are an aphrodisiac compared to LSM groups 3 and 6-10. The LSM groups 3-6 were more likely to agree compared to LSM groups 7-10, with LSM group 9 disagreeing and LSM group 10 responding dubiously.
- Overall, consumers responded positively towards the role of avocados in a healthy diet, including the diets of children and athletes.
- The majority of consumers saw avocados as a nutrient dense fruit, being a good source of vitamins, minerals and fibre.

- Most consumers agreed that avocados contain "good" fat that can be eaten as part of a healthy diet. There are still, however, consumers who see avocados as fattening, containing cholesterol and having aphrodisiac properties.

2.2 Avocados, weight loss and markers of cardiovascular health

- Results from the dietary intervention study showed that the consumption of 200 g avocado per day, within an energy restricted diet, does not compromise weight loss when substituted for 30 g of mixed dietary fat.
- Weight, body mass index and percentage body fat decreased significantly in both groups during the study, with the change being similar in both groups.
- Although the consumption of avocados significantly increased plasma oleic acid levels in the experimental group, no significant changes were observed in serum lipid levels, plasma fibrinogen, arterial compliance and blood pressure.

3. CONCLUSIONS

From the available literature it is clear that avocados are a very healthy and nutritious fruit. The avocado fruit contains a wide range of healthy nutrients, ranging from fatty acids, predominantly MUFA, to micronutrients - especially antioxidant vitamins. Avocados are fruit that are regularly consumed by South Africans despite the existence of certain misconceptions regarding the fattening properties and cholesterol content of avocados, as seen from the results obtained in the consumer study.

The results of the intervention study clearly and scientifically dispelled the myth that avocados are fattening. Although scientific evidence exists, health messages still have to reach the consumers in order to change their attitudes and beliefs.

4. RECOMMENDATIONS

- Since the effects of avocados on markers of cardiovascular health are limited and in certain cases lacking, it is recommended that further clinical intervention studies should be conducted with avocados as the primary MUFA source, especially to confirm the cholesterol lowering effect of avocados as MUFA source.
- It would also be worthwhile to do a consumption survey on avocados covering the metropolitan areas in South Africa, and to evaluate the acceptance and palatability of avocados in the diet by the sensory evaluation of different forms and recipes.
- The agricultural industry, together with health professionals, should be encouraged to convey the health benefits of avocados to consumers, and to help dispel the current misconceptions concerning avocados. It is also important that health messages to the public should be based on scientific evidence and should come from reliable references.

CONSUMER QUESTIONNAIRE

10.	SHOW CARD: Now can we please look at the following statements concerning avocados rating each of the statement on a scale of 5 to 1, where 5 = strongly agree and 1 = strongly disagree, how strongly do you agree with each statement?						
	OMO → READ OUT	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	DON'T KNOW
1.	Avocados are good for your health	-5	-4	-3	-2	-1	-6
2.	Avocados are good for children	-5	-4	-3	-2	-1	-6
3.	Avocados are fattening	-5	-4	-3	-2	-1	-6
4.	Avocados contain fat and so are bad for you	-5	-4	-3	-2	-1	-6
5.	Avocados are good for sportsmen/women	-5	-4	-3	-2	-1	-6
6.	Avocados contain good fat but you must not eat too many	-5	-4	-3	-2	-1	-6
7.	Avocados contain good fat, therefor you can eat them	-5	-4	-3	-2	-1	-6
8.	Avocados are a good source of fibre	-5	-4	-3	-2	-1	-6
9.	Avocados contain cholesterol and so are bad for you	-5	-4	-3	-2	-1	-6
10	Avocados are bad for your heart	-5	-4	-3	-2	-1	-6
11.	Avocados contain fat, but can still be eaten as part of a healthy diet	-5	-4	-3	-2	-1	-6
12	Avocados are bad for you	-5	-4	-3	-2	-1	-6
13	Avocados are a good source of vitamins and minerals	-5	-4	-3	-2	-1	-6
14	Avocados improve sexual functioning	-5	-4	-3	-2	-1	-6

7 DAY MENU PLAN / 7 DAG MAALTYDPLAN

Experimental / Eksperimenteel: 6 000 kJ

	Maaltydplan	Maandag	Dinsdag	Woensdag	Donderdag	Vrydag	Saterdag	Sondag
Ontbyt	2 broodruile 1 vrugteruil [1]melk	1 kop All-bran 100 mL vrugtesap[2] [1]melk	2 snye brood-*toast* MArmite 1 klein appel [1]melk	1 kop hawermoutpap ½ kop stowe vrugte [1]melk	2 blokkies weetbix ½ lemoen [1]melk	1 x 60 g *muffin*[3] Marmite ½ piesang [1]melk	1 kop slap mieliepap 100 mL vrugtesap [1]melk	2 snye brood-*toast* Marmite 2 pruimedante [1]melk
Tussen-in	2 broodruile 3 vetruile [1]melk	2 dun snye brood ½ avokado [1]melk	6 provitas ½ avokado [1]melk	1 volgraanbroodrol ½ avokado [1]melk	2 dun snye brood ½ avokado [1]melk	6 provitas ½ avokado [1]melk	1 volgraanbroodrol ½ avokado [1]melk	2 dun snye brood ½ avokado [1]melk
Middagete	1 broodruil Smeer vir brood 2 vrugteruil 1 groente A ruil [1]melk	3 provitas Marmite 200 mL vrugtesap Tamatie [1]melk	½ volgraanbroodrol Marmite 200 mL vrugtesap Komkommer [1]melk	½ kop gaar pasta 2 t Tamatie & uiesmoor ¾ kop lemoenskyfies Blaarslaai en seldery [1]melk	1 klein aartappel 2 teel ongegeurde, lae vet yoghurt 200 mL vrugtesap Sampioene [1]melk	½ x pita brood ¾ kop vars pynappel-blokkies & tamatie Uie & blaarslaai [1]melk	1 sny brood Marmite Tamatie 200 mL vrugtesap [1]melk	½ volgraan broodrol Marmite Aspersies 200 mL vrugtesap [1]melk
Tussenin	2 broodruile 3 vetruile [1]melk 1 vrugteruil	2 dun snye brood ½ avokado [1]melk 1 klein appel	6 provitas ½ avokado [1]melk v rantsoen ½ piesang	2 dun snye brood ½ avokado [1]melk ¼ kop rosyne	6 provitas ½ avokado [1]melk 2 gedroogte perskehalwes	6 provitas ½ avokado [1]melk 1 klein peer	2 dun snye brood ½ avokado [1]melk 2 pruimedante	2 dun snye brood ½ avokado [1]melk ½ pomelo
Aandete	1 broodruil 3 vleisruile 1 groente A ruil 1 groente B ruil [1]melk	½ kop gaar pasta[4] 90 g gaar maer maalvleis, gegeur Groente A ½ kop Groente B [1]melk	1 klein aartappel[4] 90g hoenderborsie, sonder vel, gegeur Groente A ½ kop Groente B [1]melk	½ kop gaar rys[4] 90 g skaapboud, sonder vet Groente A ½ kop Groente B [1]melk	½ volgraan broodrol[4] 90 g stokvis, gestoom of oondgerooster Groente A ½ kop Groente B [1]melk	½ kop gaar pasta[4] 90 g laevet maaskaas oor pasta Groente A ½ kop Groente B [1]melk	1 klein aartappel[4] 90 g gaar maalvleis, vetvry, gegeur Groente A ½ kop Groente B [1]melk	½ kop gaar rys[4] 90 g gaar fillet, gegeur na smaak Groente A ½ kop Groente B [1]melk
Laataand	[1]melk	[1]melk	[1]melk	[1]melk	[1]melk	[1]melk	[1]melk	[1]melk

NB: GEEN muffins mag geëet word NIE !!!!

Belangrike inligting:

[1]Melkrantsoen: Daar is 500 mL (2 koppies) vetvrye melk beskikbaar vir gebruik deur die dag. Merk 'n spesiale bekertjie waarin jy die regte hoeveelheid melk vir die dag in afmeet en gebruik dan daarvan soos nodig.

[2]Vrugtesappe Slegs onversoete, suiwer vrugtesappe mag gebruik word. Maak seker dat die woorde "No added sugar" op die houer staan voordat u dit gebruik.

Control / Kontrole: 6 000 kJ

	Maaltydplan	Maandag	Dinsdag	Woensdag	Donderdag	Vrydag	Saterdag	Sondag
Ontbyt	2 broodruile Smeer (indien verkies) 1 vrugteruil [1]melk	1 kop All-bran 100 mL vrugtesap[2] [1]melk	2 snye brood-*toast* Marmite 1 klein appel [1]melk	1 kop hawermoutpap ½ kop stowe vrugte [1]melk	2 blokkies weetbix ½ lemoen [1]melk	1 x 60 g *muffin*[3] Marmite ½ piesang [1]melk	1 kop slap mieliepap 100 mL vrugtesap [1]melk	2 snye brood-*toast* Marmite 2 pruimedante [1]melk
Tussen-in	2 broodruile 3 vetruile [1]melk van rantsoen	2 dun snye brood 15 mL laevet marg. [1]melk van rantsoen	6 provitas 15 mL laevet marg. [1]melk van rantsoen	1 volgraanbroodrol 15 mL laevet marg. [1]melk v rantsoen	2 dun snye brood 15 mL laevet marg. [1]melk van rantsoen	6 provitas 15 mL laevet marg. [1]melk van rantsoen	1 volgraanbroodrol 15 mL laevet marg. [1]melk v rantsoen	2 dun snye brood 15 mL laevet marg. [1]melk van rantsoen
Middagete	1 broodruil Smeer vir brood 2 vrugteruil 1 groente A ruil [1]melk van rantsoen	3 provitas Marmite 200 mL vrugtesap Tamatie [1]melk van rantsoen	½ volgraanbroodrol Marmite 200 mL vrugtesap Komkommer [1]melk van rantsoen	½ kop gaar pasta 2 t Tamatie & uiesmoor ¾ kop lemoenskyfies Blaarslaai en seldery [1]melk v rantsoen	1 klein aartappel 2 teel ongegeurde, lae vet yoghurt 200 mL vrugtesap Sampioene [1]melk v rantsoen	½ x pita brood ¾ kop vars pynappel-blokkies & tamatie Uie & blaarslaai [1]melk v rantsoen	1 sny brood Marmite Tamatie 200 mL vrugtesap [1]melk van rantsoen	½ volgraan broodrol Marmite Aspersies 200 mL vrugtesap [1]melk van rantsoen
Tussenin	2 broodruile 3 vetruile [1]melk van rantsoen 1 vrugteruil	2 dun snye brood 15 mL laevet marg. [1]melk v rantsoen 1 klein appel	6 provitas 15 mL laevet marg. [1]melk van rantsoen ½ piesang	2 dun snye brood 15 mL laevet marg. [1]melk v rantsoen ¼ kop rosyne	6 provitas 15 mL laevet marg. [1]melk v rantsoen 2 gedroogte perskehalwes	6 provitas 15 mL laevet marg. [1]melk v rantsoen 1 klein peer	2 dun snye brood 15 mL laevet marg. [1]melk v rantsoen 2 pruimedante	2 dun snye brood 15 mL laevet marg. [1]melk vrantsoen ½ pomelo
Aandete	1 broodruil 3 vleisruile 1 groente A ruil 1 groente B ruil [1]melk van rantsoen	½ kop gaar pasta[4] 90 g gaar maer maalvleis, gegeur Groente A ½ kop Groente B [1]melk v rantsoen	1 klein aartappel[4] 90 g hoenderborsie, sonder vel, gegeur Groente A ½ kop Groente B [1]melk v rantsoen	½ kop gaar rys[4] 90 g skaapboud, sonder vet Groente A ½ kop Groente B [1]melk van rantsoen	½ volgraan broodrol[4] 90 g stokvis, gestoom of oondgerooster Groente A ½ kop Groente B [1]melk v rantsoen	½ kop gaar pasta[4] 90 g laevet maaskaas oor pasta Groente A ½ kop Groente B [1]melk v rantsoen	1 klein aartappel[4] 90 g gaar maalvleis, vetvry, gegeur Groente A ½ kop Groente B [1]melk v rantsoen	½ kop gaar rys[4] 90 g gaar fillet, gegeur na smaak Groente A ½ kop Groente B [1]melk v rantsoen
Laataand	[1]melk	[1]melk	[1]melk	[1]melk	[1]melk	[1]melk	[1]melk	[1]melk

NB: GEEN muffins mag geëet word NIE !!!!

Belangrike inligting:

[1]Melkrantsoen: Daar is 500 mL (2 koppies) vetvrye melk beskikbaar vir gebruik deur die dag. Merk 'n spesiale bekertjie waarin jy die regte hoeveelheid melk vir die dag in afmeet en gebruik dan daarvan soos nodig.

[2]Vrugtesappe Slegs onversoete, suiwer vrugtesappe mag gebruik word. Maak seker dat die woorde "No added sugar" op die houer staan voordat u dit gebruik.

General information regarding menu plan.

<table>
<tr>
<td colspan="3">Groente A: Groot porsies van hierdie groente word toegelaat

Aspersies
Baba-murg-van-groente
Eiervrug
Brokkoli
Brusselse spruite
Kool
Blomkool
Seldery

Lemoenpampoen
Agurkies
Groenbone
Prei
Blaarslaai
Skorsies
Sampioene
Uie
Krulpampoentjie

Rissies
Radyse
Spinasie
Salotte
Tamaties
Rape
Waterblommetjies
Komkommer</td>
<td>Groente B: Slegs een porsie (120 g / 125 mL / ½ koppie) van hierdie groente word per dag toegelaat:
Beet
Botterskorsies
Wortels
Hubbard pampoen
Boerpampoen
Gemengde groente (bevrore)
Witwortels
Erte</td>
</tr>
<tr>
<td colspan="3">**Vette, olie en margarien:
Geen toelating word gemaak vir margarien op die brood of olie om voedsel in gaar te maak. Kleefwerende middels wat in blikkies gekoop word, moet in die plek van olie gebruik word vir braai doeleindes.
Alle sigbare vet moet van vleis afgesny word en die vel van hoender moet verwyder word voor gaarmaak.
Voedsel wat in die mikrogolfoond gaargemaak word is geskik mits GEEN ekstra vet tydens of na gaarmaak bygevoeg word nie.
360 mL ligte bier (bv. Castle Light) of 45 mL whiskey of 120 mL droë witwyn of 120 mL rooi of 120 mL rosé wyn kan in plaas van 2 vetruile gebruik word (slegs per geleentheid en NIE daagliks NIE)</td>
<td>Suiwelprodukte:
Lae vet kaas (die ander se vetinhoud is te hoog); 30 g (vuurhoutjiedosie grootte) = 1 vleisruil
Maaskaas: vetvry, “smooth” (< 0,5% vet/100g); 100 mL/g = 250 mL afgeroomde melk
Youghurt, laevet, onversoet of kunsmatig versoet en gegeur; vervang met gelyke hoeveelhede afgeroomde melk.</td>
</tr>
<tr>
<td colspan="4">Geurmiddels:
Kruie (vars of gedroog), speserye, knoffel, suurlemoensap, asyn (Balsamic, Cider, Wine), worcester sauce, bovril and marmite mag gebruik word om voedsel te geur.</td>
</tr>
<tr>
<td>Alle gewigte en volumes word gegee vir voedsel wat klaar gaar is en gereed om te eet.
t=teelepel (5 mL); kop=koppie (250 mL); eetl=eetlepel (12.5 mL)
4Hierdie stysels kan ook met ‘n ½ koppie stywe pap vervang word by die mans se spyskaart en ‘n ¼ koppie stywe pap by die dames se spyskaart</td>
<td>Wenke vir avokadosmere:
Avokado, tamatie, uie, komkommer, blaarslaai
Avokado, bone spruite, vetvrye maaskaas en seldery
Avokado en agurkies
Avokado, suurlemoensap, blaarslaai en tamatie
Vetvrye maaskaas, avokado en seldery
Avokado, blatjang en vetvrye maaskaas</td>
<td colspan="2">Geen muffins mag op hierdie dieet geneem word nie
Drink ten minste 8 glase skoon water versprei deur die dag.
Moet nie afwyk van die dieet nie
Indien u iets geëet het wat nie toegelaat word nie, begin onmiddellik weer korrek volgens die voorskrif eet.
Bel gerus indien u enige probleme met die dieet ondervind.</td>
</tr>
</table>

PHYSICAL ACTIVITY QUESTIONNAIRE

CHO, POTCHEFSTROOM

Physical activity questionnaire

Date: Place: Interviewer:

The information on this questionnaire is confidential

Name:

1.	Subject number						(1-4)
2.	Gender	Male	1	Female		2	(5)
3.	What is your main occupation?.....						
	Low level: office work, housework, scholar					1	
	Middle level: factory work, carpentry, farming, hospital nurse, plumber					2	(6)
	High level ("sweat work"): construction work, digging, manual labor					3	
4.	At work I sit	1. never	2. seldom	3. sometimes	4.often	5.always	(7)
5.	At work I stand	1. never	2. seldom	3. sometimes	4.often	5.always	(8)
6.	At work I walk	1. never	2. seldom	3. sometimes	4.often	5.always	(9)
7.	At work I lift heavy loads	1. never	2. seldom	3. sometimes	4.often	5.always	(10)
8.	At work I am tired	1.never	2.seldom	3. sometimes	4.often	5.always	(11)
9.	At work I sweat	1.never	2.seldom	3. sometimes	4.often	5.always	(12)
10.	Do you commute?				yes	1	
					no	2	
11.	If yes, how do you get to work/school?				walk	1	
					cycle	2	(13)
					car/taxi	3	
12.	How long does it take you to walk/cycle to work/school? (or to the taxi rank/ bus stop/ train station)				0-15 min	1	
					16-30 min	2	
					31-60 min	3	
					1-2 hours	4	(14)
13.	If you walk or cycle to work/school, what is your usual pace? (or to taxi rank/bus stop/ train station)				casual strolling	1	
					fairly brisk	2	
					brisk/fast	3	(15)
14.	Do you climb stairs often?				yes	1	
					no	2	(16)
15.	If yes, how many flights of stairs do you climb each day? (1 flight = 10 steps)						(17)
16.	How many days per week do you climb steps?						(18)
17.	Do you play sport?				yes	1	
					no	2	(19)
18.	Which sport do you play most frequently?	low level: bowling, golf, billiards				1	0.76*[1]
		middle level: tennis, athletics, cycling				2	1.26
		high level: soccer, rugby, netball, boxing				3	1.76(20

		If other, specify				)
19.	How many hours per week do you practice?<1/ 1-2/ 2-3/ 3-4/ >4 (Write appropriate code in space) 0.5, 1.5, 2.5, 3.5, 4.5*[2]					(21-23)
20.	How many months per year ? <1/ 1-3/ 4-6/ 7-9/ >9 (Write appropriate code in space) 0.04, 0.17, 0.42, 0.67, 0.92*[3]				.	(24-26)
	*[1] intensity code of sport, *[2] time code for sport, *[3] proportion of year					
21.	If you play a second sport, which is it?	low level: bowling, golf, billiards			1	0.76*[1]
		middle level: tennis, athletics, cycling			2	1.26
		high level: soccer, rugby, netball, boxing			3	1.76(27)
		Other, specify				
22.	How many hours per week do you practice? <1/ 1-2/ 2-3/ 3-4/ >4 0.5, 1.5, 2.5, 3.5, 4.5*[2]					. (28-30)
23.	How many months per year? <1/ 1-3/ 4-6/ 7-9/ >9 0.04, 0.17, 0.42, 0.67, 0.92*[3]				.	(31-33)
24.	During leisure time I watch TV/ do sitting activities (read, study, play cards)	1.never	2.sel-dom	3.some-times	4.often	5.always (34)
25.	During leisure time I walk/ do standing activities (gardening, housework)	1.never	2.sel-dom	3.some-times	4.often	5.always (35)
26.	Other leisure-time activities:..... (leisure-time = time off from work/school).		2.sel-dom	3.some-times	4.often	5.always (36)

Definitions and explanation of the questionnaire (interviewer's notes)

Item 1: Write in the subject number as on the name label provided at the recruitment station.

Item 2: Circle gender: male or female

Item 3. Occupation: paid job or unpaid duties for most of the day; including school, housework, childminding

Write in the occupation stated and circle 1,2 or 3 (low level, middle level or high level)

Item 4-9:
- never: ⊕: never, almost never
- seldom: ⊕ one-quarter of the workday or workweek
- sometimes: ⊕ half the workday or workweek
- often: ⊕ three-quarters of the workday or workweek
- always: ⊕ almost all the time

Item 14: If the subject does not climb stairs, go on to question 17.

Item 17: If the subject does not play sport, go on to question 24.

Item 18: Circle 1/2/3

Item 19 and 22: Write time code in space, note decimal point

Item 20 and 23: Write code in space, note decimal point

Item 21: Circle 1/2/3

Item 24-26:
- never: ⊕ never, almost never
- seldom: ⊕ one-quarter of off-time, 1-2 days per week
- sometimes: ⊕ half my off-time, 3-4 days per week
- often: ⊕ three-quarters of my off-time, 5-6 days per week
- always: ⊕ almost all the time, mostly 7 days per week

Item 24: sitting activities: watch TV, listen radio, reading, writing, knitting, needlework, playing cards, visiting friends

Item 25: standing activities: gardening, walking with friends, cleaning, cooking, doing laundry, ironing, dishwashing after work at your own home

Item 26: other leisure-time activities: name any other leisure-time activities that you do and how often you do these activities.

NB: *leisure-time* is time after work, school, or housework is finished

24-HOUR DIETARY RECALL / 24-UUR HERROEP

Proefpersoon: _____

Datum: _____

TYD	VOEDSEL	VOORBEREIDING	HOEVEEL	KODE

Hoe verskil naweek-eetpatroon van weeksdae:

CALENDER / KALENDER

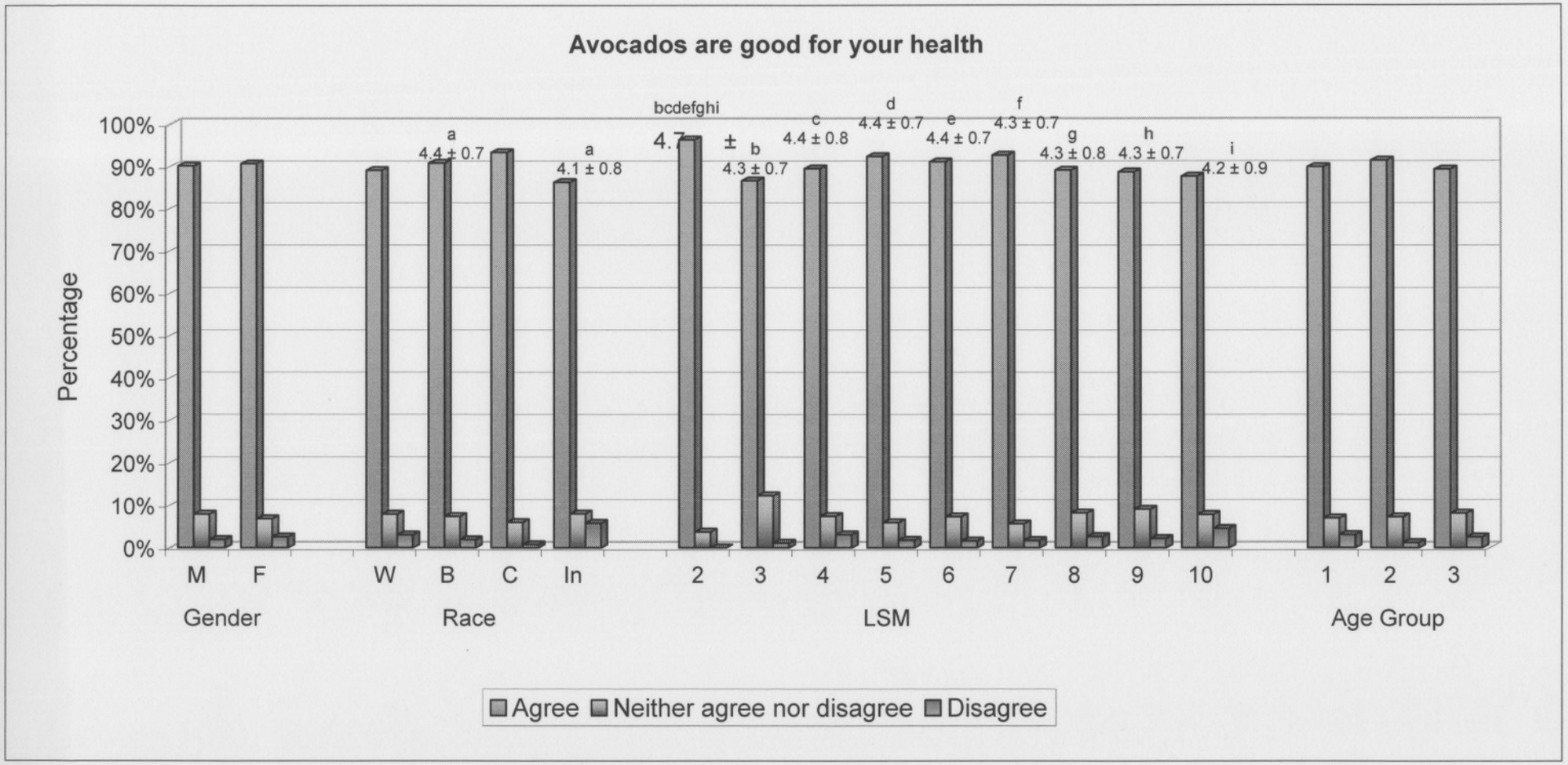
Proefpersoon: _____

DAG	APRIL	MEI	JUNIE
Wo	3	1	
Do	4	2	
Vr	5	3	
Sa	6	4	1
So	7	5	2
Ma	8	6	3
Di	9	7	4 A
Wo	10	8	5 A
Do	11	9	6 A
Vr	12	10	7
Sa	13	11	8
So	14	12	9
Ma	15	13	10
Di	16	14	11
Wo	17	15	12
Do	18	16	13
Vr	19	17	14
Sa	20	18	15
So	21	19	16
Ma	22	20	17
Di	23 A	21	18
Wo	24 A	22	19
Do	25 A	23	20
Vr	26	24	21
Sa	27	25	22
So	28	26	23
Ma	29	27	24
Di	30	28	25
Wo		29	26
Do		30	27
Vr		31	28

A Meting van arteriële meegewendheid — Metings — Weeg

Bloedtrek — Ontvang van avokado's — Invul van vraelyst

Figure 1

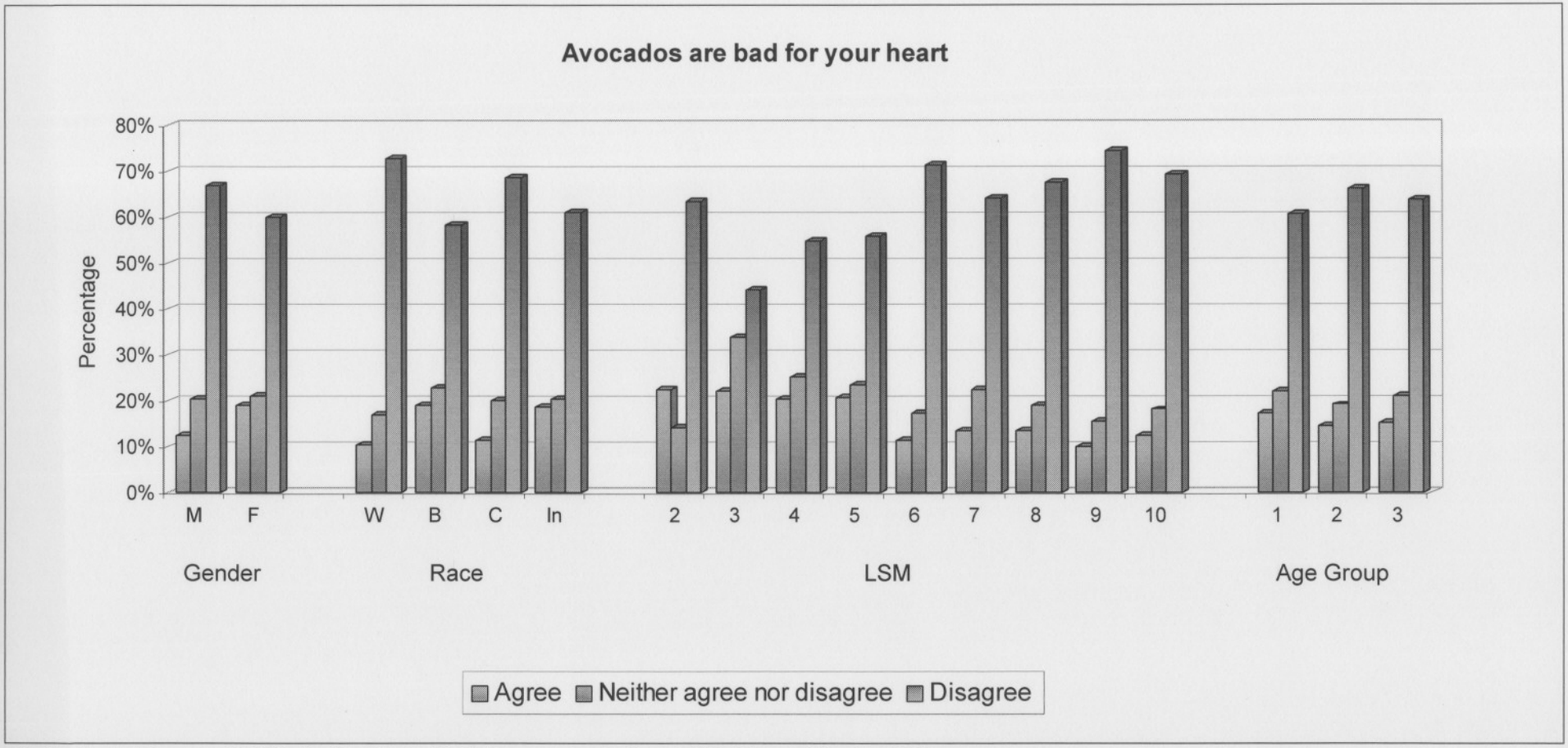


Means of groups with the same symbol differ significantly from each other, practical significance d=0.3-0.49; d=0.5-0.79; d>0.8 (Cohen, 1988)

M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

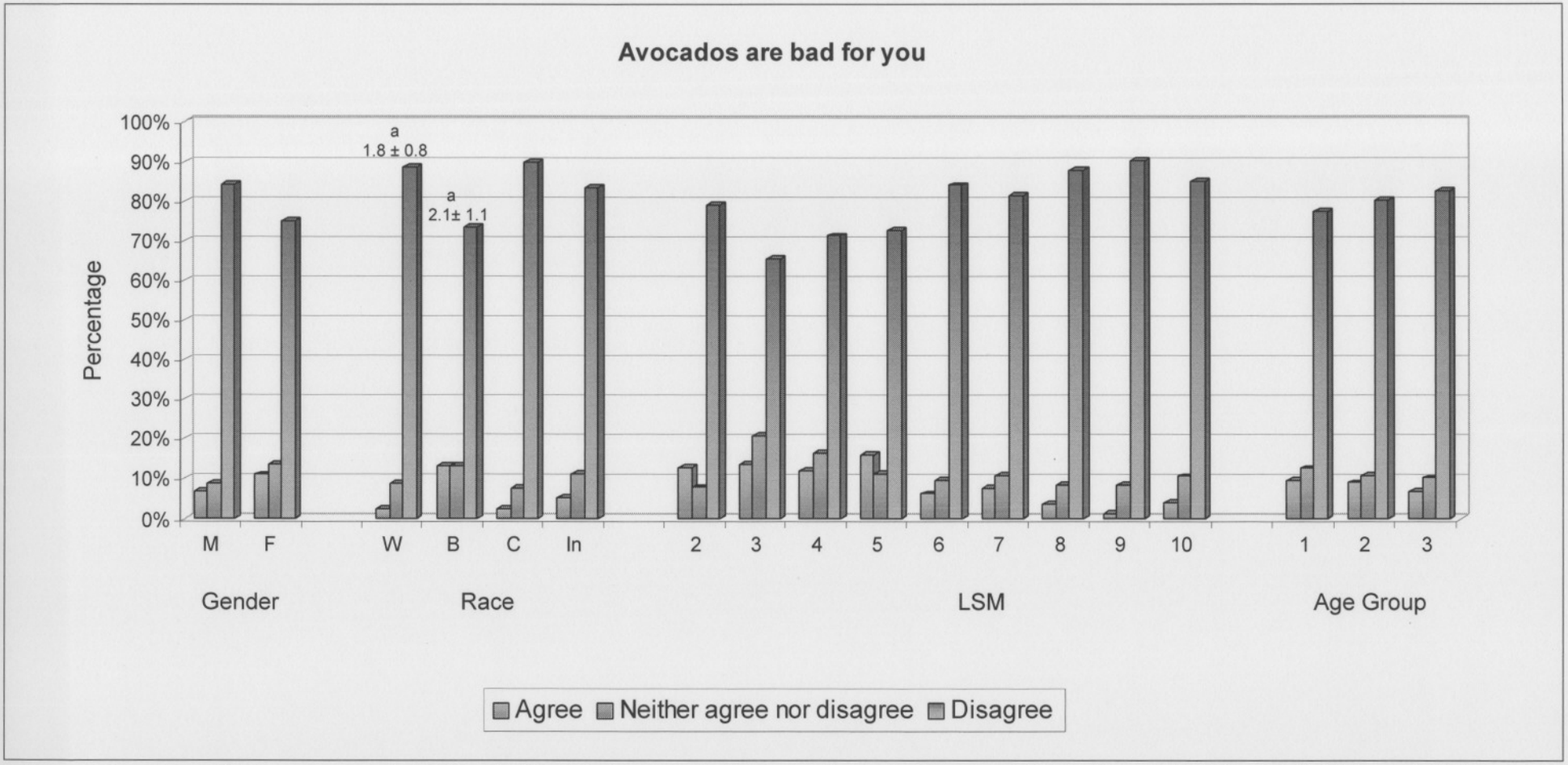
Figure 2



M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

Figure 3

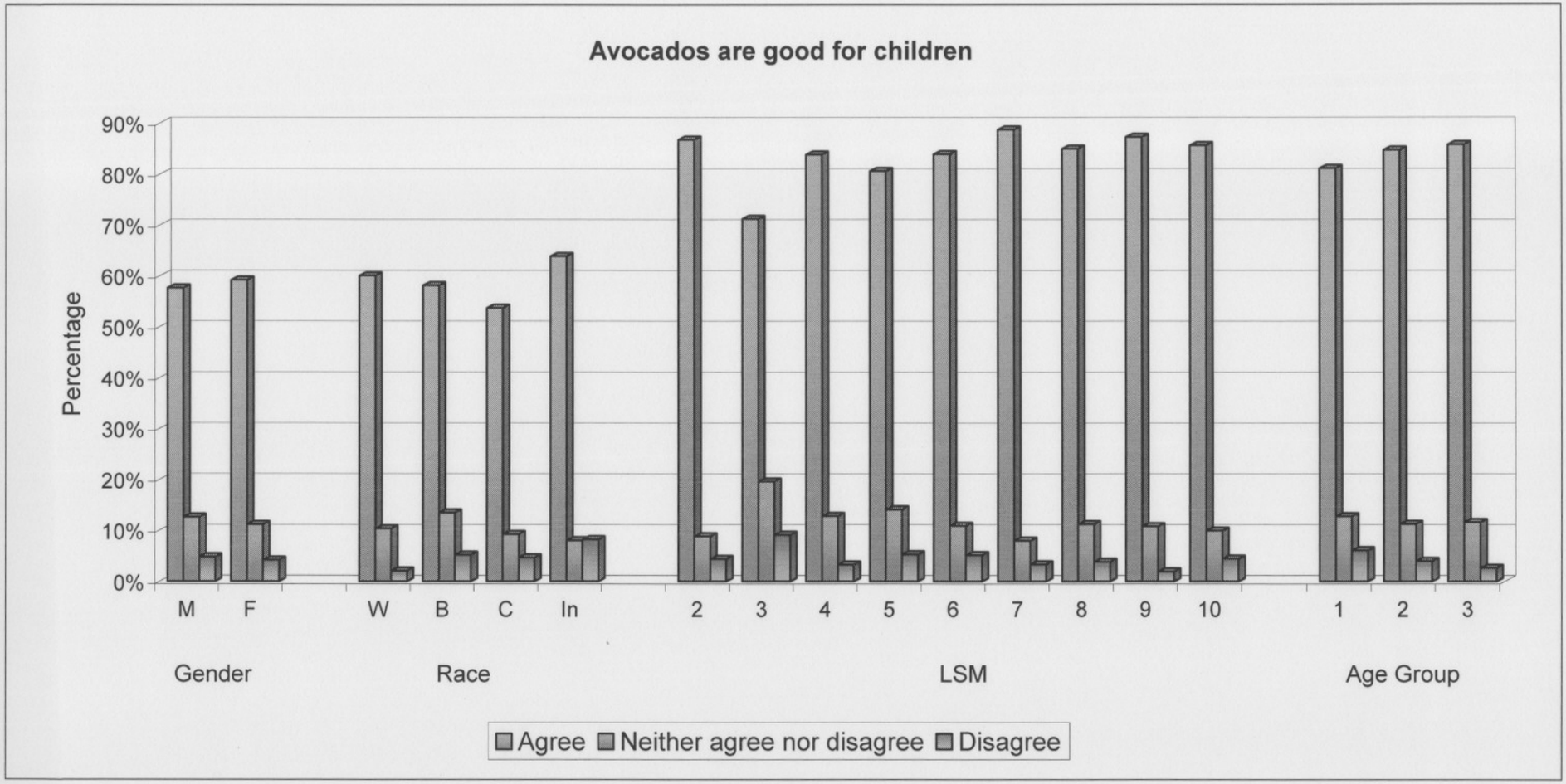


Means of groups with the same symbol differ significantly from each other, practical significance d=0.3-0.49; d=0.5-0.79; d>0.8 (Cohen, 1988)

M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

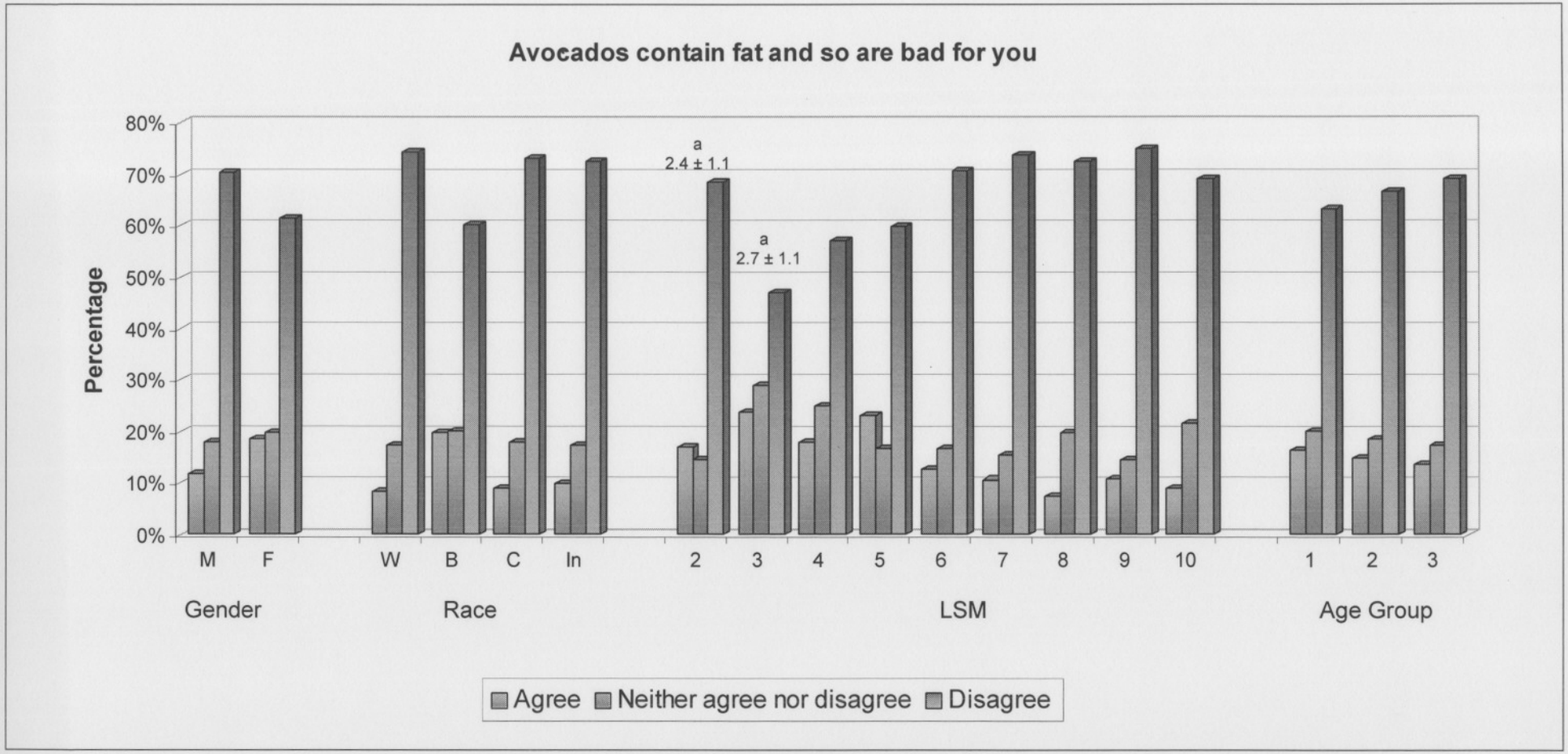
Figure 4



M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

Figure 5

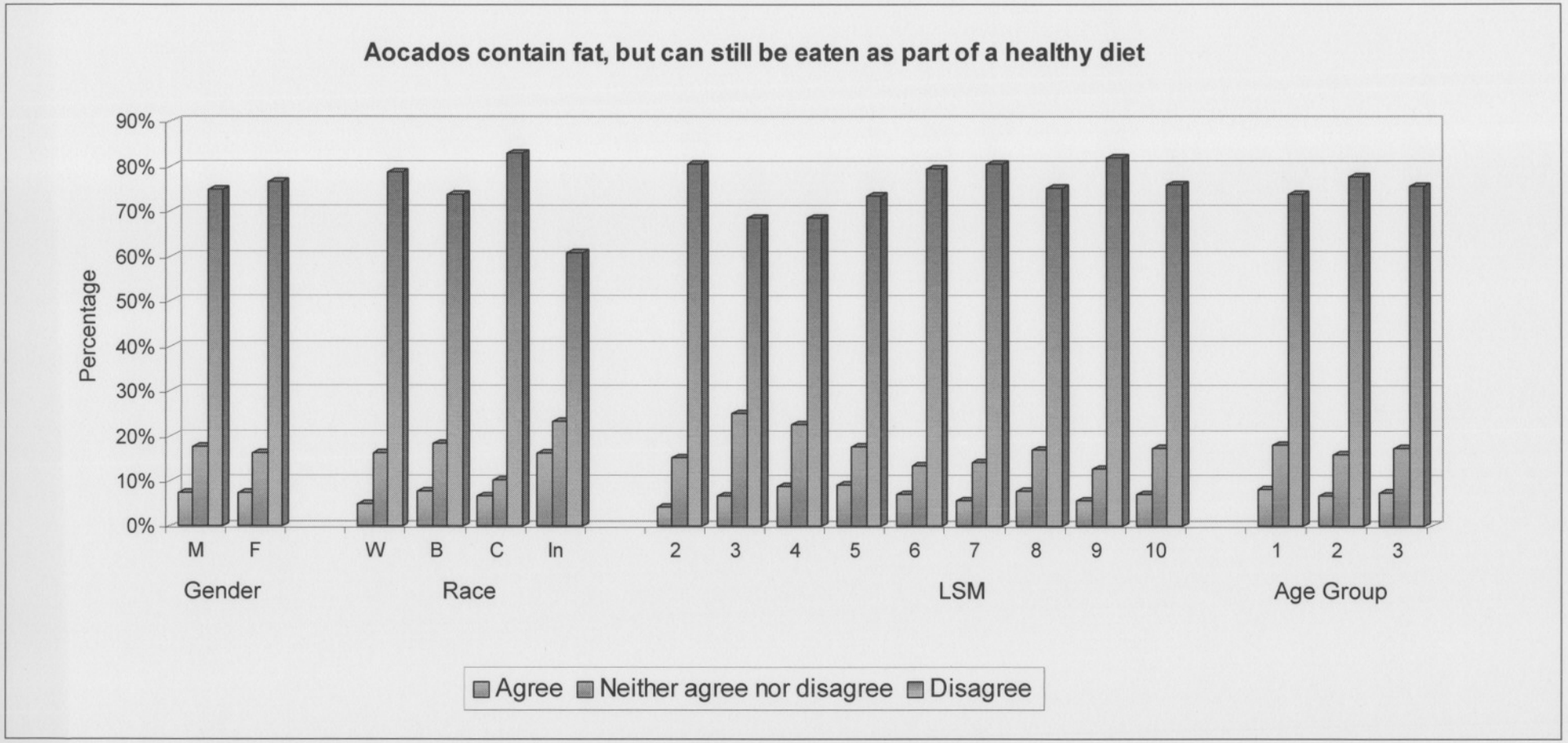


Means of groups with the same symbol differ significantly from each other, practical significance d=0.3-0.49; d=0.5-0.79; d>0.8 (Cohen, 1988)

M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

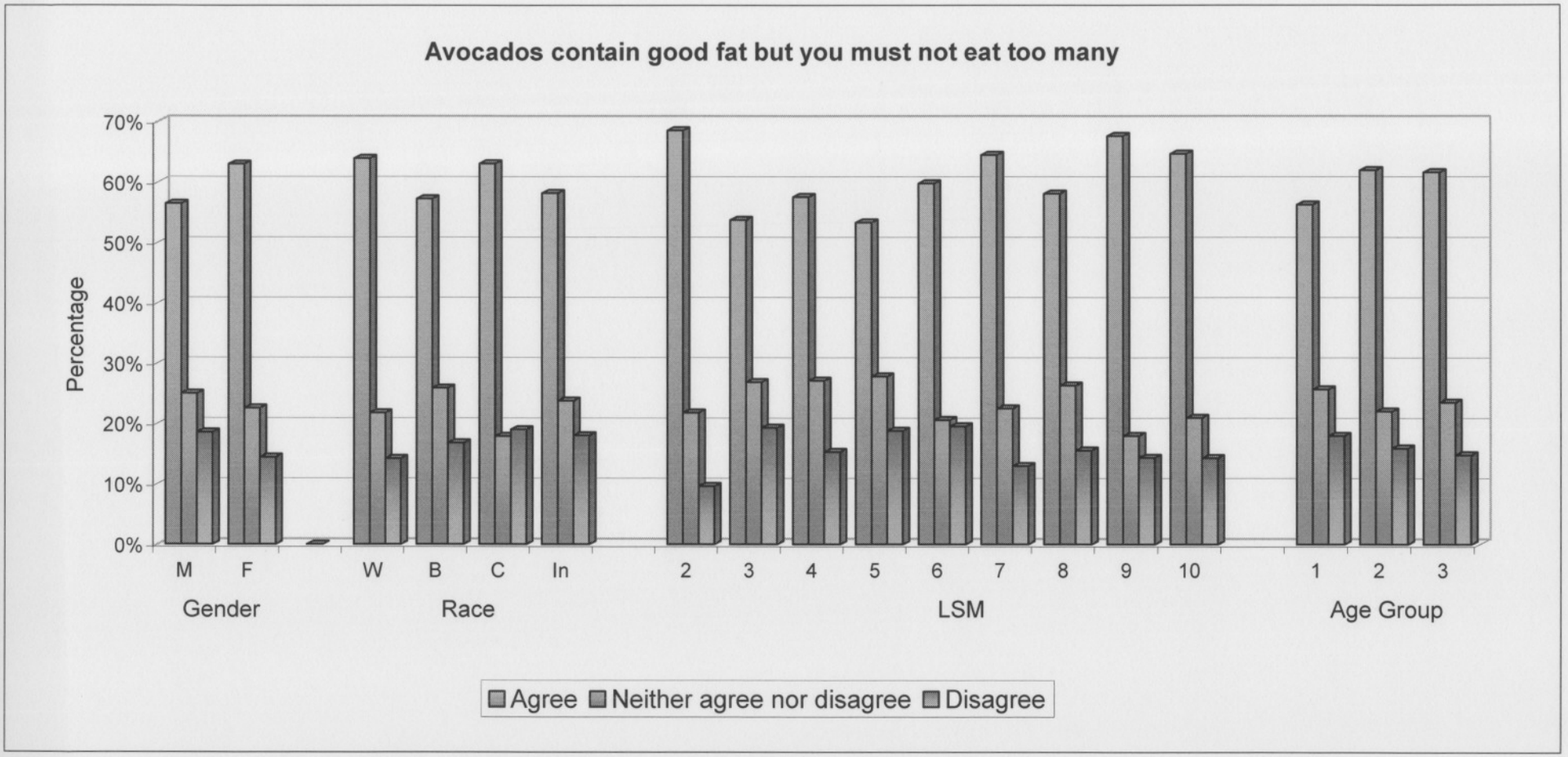
Figure 6



M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

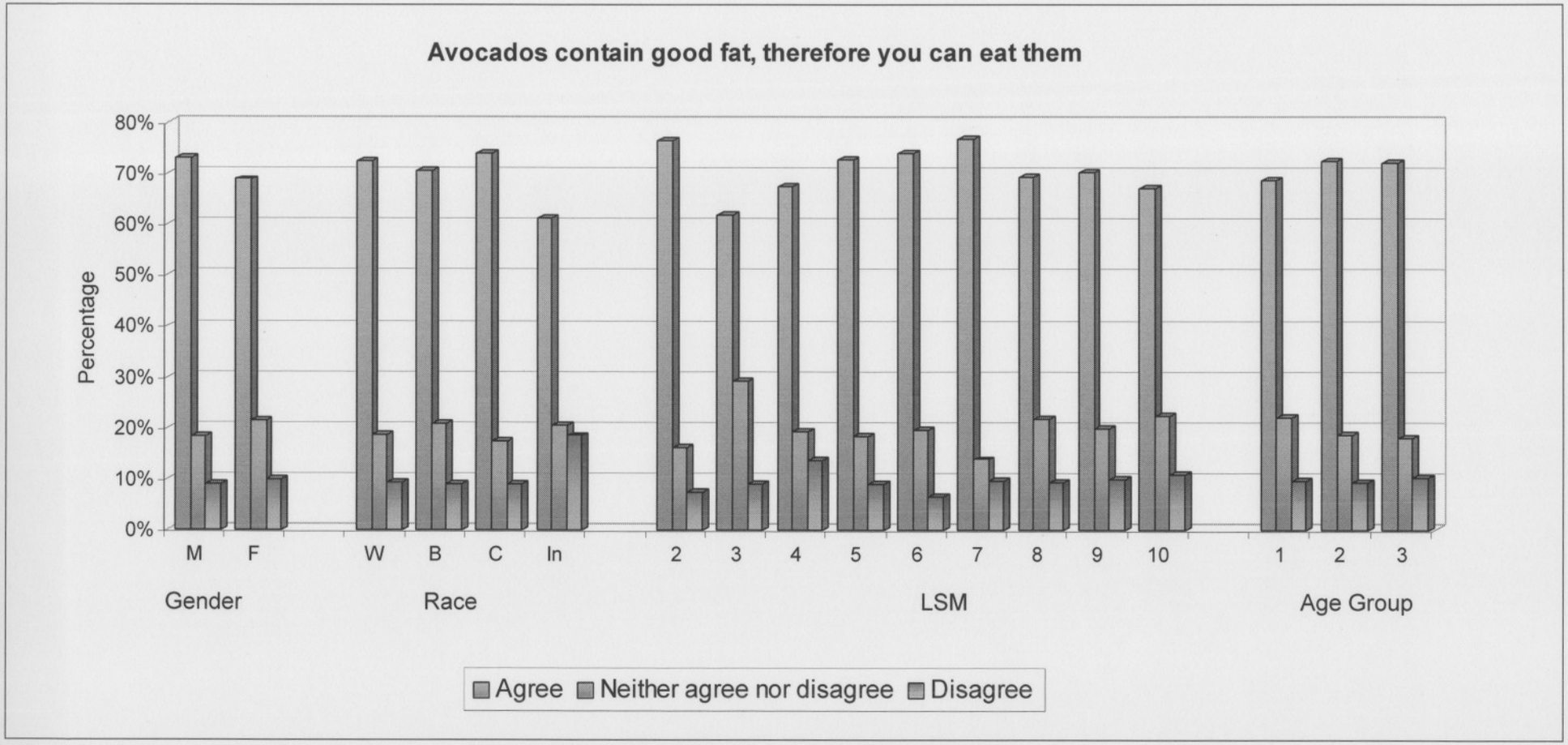
Figure 7



M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

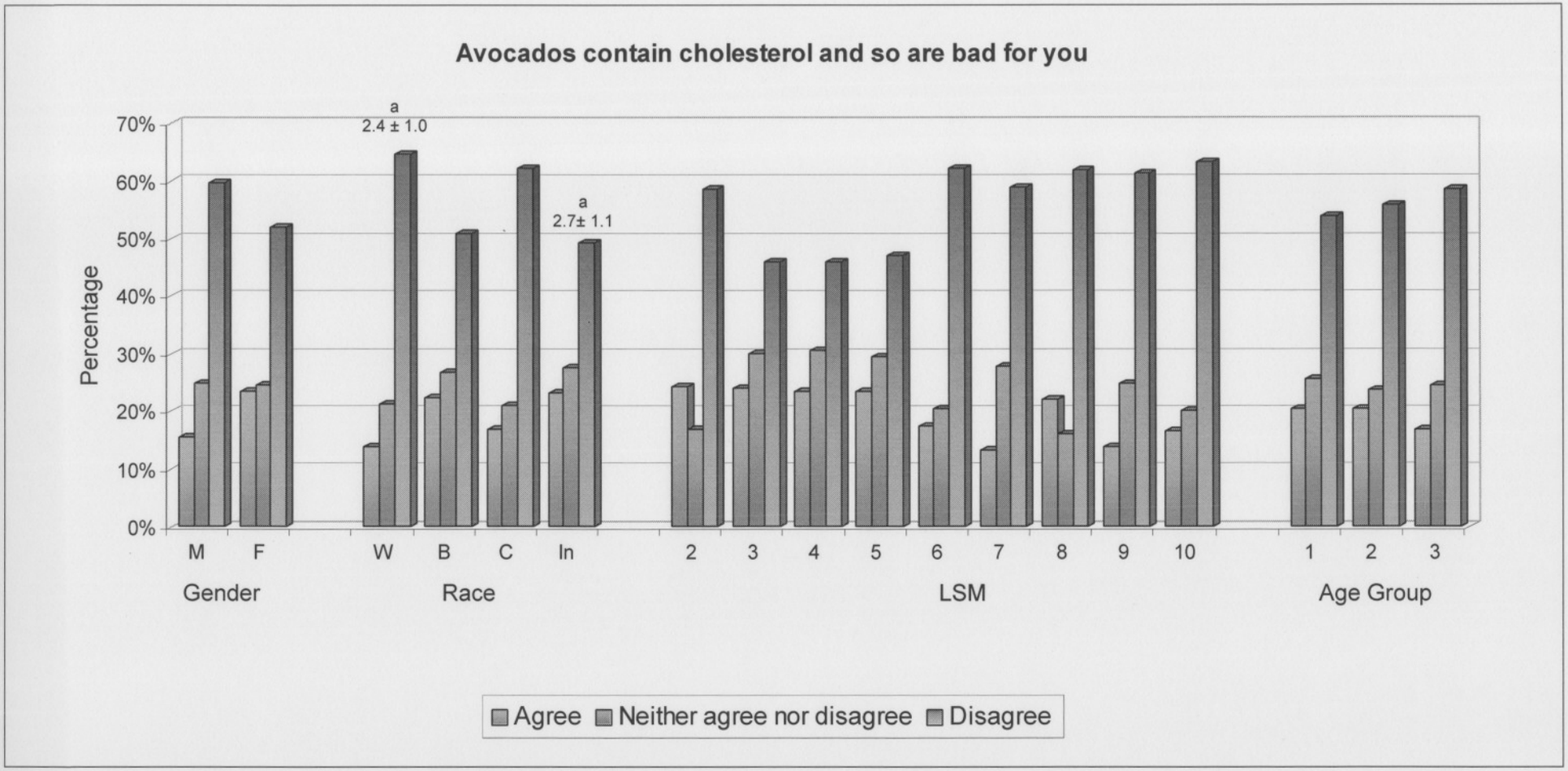
Figure 8



M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

Figure 9

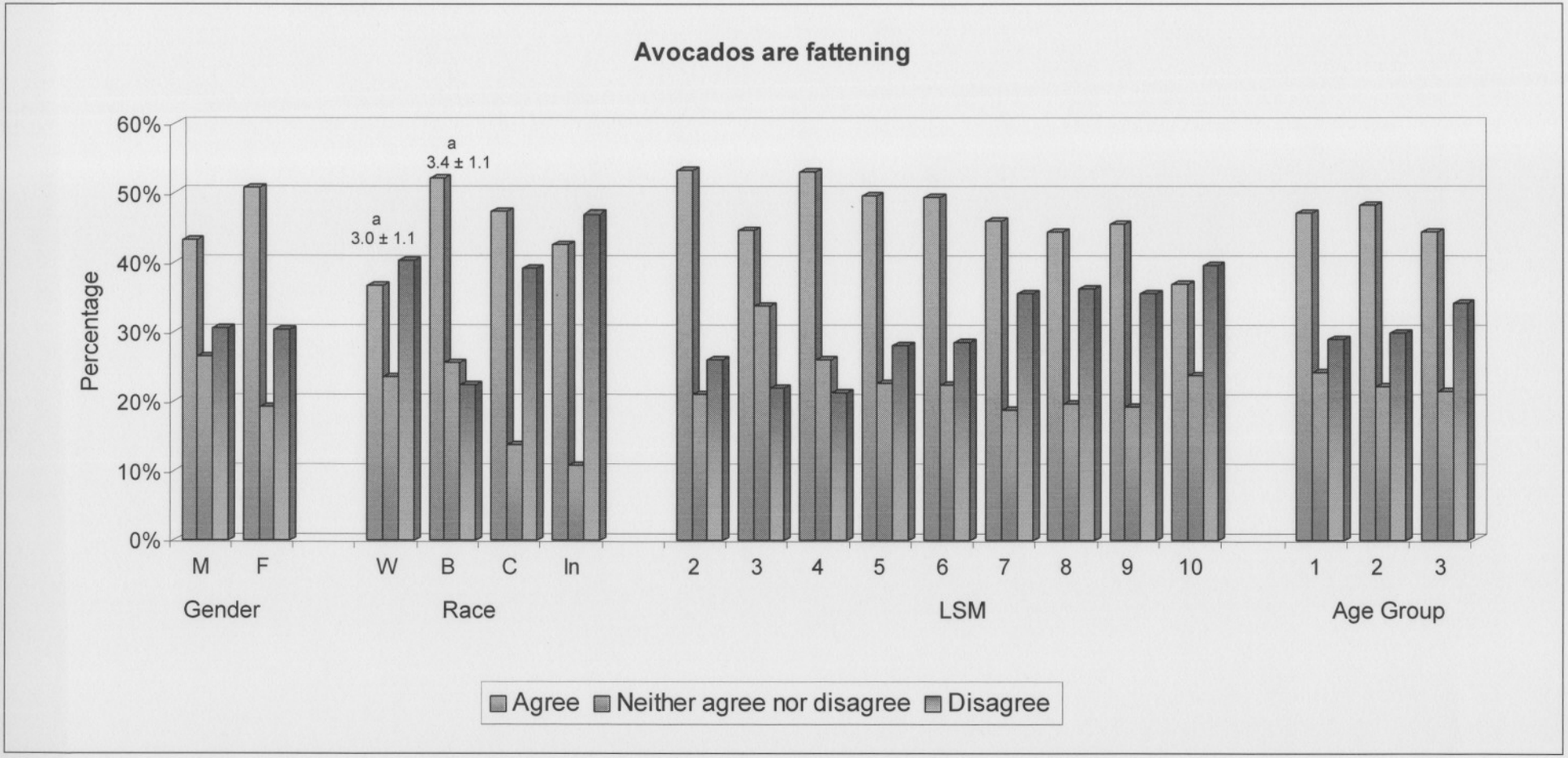


Means of groups with the same symbol differ significantly from each other, practical significance d=0.3-0.49; d=0.5-0.79; d>0.8 (Cohen, 1988)

M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

Figure 10

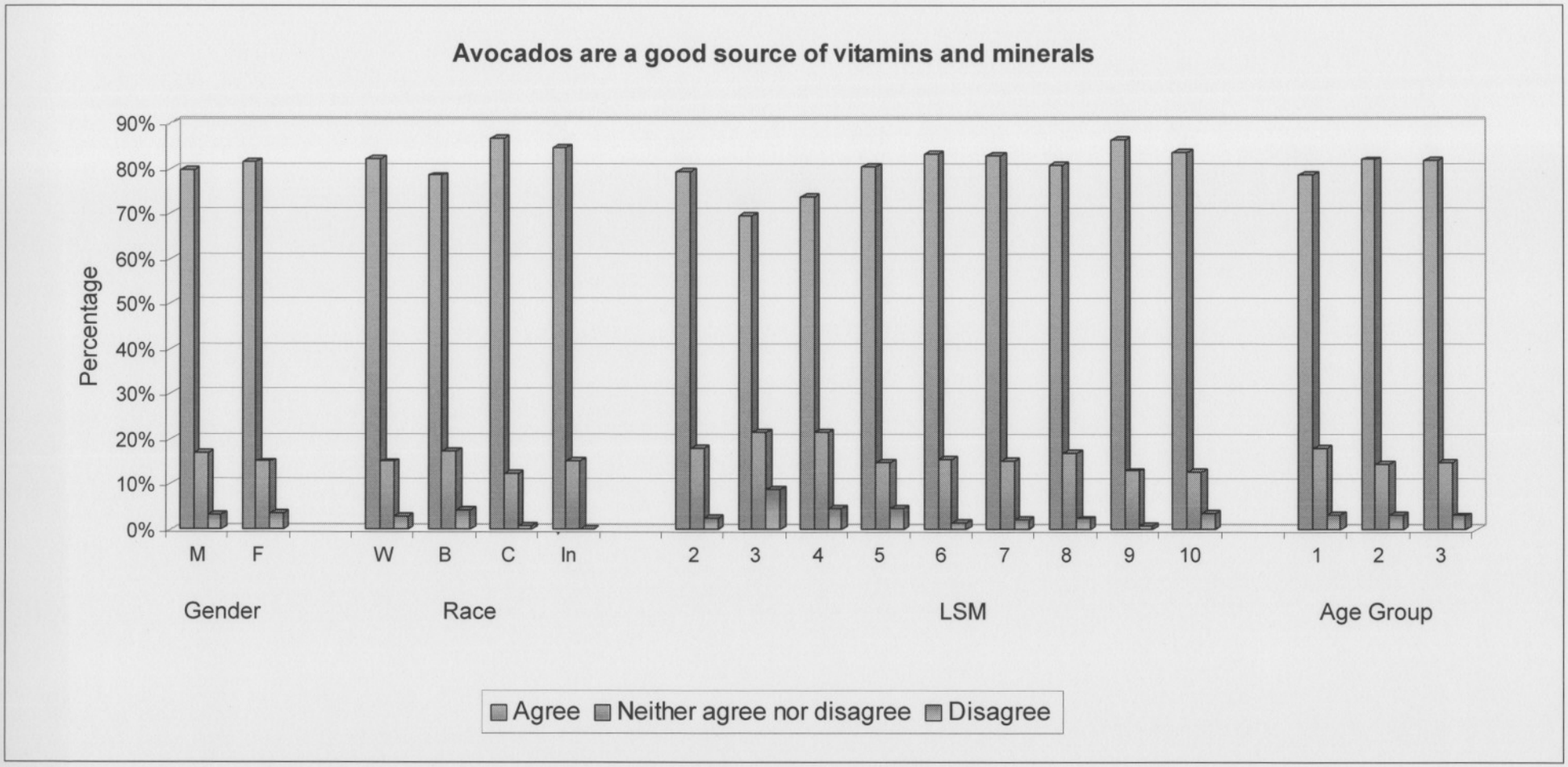


Means of groups with the same symbol differ significantly from each other, practical significance d=0.3-0.49; d=0.5-0.79; d>0.8 (Cohen, 1988)

M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

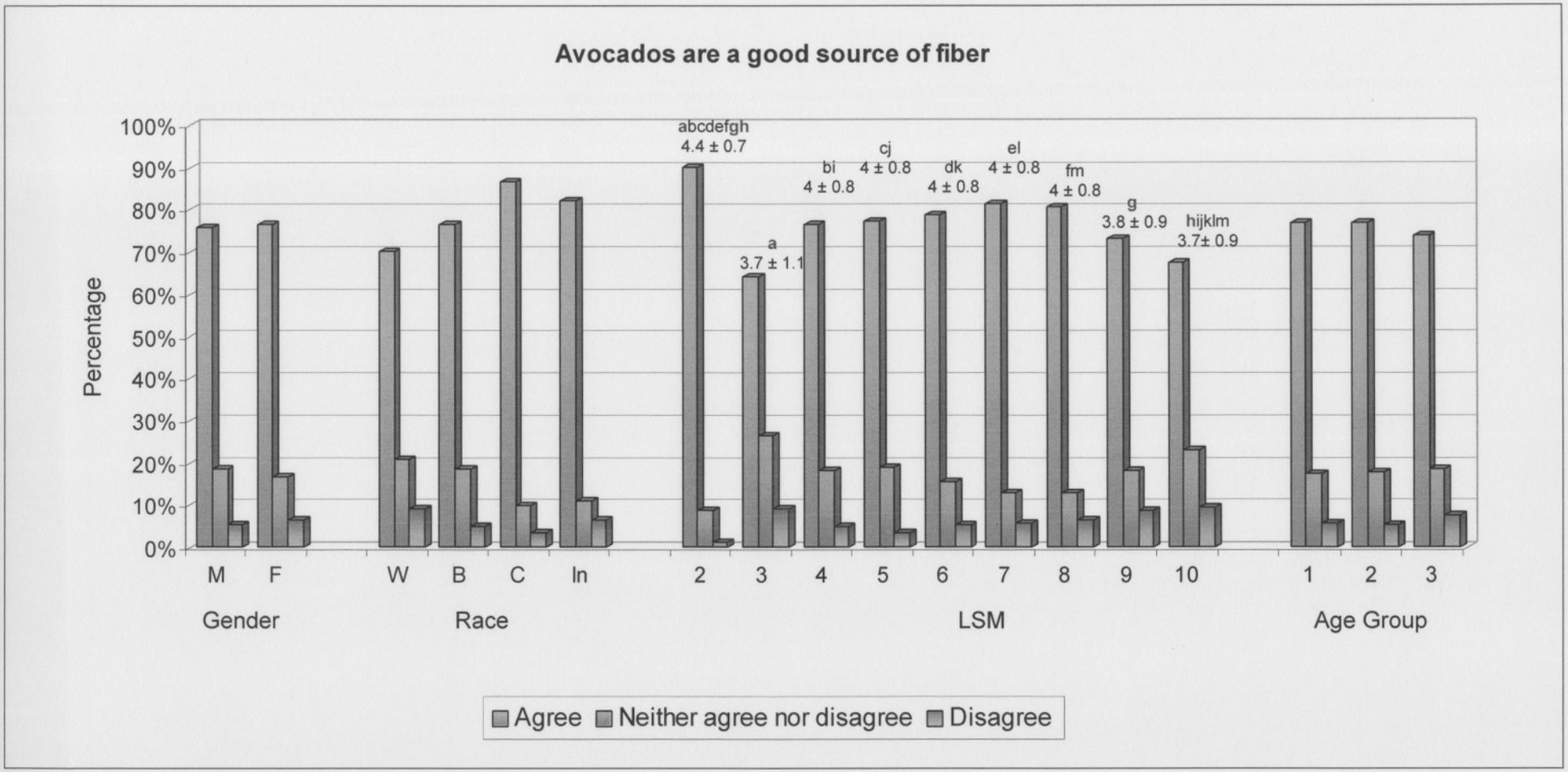
Figure 11



M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

Figure 12

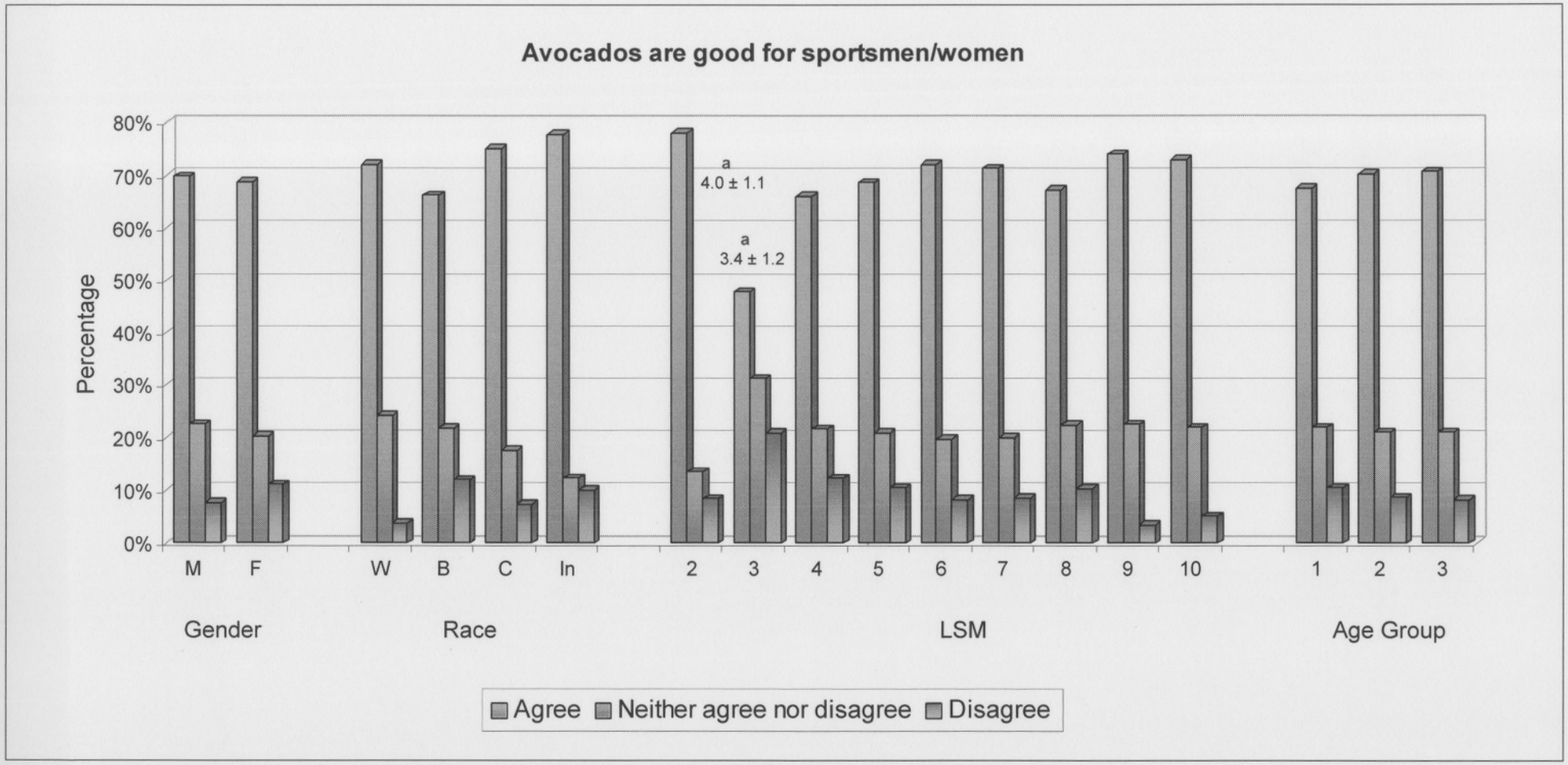


Means of groups with the same symbol differ significantly from each other, practical significance d=0.3-0.49; d=0.5-0.79; d>0.8 (Cohen, 1988)

M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

Figure 13

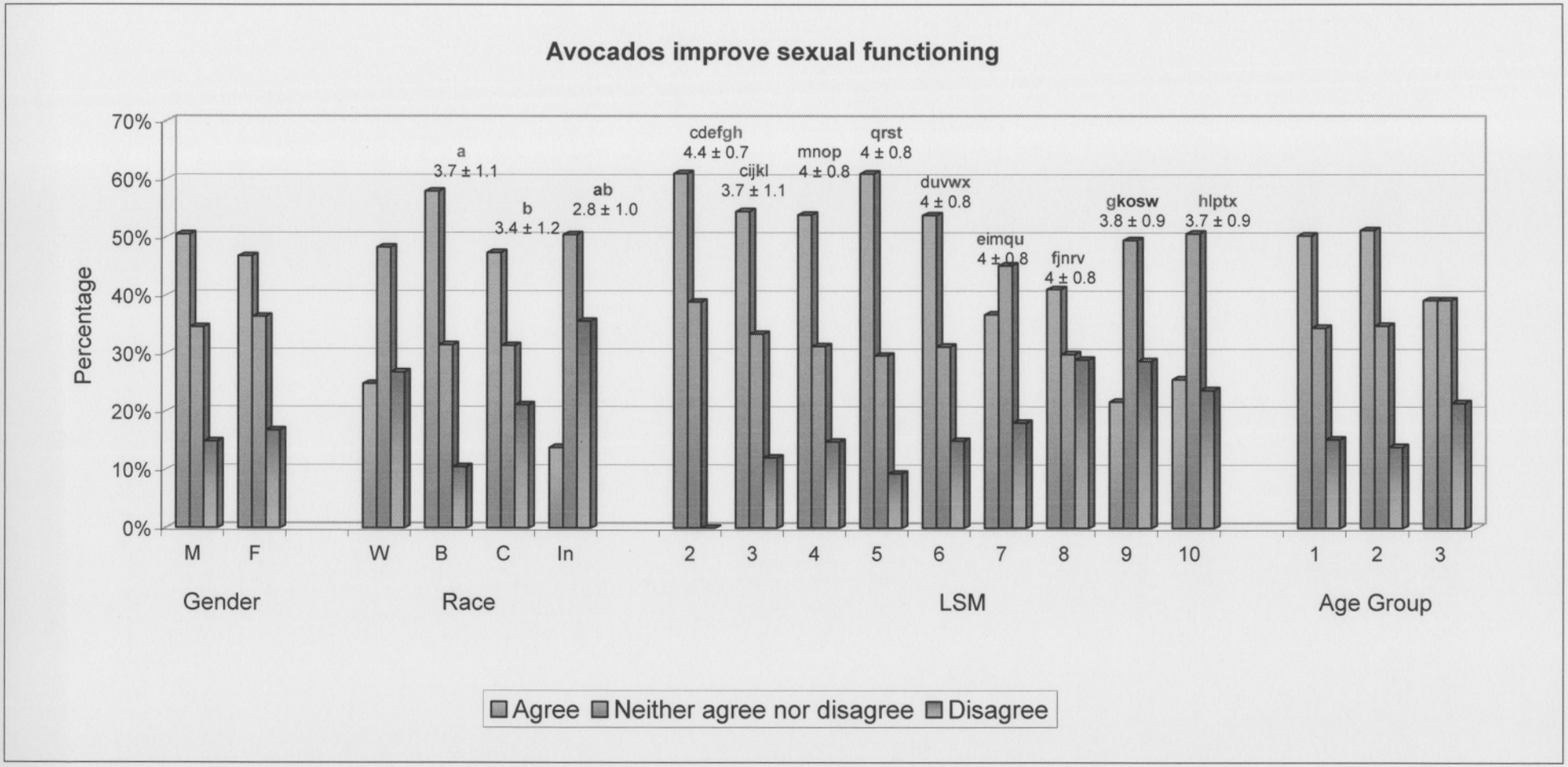


Means of groups with the same symbol differ significantly from each other, practical significance d=0.3-0.49; d=0.5-0.79; d>0.8 (Cohen, 1988)

M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+years

Figure 14



Means of groups with the same symbol differ significantly from each other, practical significance d=0.3-0.49; d=0.5-0.79; d>0.8 (Cohen, 1988)

M: Male; F: Female; W: White; B: Black; C: Coloured; In: Indian; LSM: Living Standard Measure

Age group 1: 16-29 years ; Age group 2: 30-49 years; Age group 3: 50+year