An overview of indicators of nutritional status of Queensland adults: collected as part of the AusDiab Study

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Report Prepared By:
Terry Coyne, Annette Dobson, Sophia Dunn, Michael Findlay, David Firman, Aloysa Hourigan, Torukiri Ibiebele, Brian Kingsley, Amanda Lee, Dympna Leonard, Christine McClintock, Jonathan Shaw, Greg Ward and Faruk Ahmed.

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Further copies of this publication are available from:
Manager,
Epidemiology Services Unit
Health Information Centre
Queensland Health
GPO Box 48
Brisbane QLD 4001
Ph (07) 32341881

Background

This report provides an overview of data collected specifically in Queensland as part of a national study of diabetes prevalence and cardiovascular risk factors (The Australian Diabetes, Obesity and Lifestyle Study – AusDiab). Because Queensland Health was responsible for coordination and some staffing for the Queensland phase of the study, there was an opportunity to collect additional data.

The Epidemiology Services Unit and Public Health Services consulted with public health nutritionists and other health professionals in the state, nationally and internationally to determine which indicators might be of the highest priority, given limited funds. Nutritional status and vascular health indicators were considered the most valuable to collect, particularly in relation to diabetes status and cardiovascular risk factors. Those given highest priority were red cell folate, plasma homocysteine, serum carotenoids (α-carotene, β-carotene, β-cryptoxanthin, lutein/zeaxanthin and lycopene) and serum ferritin – in that order. Seven additional questions related to dietary intake were also included for comparison with other state studies, with the 1995 National Nutrition Survey and to validate against biomarkers (red cell folate and carotenoids).

The main purpose of this report is to provide potential users with basic data to encourage and assist with further analysis. **It should be recognised that the data reported here have been weighted by age and sex to the Queensland population, but none of the analyses have adjusted for covariates or confounding factors. This should be taken into consideration when reviewing these data. Therefore conclusions for policy and program development should not be drawn from these data without further analysis.**

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Abbreviations and Acronyms

ACS	Automated Chemiluminescence System
AIHW	Australia Institute of Health and Welfare
AMI	Acute Myocardial Infarction
AusDiab	Australian Diabetes, Obesity and Lifestyle Study
BMI	Body Mass Index
CDs	Census Collection Districts
^{o}C	degrees Centigrade
EDTA	Ethylene Diamine Tetra Acetate
ESU	Epidemiological Services Unit
gms	grams
HBA1c	Haemoglobin A1c
HDL	High Density Lipoprotein Cholesterol
HPLC	High Performance Liquid Chromatography
IFG	Impaired Fasting Glucose
IGM	Impaired Glucose Metabolism
IGT	Impaired Glucose Tolerance
LDL	Low Density Lipoprotein Cholesterol
mmol/L	millimol per Litre
mls	millilitres
NHMRC	National Health and Medical Research Council
NHANES	National Health and Nutrition Examination Survey
NNS	National Nutrition Survey
NTD	Neural Tube Defect
NIDDM	Non Insulin Dependent Diabetes Mellitus
nmol	nanomol
µmol	micromol
µg/L	microgram per Litre
<	less than
>	greater than
≤	less than or equal to
≥	greater than or equal to
QHPS	Queensland Health Pathologic Services per minute
rpm	revolutions
SE	Standard Error
SES	Socio economic status
TC	Total Cholesterol

1.0 Summary

- Specific data related to nutritional status were collected as part of the national Australian Diabetes, Obesity and Lifestyle Study (AusDiab), which was conducted in Queensland between October and December 2000.
- Blood samples were collected from study participants and tested for red cell folate, plasma homocysteine, serum carotenoids, and serum ferritin.
- Additional dietary intake questions were administered which focused on consumption of vegetables, fruit, types of milk or fats used and vitamin/mineral supplement usage.
- Over 1600 adults aged 25 years or more were examined in six urban centres in Queensland: Cairns, Brisbane (Chapel Hill and Kedron), Toowoomba, Nambour and Currumbin. For this report, complete data are available for 1583 persons and data are weighted to match the age and sex distribution of the Queensland population.
- The prevalence of diabetes for adults in Queensland (7%) was slightly below the national level (7.5%), but the prevalence of impaired glucose metabolism (17%) was slightly higher than the national level (16.3%).
- Unadjusted mean red cell folate was 626 nmol/L for males and 675 nmol/L for females. These values appear higher than those reported in the United States National Health and Nutrition Examination (NHANES) Survey III for white males (adjusted value: 512.8 nmol/L) and females (adjusted value: 532.6 nmol/L) aged 17 years and above.
- Approximately 4.9% of males and 4.5% of females had red cell folate values below 315 nmol/L (cut off point for red cell folate deficiency).
- Unadjusted mean plasma homocysteine was 10.6 μmol/L for males and 8.8 μmol/L for females. These values appear close to the levels reported in NHANES III for white adults aged 12 years and more (unadjusted values: 9.6 μmol/L for males and 8.1 μmol/L for females).
- Homocysteine levels increased with age and were higher in people with diabetes than people without diabetes.
- In general, women had higher levels of serum carotenoids than men (except for lycopene). Serum carotenoid levels increased with age, except for lycopene. Serum carotenoid levels were lower in people who smoke, who consume more than 60 alcoholic drinks/month, engage in no physical activity, are sedentary and are obese.
- Males in all age groups had consistently higher mean serum ferritin values than females (224 μmol/L for males and 89 μmol/L for females).
- Only 1.0% of males and 7.2% of females had serum ferritin levels considered indicative of low iron stores.

- More males (52.0%) consumed whole or full cream milk than females (38%), while more females than males consumed low fat or skim milk (20% versus 13% respectively).
- More males than females reported never or rarely trimming fat from meat, eating three or fewer servings of vegetables a day, eating one serving or less of fruit, and eating take away food three times or more per week.
- Associations* between blood levels of nutritional indicators and short dietary questions suggest that:
    - mean red cell folate and serum carotenoids (except lycopene) increased with increasing number of serves of vegetables reported usually eaten each day;
    - mean red cell folate, and serum carotenoids (except lycopene) increased with increasing fruit intake;
    - mean red cell folate and serum carotenoids (except lycopene) decreased with increasing number of times per week take away food was reported eaten, and
    - mean β-carotene and red cell folate were highest in those participants who reported not eating meat compared with those who never trimmed fat from meat.

These analyses have not taken account of possible confounding variables such as age, sex, cholesterol, alcohol consumption, smoking, vitamin supplement usage, etc.

2.0 Introduction

2.1 The Australian Diabetes, Obesity and Lifestyle Study (AusDiab) National Study

The Australian Diabetes, Obesity and Lifestyle Study (AusDiab)[1] was the first national study to determine the prevalence of diabetes and impaired glucose metabolism based on fasting blood glucose and two-hour post glucose load blood tests. The study was conducted in 1999 and 2000 among a sample of 11,247 adults aged 25 years and over, residing in 42 randomly selected urban and non-urban areas in the six states of Australia and the Northern Territory.

The overall prevalence of diabetes as reported by AusDiab[1] was 7.5% in the total population, 7.0% for females and 8.0% for males. A further 16.3% of the population had impaired glucose metabolism (IGM) [either impaired glucose tolerance (IGT) or impaired fasting glycaemia (IFG)], 15.3% for females and 17.3% for males. Thus, 22.3% of females and 25.0% of males were found to have some form of impaired glucose metabolism[1].

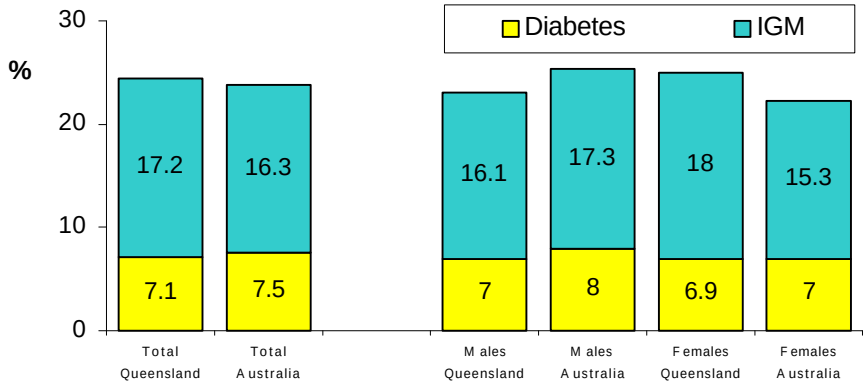
Extensive information related to risk factors for diabetes and cardiovascular disease were also collected – family history, women's health, obesity, physical activity and dietary intake as well as other lifestyle factors such as tobacco and alcohol use.

2.2 Queensland Component

Queensland was the last state in the country in which the AusDiab study was conducted. The study was carried out in six urban centres: Cairns, Brisbane (Kedron and Chapel Hill), Nambour, Toowoomba and Currumbin between October and mid December 2000. A total of 1634 adults aged 25 years and over participated in the study examinations.

The prevalence of diabetes and IGM reported for Queensland compared with the national figures is illustrated in Figure 2.1. Prevalence of diabetes in male (7.0%) and female (6.9%) Queenslanders appeared to be slightly below the national prevalence of diabetes (8.0% males; 7.0% females)[2]. Prevalence of IGM however, appeared to be higher for females in Queensland (18.0% versus 15.3%) and lower for male Queenslanders (16.1% versus 17.3%) compared with national figures[2].

Figure 2.1 Prevalence of Diabetes and Impaired Glucose Metabolism in Queensland and Australian adults, AusDiab 2000



2.3 Additional blood and dietary data collected

Because Queensland Health was involved with the coordination and some staffing for the AusDiab study, there was an opportunity to collect additional data. Extra blood samples were collected and tested for indicators of nutritional status (red cell folate, plasma homocysteine, serum carotenoids, and serum ferritin). Additional dietary intake questions focused on types of milk consumed, frequency meat was trimmed of fat, consumption of vegetables and fruit, frequency of eating fast foods, vitamin/mineral supplement use, and types of fats used in cooking.

3.0 Methods

3.1 Sampling and Recruitment

Sampling was planned at the national level. Sample collection was based on a stratified cluster method, with seven strata (six states and the Northern Territory) used and clusters formed through census collection districts (CDs). For each stratum, six CDs were randomly selected without replacement and with probability proportional to size. The criteria for selection were based on: a) the number of enumerated persons aged 25 years and over, b) percent of persons identified as Aboriginal or Torres Strait Islander and c) 'percentage rural' using the Australia Bureau of Statistics Urban/Locality definition of rurality. CDs were excluded from the sampling frame if the population did not contain at least 100 persons aged 25 years and over, were 100% Aboriginal or Torres Strait Islander or 100% rural.

Trained interviewers conducted house-to-house first contact interviews and eligible participants were invited to attend the physical examination component which was conducted at a study examination site within or close to the selected collection district. Full details of the survey methodology can be obtained from the report, *The Australia Diabetes, Obesity and Lifestyle Study (AusDiab) – Methods and Response Rates* [3].

3.2 Blood collection and handling

Participants arrived for the study examination having fasted for at least 12 hours. After the fasting blood sample was drawn, participants consumed a 75 gram glucose drink. Two hours after consuming the glucose load, blood was drawn for the glucose tolerance determination and additional blood was collected to test for the nutrition indicators: red cell folate, plasma homocysteine, serum carotenoids and serum ferritin.

A vacutainer system was used to collect a total of 16 mls of blood for the nutritional indicators. Approximately 4 mls were collected for each of the following: fluoride oxalate tube for blood glucose, a plain tube for serum for carotenoids and ferritin, a heparin tube for plasma for homocysteine and an EDTA tube for whole blood for red cell folate.

After the blood was collected, the heparin tube was immediately chilled (not frozen). The plain tube for serum was immediately wrapped in aluminium foil to protect it from light. The EDTA tube for folate was kept at 4°C.
The serum and the plasma tubes were then centrifuged at 3000 rpm for 10 minutes. Following this, the serum and plasma were processed for testing. The serum was pipetted into two tubes – an aliquot tube for carotenoid testing (minimum volume 1.0 ml), and an ACS tube for ferritin testing (minimum volume 0.5 ml). The plasma was

pipetted into an aliquot tube for homocysteine testing (minimum volume 1.0 ml). These were then frozen and packed in dry ice and shipped to the Queensland Health Pathology Services (QHPS) laboratory at Princess Alexandra Hospital, in Brisbane. The EDTA tube containing whole blood for red cell folate was kept at 4°C and packaged with cold packs and shipped to the same laboratory. All shipments were received at the QHPS laboratory within 48 hours of collection.

3.3 Laboratory Analysis

Ferritin and red cell folate were measured using the Bayer Advia Centuar automated immunoassay system (Bayer, Melbourne Australia). Chemiluminescent labels are used in this immunoassay system[4]. The ferritin assay was a two-site immunometric assay and red cell folate was a competitive protein-binding assay. Homocysteine was measured by HPLC (high performance liquid chromatography) by the method of Araki and Sako[5] with mobile phase modifications as described by Ubbink et al[6]. Carotenoids were determined simultaneously according to the HPLC procedure of Talwar et al[7].

Fasting and two hour glucose was measured enzymatically (glucose oxidase) on an Olympus AU600. Lipids (total cholesterol [TC], high density lipoprotein cholesterol [HDL] and triglycerides) were also measured enzymatically on an Olympus AU600. Low density lipoprotein cholesterol [LDL] was calculated from the Friedewald's formula[LDL=TC–HDL-(Triglyceride/5)][8]. Glycated haemoglobin ($HbA1_c$) was measured on Bio-Rad variant system using boronate affinity HPLC.

3.4 Statistical Analysis

The data used in this report came from the Epidemiology Services Unit (Health Information Centre, Queensland Health), and from the AusDiab Indexionary provided by the International Diabetes Institute. A data set was produced by combining data sets from biochemical results, general questionnaire, health knowledge, attitudes and practices questionnaire, diabetes questionnaire, general health and well-being questionnaire and additional dietary questionnaire. This report presents population means and standard error of means for red cell folate, plasma homocysteine, serum carotenoids and serum ferritin. It also presents prevalence of deficient and low levels of red cell folate, elevated levels of plasma homocysteine and low and elevated levels of serum ferritin.

Reported means for red cell folate, plasma homocysteine, serum carotenoids and serum ferritin were all weighted to the Queensland population distribution by age and sex. The population means and standard errors of means and prevalence of low or elevated levels of nutritional indicators were obtained after weighting by using means and frequencies procedures respectively using SAS software version 8.02. Criteria

used to define the categorical variables (selected demographic and risk factor characteristics) are presented in Appendix A.
Because the study design employed a stratified cluster sampling method and for the purpose of commentary, the following formula was used to compare differences in group means using weighted data.

$$\text{Difference (diff)} = \bar{x}_1 - \bar{x}_2$$
$$\text{SE(diff)} = \sqrt{[SE(\bar{x}_1)]^2 + [SE(\bar{x}_2)]^2}$$

where:
$\bar{x}_1$ = mean of first variable; $\bar{x}_2$ = mean of second variable; SE = standard error; SE^2 = standard error squared.
Comments on differences were made if difference was greater than 2SE(diff).

No adjustments have been made for potentially confounding factors such as age, sex, education, cholesterol level, smoking status, physical activity, body mass index, alcohol intake or vitamin use; therefore, caution must be taken when interpreting these results.

NOTE - for correct p-values and confidence intervals for prevalence data, the weighting variable "wtdrclin", along with the variable which defines the primary sampling unit (PSU) "cdcluste" and the variable "state" which defines the strata must be used in a statistical package that correctly handles complex survey designs. Two such packages are STATA and SUDAAN. SPSS does not adequately handle complex survey data. Although the prevalence will be correct when using SPSS and the weighting variable "wtdrclin", measures of error, such as p-values and confidence intervals will be an underestimate.

3.5 Response Rate

The response rate for the AusDiab Study, in Queensland and elsewhere in Australia, was low (~30%). A low response rate in a population-based study challenges the external validity of the data analyses. A study of Queensland AusDiab response rate found that the age and sex distribution of AusDiab respondents differed significantly from Queensland age/sex profiles for the target age group (25-74 years). After adjusting for age and sex differences, however, the proportions of respondents with previously diagnosed and undiagnosed diabetes who attended for a physical examination, showed modest bias in opposite directions such that the total proportion of persons with diabetes was likely to be relatively unbiased.

People in the AusDiab sample had lower age-adjusted smoking rates than the general population, were recruited from Collection Districts with higher socio economic status (SES) scores than the Queensland average, and had body mass index scores a slightly above values measured in the 1995 National Nutrition Survey.

The bias investigation carried out on the Queensland AusDiab data, focussing on diabetes prevalence, suggested that only a modest amount of bias is likely to have resulted from the relatively low response rate achieved. In particular, any bias present is unlikely to have a significant impact on associations found between nutrition indicators and lifestyle variables (after adjustments for age and sex have been made).

4.0 Queensland – Specific Blood and Dietary Variables

4.1 Number of Participants

Table 4.1 provides the numbers of participants with complete data for the relevant data sets by sex and by selected demographic and risk factor characteristics. Complete data are available for the following datasets: diabetes status as determined by fasting blood glucose and/or oral glucose tolerance, blood variables including lipids and Queensland-specific blood indicators (red cell folate, plasma homocysteine, serum carotenoids and serum ferritin), selected demographic characteristics and Queensland-specific short dietary questions. It should be noted that for individual data sets these numbers will be larger; eg. diabetes status is available for 1634 participants, whereas Queensland specific blood data are available for 1604 adults. Thus the final numbers will depend on which data sets the researchers need to use. Haemoglobin data is not reported for this study but could be made available if needed. The definitions used to derive categories for selected demographic and risk factor characteristics are found in Appendix A.

Table 4.1 Number of participants (and percentage) in the combined data set by sex and by selected characteristics						
		Males		Females		Total
Characteristics	**Categories**	**No**	**%**	**No**	**%**	
Age group (10yr)	25-34	86	46.5	99	53.5	185
	35-44	128	39.4	197	60.6	325
	45-54	164	42.2	225	57.8	389
	55-64	134	41.0	193	59.0	327
	65-74	100	43.0	135	57.0	235
	75+	47	42.7	63	57.3	110
All age groups	**[3]25**	**659**	**41.9**	**912**	**58.1**	**1571**
Education	Post-graduate qualifications	61	52.1	56	47.9	117
	Trade certificate, bachelors degree, etc.	418	50.3	413	49.7	831
	Secondary school or less	177	28.6	442	71.4	619
Smoking status	Never	329	36.8	565	63.2	894
	Former	234	51.4	221	48.6	455
	Current	90	43.9	115	56.1	205
Cholesterol ranges	< 5.5 mmol/L	300	42.0	414	58.0	714
	5.5 < 6.5 mmol/L	225	42.1	309	57.9	534
	≥ 6.5 mmol/L	134	41.5	189	58.5	323
Physical activity - intensity	Vigorous	117	53.9	100	46.1	217
	Moderate	225	43.3	295	56.7	520
	Light	206	39.6	314	60.4	520
	None	111	35.4	203	64.6	314
Physical activity - beneficial to health	Sufficient	366	47.3	407	52.7	773
	Insufficient but not sedentary	182	37.6	302	62.4	484
	Sedentary	111	35.4	203	64.6	314
Body mass index	Underweight	17	18.9	73	81.1	90
	Normal	196	36.2	346	63.8	542
	Overweight	304	53.7	262	46.3	566
	Obese	142	38.1	231	61.9	373
Alcohol intake	None	112	32.0	238	68.0	350
	≤60 drinks/month	417	39.9	628	60.1	1045
	>60 drinks/month	130	73.9	46	26.1	176
Vitamin use during previous 24 hrs	Yes	158	32.9	322	67.1	480
	No	468	46.4	540	53.6	1008
Diabetes status	Normal	469	42.0	647	58.0	1116
	IFG or IGT	126	40.6	184	59.4	310
	Diabetes Mellitus	60	47.6	66	52.4	126

4.2 Red Cell Folate

Red cell folate was considered a high priority to be determined in Queensland adults for a number of reasons:

- There is a strong association between folate status and neural tube defects (NTDs). The 1995 rate of NTDs in Australia was 15.0/10,000 live births AIHW[9]. Supplements of folic acid have been shown to be effective in preventing occurrence of NTDs Lumley et al[10].
- In Australia, it is estimated that 50% of neural tube defects could be prevented with daily intake of 400 µg of folic acid throughout the periconceptional period, NHMRC Expert Panel[11].
- Low levels of serum folate are associated with high serum homocysteine levels. High homocysteine levels are highly correlated with high risk of arteriosclerotic vascular disease[12]. Increased dietary intake of folic acid has been shown to reduce homocysteine levels[13].
- There are limited data in Australia on levels of red blood cell folate in women of childbearing age. There are no data on levels of red blood cell folate among older individuals[14].
- Red cell folate was evaluated in Indigenous communities as part of the Well Persons Health Check[15]. The collection of red cell folate in the non-Indigenous community will allow for meaningful comparisons.
- The NHMRC Expert Panel[11] recommended that blood folate levels should be measured in the 1995 National Nutrition Survey, but this did not eventuate.
- Plans for the Australian Health Measurement Survey have recommended red cell folate, and B12 levels be collected on all males and females 12 years of age and over in the 2004 survey[15].
- Red cell folate concentrations are considered reliable measures of folate status; red cell folate reflects intake over the past three months whereas serum folate is reflective of recent intake[74].
- High intake of vegetables and fruit, which are major sources of folate in the diet, is associated with low levels of cardiovascular disease[16] and cancer[17].
- Approximately 79% of Queensland adults consume three or fewer servings of vegetables and 28% consume none or one serving of fruit per day[18]. The NHMRC recommends five servings of vegetables and two servings of fruit per day [73].
- Folate may play an important role in cancer prevention[19].
- Treatment with a combination of folic acid, vitamin B12, and vitamin B6 has been shown to significantly reduce homocysteine levels and decrease the rate of re-stenosis in patients with diagnosed coronary artery disease[20].
- These data could also serve as a benchmark to evaluate the national policy of voluntary fortification of foods with folate.

4.2.1 Findings for red cell folate

4.2.1.1 Mean red cell folate

Comparison of group means of red cell folate (Table 4.2.1 using the formula on page 7) shows that mean red cell folate levels were significantly lower among:

- males compared with females
- younger males (25-34 years old) compared with older males (45 to 54 years old and 65 to 74 years old)
- younger females (25-34 years old and 35-44 years old) compared with older females (55+ years)
- males and females categorised as *current* smokers compared with *never* smokers
- males categorised as *underweight* compared with those with *normal*, *overweight* or *obese* body mass index and
- males and females who did not use vitamin/mineral supplements compared with those who used vitamin/mineral supplements.

Mean red cell folate levels were significantly higher among males and females with diabetes mellitus compared with those with normal blood glucose.

There did not appear to be significant differences in mean red cell folate among males and females with regard to educational level, cholesterol level, physical activity status, alcohol consumption or body mass index for females only.

Table 4.2.1 Mean red cell folate (nmol/L) and Standard Error (SE) by sex and by selected characteristics, (weighted to Queensland population)					
		Red Cell Folate			
		Males		Females	
Characteristics	**Categories**	**Mean**	**SE**	**Mean**	**SE**
Age group (10yr)	25-34	563	41	640	19
	35-44	607	14	635	15
	45-54	675	8	683	16
	55-64	645	29	720	23
	65-74	688	22	697	27
	75+	634	61	779	37
All age groups	**[3]25**	**626**	**11**	**675**	**16**
Education	Post-graduate qualifications	658	31	653	32
	Trade certificate, bachelors degree, etc	622	13	675	23
	Secondary school or less	628	16	678	16
Smoking status	Never	631	13	687	14
	Former	661	17	694	12
	Current	534	20	587	29
Cholesterol ranges	< 5.5 mmol/L	632	6	674	16
	5.5 to < 6.5 mmol/L	624	28	668	29
	≥6.5 mmol/L	617	27	686	28
Physical activity intensity	Vigorous	637	13	688	27
	Moderate	603	19	681	18
	Light	635	16	645	19
	None	643	34	704	26
Physical activity beneficial to health	Sufficient	622	6	668	19
	Insufficient but not sedentary	626	21	666	23
	Sedentary	643	34	704	26
Body mass index	Underweight	499	23	681	29
	Normal	598	11	691	19
	Overweight	629	23	633	24
	Obese	681	15	691	22
Alcohol intake	None	617	20	667	18
	≤60 drinks/month	627	15	681	17
	>60 drinks/month	630	21	623	47
Vitamin use during previous 24 hrs	Yes	706	32	777	20
	No	602	14	626	11
Diabetes status	Normal	603	11	661	12
	IFG or IGT	693	16	681	28
	Diabetes Mellitus	737	45	765	40

4.2.1.2 Prevalence of low red cell folate levels

A review of the literature for prevalence of low red cell folate and red cell folate deficiency, revealed that different cut off points were employed by various researchers (as shown below):

Researchers	Cut off point
Ford and Bowman[21]	<317 nmol/L Folate deficiency
Ray JG et al[22]	<215 nmol/L Folate deficiency
Cafolla et al[23]	<340 nmol/L Low red cell folate
Machlin LJ[24]	<315 nmol/L Folate deficiency
Lakshmi et al[25]	<315 nmol/L Folate deficiency
Gibson R[26]	<317 nmol/L Folate deficiency 317-363 nmol/L borderline/marginal folate levels
Cafolla et al[23]	<340 nmol/L Low folate
The Life Sciences Research Office (an expert panel that examined the NHANES II folate data[27]	<140 ng/ml Folate deficiency (<317 nmol/L)

In order to compare with other Queensland studies and with international studies, this study used two cut off points. A cut off point of <315 nmol/L to define folate deficiency (Table 4.2.2), and a cut off point of <363 nmol/L to define marginal, borderline or low red cell folate (Table 4.2.3). Table 4.2.2. indicates that the prevalence of red cell folate deficiency is 4.9% for males and 4.5% for females, while prevalence of marginal or low red cell folate is 8.3% for males and 7.2% for females (Table 4.2.3). The prevalence of red cell folate deficiency is low for Queensland compared to the prevalence of 7% reported in NHANES III for the white adult (>18 years) population in the United States[21] (cut off point of <317 nmol/L defined red cell folate deficiency in NHANES III).

In general, those with significantly higher prevalence red cell folate deficiency and low folate levels were:

- younger females between ages 25 and 34 years and 35 to 44 years compared with older females over 75 years
- younger males (25-34 years) compared with older males between 65 and 74 years
- males with *trade certificate, bachelors degree* and *secondary school or less* qualifications compared with males with *post-graduate educational qualifications*
- females categorised as *current* smokers compared with *never* smokers and
- males *who did not* use vitamin and mineral supplements compared with those *who did* use vitamin supplements.

Red cell folate deficiency and low red cell folate were significantly less prevalent among study participants with diabetes mellitus compared with those with normal blood glucose.

There appeared to be no statistical difference in prevalence of red cell folate deficiency with regard to:

- educational attainment (females only)
- smoking status (males only)
- cholesterol range (males and females)
- physical activity (intensity and beneficial to health) (males and females)
- body mass index (males and females)
- alcohol consumption (males and females) and
- vitamin use (females only).

Table 4.2.2 Prevalence of red cell folate deficiency (<315 nmol/L) by sex and by selected characteristics, (weighted to Queensland population)					
		Red Cell Folate			
		Males		Females	
Characteristics	**Categories**	**Percent**	**SE**	**Percent**	**SE**
Age group (10yr)	25-34	11.6	4.9	8.6	2.1
	35-44	1.5	1.1	5.3	1.6
	45-54	3.2	2.5	1.5	1.2
	55-64	3.5	1.9	3.5	1.6
	65-74	1.3	1.3	3.4	2.0
	75+	6.8	5.1	0.0	0.0
All age groups	**[3]25**	**4.9**	**1.1**	**4.5**	**1.3**
Education	Post-graduate qualifications	0.0	0.0	4.4	4.6
	Trade certificate, bachelors degree, etc.	6.4	1.8	4.7	2.1
	Secondary school or less	2.8	1.0	4.3	1.2
Smoking status	Never	4.6	1.3	2.8	0.9
	Former	2.5	0.5	4.0	1.3
	Current	10.4	2.8	12.4	2.1
Cholesterol ranges	< 5.5 mmol/L	3.8	1.5	4.7	1.3
	5.5 to < 6.5 mmol/L	7.4	3.7	5.1	1.9
	≥6.5 or more mmol/L	3.2	1.0	2.9	1.8
Physical activity intensity	Vigorous	2.3	1.4	3.0	2.9
	Moderate	6.0	1.7	4.6	1.4
	Light	4.7	2.0	4.6	2.1
	None	6.0	4.6	5.0	2.2
Physical activity beneficial to health	Sufficient	4.7	1.0	5.1	1.8
	Insufficient but not sedentary	4.5	1.7	3.2	1.6
	Sedentary	6.0	4.6	5.0	2.2
Body mass index	Underweight	11.3	8.0	3.5	2.8
	Normal	4.2	1.4	4.8	2.2
	Overweight	6.1	2.8	5.4	2.0
	Obese	2.1	1.0	3.3	1.2
Alcohol intake	None	8.1	2.4	4.5	1.7
	≤60 drinks/month	4.2	2.1	4.0	1.8
	>60 drinks/month	4.3	2.4	10.3	7.5
Vitamin use during previous 24 hrs	Yes	0.0	0.0	1.8	1.2
	No	6.0	1.6	6.1	1.9
Diabetes status	Normal	5.5	1.3	5.2	1.6
	IFG or IGT	3.0	2.0	3.0	1.9
	Diabetes Mellitus	1.7	1.6	0.0	0.0

Table 4.2.3 Prevalence of marginal/borderline (low) red cell folate (<363 nmol/L) by sex and by selected characteristics, (weighted to Queensland population)

		Red Cell Folate			
		Males		Females	
Characteristics	**Categories**	**Percent**	**SE**	**Percent**	**SE**
Age group (10yr)	25-34	15.7	3.3	9.9	2.7
	35-44	3.3	2.1	9.0	1.2
	45-54	6.9	2.7	5.1	2.3
	55-64	6.7	2.9	5.5	2.9
	65-74	3.8	2.2	5.8	2.1
	75+	16.5	6.0	2.9	3.1
All age groups	**[3]25**	**8.3**	**1.1**	**7.2**	**1.5**
Education	Post-graduate qualifications	1.4	1.3	6.6	6.9
	Trade certificate, bachelors degree, etc.	10.6	1.7	6.5	2.2
	Secondary school or less	5.1	2.0	7.7	1.7
Smoking Status	Never	8.0	2.7	5.1	1.1
	Former	4.4	1.1	6.9	1.8
	Current	16.3	3.8	16.5	2.6
Cholesterol ranges	<5.5mmol/L	7.5	1.6	7.6	1.6
	5.5 to<6.5mmol/L	10.6	3.0	7.9	2.4
	≥6. 5 mmol/L	6.5	2.0	4.6	2.1
Physical activity intensity	Vigorous	6.3	3.7	3.0	2.9
	Moderate	10.8	2.1	8.2	2.2
	Light	6.4	2.7	7.3	2.7
	None	9.3	4.9	7.9	2.6
Physical activity beneficial to health	Sufficient	8.4	1.6	7.5	2.1
	Insufficient but not sedentary	7.5	2.5	6.2	1.7
	Sedentary	9.3	4.9	7.9	2.6
Body mass index	Underweight	23.2	9.8	5.5	3.3
	Normal	9.9	3.2	8.2	2.6
	Overweight	8.2	2.6	8.2	3.8
	Obese	4.0	1.5	4.8	1.5
Alcohol intake	None	13.5	2.9	9.1	1.1
	≤60 drinks/month	7.2	2.0	6.0	1.7
	>60 drinks/month	7.9	2.6	14.3	6.6
Vitamin use during previous 24 hrs	Yes	2.6	2.5	3.3	1.3
	No	9.1	1.3	9.6	2.6
Diabetes status	Normal	9.6	1.0	7.9	2.0
	IFG or IGT	4.3	2.1	6.4	2.6
	Diabetes Mellitus	2.8	2.6	1.4	1.4

4.2.2 Discussion regarding interpretation of red cell folate findings

Other researchers have found associations between red cell folate levels and the various characteristics. Some of these associations are summarised below:

Selected characteristics	Association with red cell folate
Gender	Females have a higher mean levels than males[22,28,29].
Age	Folate concentrations increased with increasing age in both genders[21] Mean levels higher in older women than younger women[30]
Educational level	No significant linear trends between adjusted red cell folate and educational attainment[21]
Smoking status	Lower levels of folate among smokers compared with non smokers[23,28,31]
Cholesterol	Positive correlation between red cell folate and HDL cholesterol[31] Higher levels of folate in subjects with lower total cholesterol levels[29]
Physical activity	No change in red cell folate with exercise[21]
Body mass index	Lower concentrations in overweight subjects than subjects with normal BMI[29]
Alcohol consumption	Folate deficiency associated with chronic alcoholism[32]
Vitamin use	Increased folate levels with vitamin supplementation and fortification[32]
Diabetes status	Lower folate levels in those with diabetes compared to those without diabetes[29]

Although no confounding factors were adjusted for, our findings were consistent with published data with regard to the association of red cell folate with gender, age, smoking status, diabetes status and vitamin use. Some inconsistencies, however, were observed between the Queensland data and published reports. For example, we observed:

- no significant association between red cell folate and alcohol use
- significantly higher prevalence of red cell folate deficiency and low red cell folate among males with *secondary school or less* and *trade certificate, bachelors degree* qualifications but not females with similar qualifications
- significantly lower levels of mean red blood cell folate in *underweight* males compared with males who were of *normal*, *overweight* or *obese* body weight and
- significantly higher prevalence of red cell folate deficiency and low red cell folate among males who *did not take* vitamin supplements compared to *those who did*

take vitamin supplements (similar observation not statistically significant for females).

These inconsistencies with published literature could be due to associations of covariates of red cell folate that were not taken into account in our analyses such as age, smoking status, body mass index, cholesterol level, alcohol consumption, use of vitamin supplements, dietary folate intake, use of oral contraceptive and hormone replacement therapy (in females), diabetes status and use of other medications.
Interpretation of results should be made with caution and these confounding factors should be taken into consideration when further statistical analyses and verification are undertaken.

4.3 Plasma homocysteine

Determination of homocysteine levels in the adult population of the Queensland AusDiab study was considered a high priority for the following reasons:

- Homocysteine is a strong independent risk factor for vascular diseases of coronary, cerebral and peripheral arteries[13]. An increase of 5 µmol/L results in an estimated increase in relative risk of coronary heart disease of about 60% for men and 80% for women[12].
- Cardiovascular disease is one of the leading causes of premature death in Australia.
- There are scant data on homocysteine levels in Australian adults although some small studies have been conducted in Melbourne[33]; the Hunter district of New South Wales[34]; Western Australia[35]; blood donors in Brisbane[36]; and Indigenous people in Brisbane[37]. There are no data, however, on population-based studies in Australia.
- Homocysteine is highly negatively correlated with serum folate, red cell folate and Vitamin B-12[21].
- Trials with high intake of folate, B-6 and B-12 are associated with low serum homocysteine levels[13,38], and reduced rates of re-stenosis in persons with defined coronary artery disease[20].

4.3.1 Findings for Plasma Homocysteine

4.3.1.1 Mean plasma homocysteine levels

Plasma homocysteine concentrations were significantly higher for the following groups of Queensland adult study participants (Table 4.3.1):

- males compared with females
- males and females over age 65 years compared with males and females less than 65 years

- females with a *secondary or less* educational qualification compared with those with *trade certificate, bachelors degree* qualifications
- males with *secondary or less* educational qualification compared with those with a *post-graduate* qualification
- females with cholesterol levels $\geq$ *6.5 mmol/L* compared with those with cholesterol levels *<5.5 mmol/L*
- males engaged in *moderate* physical activity compared with those engaged in *vigorous* physical activity
- females with *normal*, *overweight* and *obese* body mass index categories compared with those with *underweight* body mass index
- females who *did not* use vitamin supplement compared with those who *did use* vitamin supplement and
- females with *impaired glucose tolerance* and *diabetes* compared with those with *normal* blood glucose.

Mean plasma homocysteine levels were observed to be significantly lower for the following categories of study participants (Table 4.3.1):

- males and females who consumed *<60 drinks/month* compared with those *did not* consume alcohol and
- males engaged in *insufficient* physical activity beneficial to health compared with those engaged in *sufficient* physical activity beneficial to health.

There did not appear to be significant differences in mean plasma homocysteine concentrations with regard to:

- smoking status (male and female)
- cholesterol concentration (males only)
- physical activity (females only)
- body mass index (males only)
- vitamin use (males only) and
- diabetes status (males only).

Table 4.3.1 Mean plasma homocysteine (mmol/L) and Standard Error (SE) by sex and by selected characteristics, (weighted to Queensland population)

		Plasma Homocysteine			
		Males		Females	
Characteristics	**Categories**	**Mean**	**SE**	**Mean**	**SE**
Age group (10yr)	25-34	9.9	0.3	8.2	0.3
	35-44	10.2	0.4	7.9	0.2
	45-54	10.4	0.5	8.2	0.1
	55-64	10.5	0.4	9.0	0.3
	65-74	12.2	0.5	10.6	0.4
	75+	14.2	0.8	11.9	0.4
All age groups	**³25**	**10.6**	**0.1**	**8.8**	**0.2**
Education	Post-graduate qualifications	10.0	0.3	8.7	0.9
	Trade certificate, bachelors degree, etc.	10.6	0.2	8.2	0.1
	Secondary school or less	10.9	0.2	9.5	0.3
Smoking status	Never	10.6	0.3	8.8	0.3
	Former	10.8	0.3	8.3	0.3
	Current	10.6	0.2	9.4	0.8
Cholesterol ranges	< 5.5 mmol/L	10.5	0.2	8.4	0.3
	5.5 to < 6.5 mmol/L	10.6	0.1	9.0	0.2
	≥6.5 mmol/L	11.0	0.3	9.5	0.4
Physical activity intensity	Vigorous	10.2	0.3	9.1	1.1
	Moderate	11.3	0.3	8.4	0.2
	Light	10.1	0.2	8.6	0.2
	None	11.0	0.5	9.4	0.4
Physical activity beneficial to health	Sufficient	10.8	0.1	8.7	0.4
	Insufficient but not sedentary	10.2	0.2	8.4	0.2
	Sedentary	10.9	0.5	9.4	0.4
Body mass index	Underweight	12.6	2.8	7.5	0.2
	Normal	10.9	0.3	8.5	0.2
	Overweight	10.4	0.2	9.0	0.4
	Obese	10.5	0.3	9.7	0.5
Alcohol intake	None	11.3	0.3	9.5	0.3
	≤60 drinks/month	10.4	0.1	8.5	0.2
	>60 drinks/month	11.0	0.5	9.0	0.4
Vitamin use during previous 24 hrs	Yes	10.2	0.5	8.1	0.2
	No	10.7	0.2	8.9	0.3
Diabetes status	Normal	10.5	0.1	8.5	0.1
	IFG or IGT	10.8	0.3	9.8	0.6
	Diabetes Mellitus	12.3	1.0	10.2	0.5

4.3.1.2 Prevalence of elevated plasma homocysteine levels

Plasma homocysteine level >15 μmol/L has been associated with high risk of vascular disease in several studies[37]; this level has therefore been used in this report to define elevated homocysteine levels.

Across all categories of selected characteristics, males have significantly higher prevalence of elevated plasma homocysteine concentrations than females (Table 4.3.2). Significantly higher prevalence of elevated homocysteine concentrations were also observed among:

- males and females over 65 years compared with males and females below 64 years
- females with a *secondary school or less* educational qualification compared with those with a *trade certificate, bachelors degree* qualifications
- females with *sedentary* physical activity beneficial to health compared with those engaged in *sufficient* and *insufficient* physical activity
- males engaged in *moderate* physical activity compared with those engaged in *vigorous* physical activity and
- females who had *diabetes mellitus* compared with those with *normal* blood glucose level.

Significantly lower prevalence of elevated homocysteine concentrations were observed among:

- males who consumed *≤60 drinks/month* compared with those who *did not consume alcohol* and
- females who consumed *≤60 drinks* and *>60 drinks/month* compared with those who *did not* consume alcohol.

There appeared to be no significant differences in the prevalence of elevated plasma homocysteine levels associated with the following factors:

- educational status (males only)
- smoking status (males and females)
- cholesterol levels (males and females)
- physical activity (females only)
- physical activity beneficial to health (males only)
- body mass index (males and females)
- vitamin use (males and females) and
- diabetes status (males only).

Table 4.3.2 Prevalence of elevated Plasma Homocysteine levels (>15 mmol/L) by sex and by selected characteristics, (weighted to Queensland population)					
		Plasma Homocysteine level			
		Males		Females	
Characteristic	**Categories**	**Percent**	**SE**	**Percent**	**SE**
Age group (10yr)	25-34	8.1	1.7	2.3	1.5
	35-44	5.2	1.3	1.9	1.1
	45-54	7.8	2.3	2.6	0.6
	55-64	7.1	2.5	2.3	1.1
	65-74	18.5	4.3	10.5	2.8
	75+	35.3	3.6	23.4	1.8
All age groups	**[3]25**	**9.7**	**0.8**	**4.7**	**1.0**
Education	Post-graduate qualifications	7.5	2.7	3.6	3.8
	Trade certificate, bachelors degree, etc.	9.3	1.2	3.1	0.9
	Secondary school or less	11.7	1.1	6.7	1.4
Smoking Status	Never	9.9	1.6	5.1	1.1
	Former	10.3	1.7	4.5	1.3
	Current	6.8	2.1	3.8	2.1
Cholesterol ranges	< 5.5 mmol/L	11.6	2.5	4.7	1.6
	5.5 to < 6.5 mmol/L	7.7	1.8	4.1	1.1
	≥6.5 mmol/L	8.4	2.0	6.1	1.9
Physical activity intensity	Vigorous	5.2	2.0	4.7	2.8
	Moderate	12.4	1.6	3.2	1.2
	Light	7.9	1.4	3.0	0.7
	None	13.4	4.6	10.0	2.9
Physical activity beneficial to health	Sufficient	9.3	0.8	3.2	1.8
	Insufficient but not sedentary	8.3	1.6	3.7	0.9
	Sedentary	13.5	4.6	10.0	2.9
Body mass index	Underweight	7.9	8.5	1.5	0.9
	Normal	11.7	2.6	4.6	1.2
	Overweight	8.7	0.7	4.6	1.3
	Obese	9.2	1.1	6.6	2.1
Alcohol intake	None	17.4	3.2	10.1	1.1
	≤60 drinks/month	8.2	0.8	3.1	1.1
	>60 drinks/month	8.8	3.9	0.7	0.6
Vitamin use during previous 24 hrs	Yes	7.7	2.4	2.8	1.2
	No	9.6	1.2	5.0	1.0
Diabetes status	Normal	8.9	0.5	3.4	0.9
	IFG or IGT	10.8	2.6	7.8	2.3
	Diabetes Mellitus	17.8	5.5	9.1	2.5

4.3.2 Discussion regarding interpretation of plasma homocysteine findings

Other studies have found associations between plasma homocysteine and the selected characteristics which are summarised in the table below:

Selected characteristics	Association with plasma homocysteine
Gender	Concentrations consistently higher in males than females[22,37,39,40]
Age	Levels increase with age[39,40,41,42]
Educational level	Subjects in highest quartile of plasma homocysteine had less education[42]
Smoking status	Cigarette smoking positively related to homocysteine concentrations[39,40,42]
Cholesterol	Inverse correlation between homocysteine and HDL cholesterol[31]. Subjects in highest quartile of homocysteine had higher mean cholesterol[31,42]
Physical activity	Physical inactivity positively related to homocysteine concentration[39]
Body mass index	Positive association observed between serum homocysteine and obesity[37]
Alcohol consumption	Homocysteine positively associated with alcohol intake[40] Chronic alcohol abuse associated with markedly elevated homocysteine[43] Strong negative association between alcohol consumption and homocysteine levels[44] Levels of homocysteine raised after consumption of red wine and spirits as compared with water consumption, no increase after beer consumption[45] The inverse association was attributed to the folate content of beer consumed in Wales.
Vitamin use	Lower concentrations in individuals who used vitamin supplements on a daily basis than in non-vitamin users[40,46]
Diabetes status	Direct relationship observed between serum homocysteine and diabetes[37] Higher plasma homocysteine in patients with poorly controlled diabetes compared with patients with well-controlled diabetes[47]

Although our analysis has not adjusted for possible confounding factors for homocysteine, our study has found some consistent findings with other published

reports with regard to homocysteine levels, gender, education, physical activity and diabetes status.
Confounding factors associated with plasma homocysteine as reported in the literature include smoking, caffeine intake, folate intake, vitamin B6 and B12, dietary folate intake, use of medication, renal function, body mass index and perhaps type of alcohol consumed.

In the present study, lower prevalence of homocysteine was observed among males and females who consumed alcohol compared with non-drinkers. This finding is inconsistent with the results of Jacques et al[40], but consistent with the findings of Ubbink et al[44], who reported an inverse association between alcohol consumption and homocysteine levels attributed to the folate content of beer in Wales. Therefore, do the subjects in this study consume more beer than other alcoholic beverages? Do low homocysteine levels observed in drinkers in this study, reflect the consumption of more beer than wine or spirits in this population? What is the folate content of Queensland beers? Other questions arising from the homocysteine data are about the gender specificity of some of the significant associations.

4.4 Serum Carotenoids

Determination of serum carotenoid levels was included in this study because of several important issues:

- Several carotenoids, but especially β-carotene and lycopene, have been shown to be inversely related to blood glucose levels and diabetes status in a large US population-based study[48].
- Lower levels of several carotenoids have been associated with reported angina pectoris in large US studies[49].
- A number of carotenoids may be useful biomarkers of vegetable and fruit intake[50,51].
- Increased consumption of vegetables and fruit (the major contributors of carotenoids in the diet) has been associated with decreased risk of several types of cancers[52].
- Carotenoids may exert immunomodulatory functions[17].
- The risk of ischaemic heart disease is about 15% lower at the 90th percentile compared with the 10th percentile of fruit and vegetable intake[16].
- 79% of adult Queenslanders consume three or fewer serving of vegetables per day and 28% consume none or one serving of fruit[18.] The NHMRC recommends five servings of vegetables and two servings of fruit per day[73].
- Individual carotenoids can be analysed by a single method, which is considered reliable and provides levels of α-carotene, β-carotene, β-cryptoxanthin, lutein/zeaxanthin and lycopene[53].

4.4.1 Findings for serum carotenoids

4.4.1.1 Mean serum carotenoid levels

Serum carotenoids, namely α-carotene, β-carotene, β-cryptoxanthin, lutein/zeaxanthin and lycopene, showed a fairly similar trend for most of the selected characteristics in the study population (Tables 4.4.1 – 4.4.5).

On average, females had higher mean serum α-carotene, β-carotene, β-cryptoxanthin and lutein/zeaxanthin levels than males, but not serum lycopene levels.
Significantly lower mean levels of **a-*carotene*** (Table 4.4.1) were observed among:

- younger females (25-34 years old) compared with older females (75+ years old)
- males with a *secondary or less* education compared with males with *trade certificate and bachelors*, or*post-graduate* qualifications
- males who were categorised as *current* smokers compared with *never* smokers
- females who were categorised as *current* smokers compared with *former* and *never* smokers
- males and females categorised as *obese* compared with those with *normal* body mass index
- males who consumed *>60 drinks/month* compared with those who consumed ≤ *60 drinks/month*
- females who consumed *>60 drinks/month* compared with those who consumed ≤ *60 drinks/month* and those who *did not consume* alcohol and
- females who had *diabetes mellitus* compared with those with *normal* blood glucose levels.

Table 4.4.1 Mean serum a-carotene (mmol/L) and Standard Error (SE) by sex and by selected characteristics, (weighted to Queensland population)					
		Serum Alpha Carotene			
		Males		Females	
Characteristics	**Categories**	**Mean**	**SE**	**Mean**	**SE**
Age group (10yr)	25-34	0.12	0.02	0.16	0.02
	35-44	0.15	0.03	0.21	0.04
	45-54	0.14	0.01	0.21	0.03
	55-64	0.16	0.01	0.21	0.02
	65-74	0.18	0.03	0.20	0.03
	75+	0.18	0.04	0.26	0.03
All age groups	**³25**	**0.15**	**0.02**	**0.20**	**0.03**
Education	Post-graduate qualifications	0.20	0.01	0.16	0.02
	Trade certificate, bachelors degree, etc.	0.14	0.02	0.21	0.03
	Secondary school or less	0.13	0.03	0.20	0.03
Smoking status	Never	0.16	0.01	0.21	0.03
	Former	0.16	0.02	0.22	0.03
	Current	0.07	0.01	0.11	0.01
Cholesterol ranges	< 5.5 mmol/L	0.14	0.02	0.20	0.03
	5.5 to < 6.5 mmol/L	0.15	0.02	0.19	0.03
	≥6.5 mmol/L	0.16	0.03	0.22	0.03
Physical activity intensity	Vigorous	0.18	0.04	0.20	0.02
	Moderate	0.14	0.03	0.22	0.03
	Light	0.14	0.01	0.19	0.03
	None	0.12	0.01	0.18	0.03
Physical activity beneficial to health	Sufficient	0.16	0.02	0.21	0.03
	Insufficient but not sedentary	0.14	0.02	0.20	0.03
	Sedentary	0.12	0.01	0.18	0.03
Body mass index	Underweight	0.22	0.03	0.21	0.04
	Normal	0.17	0.03	0.24	0.03
	Overweight	0.15	0.01	0.20	0.03
	Obese	0.10	0.01	0.14	0.02
Alcohol intake	None	0.19	0.04	0.22	0.04
	≤60 drinks/month	0.15	0.02	0.20	0.02
	>60 drinks/month	0.10	0.02	0.11	0.03
Vitamin use during previous 24 hrs	Yes	0.15	0.02	0.24	0.03
	No	0.14	0.02	0.18	0.03
Diabetes status	Normal	0.15	0.02	0.21	0.03
	IFG or IGT	0.14	0.01	0.20	0.04
	Diabetes Mellitus	0.13	0.03	0.10	0.01

Significantly lower mean levels of **b-*carotene*** (Table 4.4.2) were observed among:

- younger males (25-44 years old) compared with older males (55+ years)
- younger females (25-34 years old) compared with older females (45+ years)
- males and females categorised as *current* smokers compared with those categorised as *former* and *never* smokers
- males categorised as *sedentary* compared with males who engaged in *sufficient* activity beneficial to health
- males and females categorised as *obese* compared with *overweight*, *normal* and *underweight* males and females
- males and females who consumed *>60 alcoholic drinks/month* compared with those who consumed $\leq$ *60 drinks per month* and *non-drinkers*
- females categorised as *vitamin users* compared with *non-users* and
- females with *diabetes mellitus* compared with those with *normal* blood glucose levels.

Table 4.4.2 Mean serum b-carotene (mmol/L) and Standard Error (SE) by sex by selected characteristics, (weighted to Queensland population)					
		Serum Beta Carotene			
		Males		Females	
Characteristics	**Categories**	**Mean**	**SE**	**Mean**	**SE**
Age group (10yr)	25-34	0.46	0.07	0.59	0.06
	35-44	0.50	0.07	0.75	0.11
	45-54	0.57	0.07	0.84	0.08
	55-64	0.68	0.03	0.95	0.08
	65-74	0.76	0.09	0.91	0.14
	75+	0.79	0.07	1.25	0.12
All age groups	**³25**	**0.57**	**0.06**	**0.81**	**0.10**
Education	Post-graduate qualifications	0.70	0.05	0.73	0.09
	Trade certificate, bachelors degree, etc.	0.57	0.05	0.83	0.11
	Secondary school or less	0.54	0.10	0.80	0.09
Smoking status	Never	0.63	0.04	0.85	0.09
	Former	0.60	0.07	0.86	0.10
	Current	0.33	0.07	0.49	0.07
Cholesterol ranges	< 5.5 mmol/L	0.53	0.04	0.76	0.09
	5.5 to < 6.5 mmol/L	0.59	0.08	0.78	0.09
	≥6.5 mmol/L	0.63	0.10	1.00	0.12
Physical activity intensity	Vigorous	0.65	0.11	0.82	0.10
	Moderate	0.58	0.08	0.87	0.09
	Light	0.57	0.06	0.81	0.12
	None	0.47	0.03	0.71	0.08
Physical activity beneficial to health	Sufficient	0.62	0.06	0.87	0.10
	Insufficient but not sedentary	0.52	0.07	0.79	0.10
	Sedentary	0.47	0.03	0.71	0.08
Body mass index	Underweight	0.60	0.06	0.90	0.14
	Normal	0.66	0.07	0.98	0.11
	Overweight	0.58	0.06	0.76	0.09
	Obese	0.40	0.06	0.54	0.06
Alcohol intake	None	0.72	0.12	0.80	0.12
	≤60 drinks/month	0.59	0.05	0.84	0.09
	>60 drinks/month	0.39	0.07	0.46	0.10
Vitamin use during previous 24 hrs	Yes	0.68	0.08	1.05	0.11
	No	0.54	0.06	0.69	0.09
Diabetes status	Normal	0.58	0.06	0.85	0.10
	IFG or IGT	0.57	0.06	0.79	0.17
	Diabetes Mellitus	0.52	0.14	0.49	0.04

Significantly lower mean levels of **b-*cryptoxanthin*** (Table 4.4.3) were observed among:

- younger males (25-34 years old) compared with older males (55+ years)
- younger females (25-34 years old) compared with older females (45+ years)
- males with a *trade certificate and bachelors degree* or *secondary or less* educational qualifications compared with *post-graduate* education qualification
- males and females categorised as *current* smokers compared with *former* and *never* smokers
- females with cholesterol level *<5.5 mmol/L* compared with those with cholesterol level between *5.5 to <6.5 mmol/L* and *≥6.5 mmol/L* levels
- females categorised as *obese* compared with *overweight* and *normal* females and
- males and females who consumed *>60 alcoholic drinks/month* compared with those who consumed *≤60 alcoholic drinks/month* and *non*-drinkers.

Table 4.4.3 Mean serum b-cryptoxanthin (mmol/L) and Standard Error (SE) by sex and by selected characteristics, (weighted to Queensland population)

		Serum b-Cryptoxanthin			
		Males		Females	
Characteristics	**Categories**	**Mean**	**SE**	**Mean**	**SE**
Age group (10yr)	25-34	0.18	0.02	0.20	0.02
	35-44	0.24	0.04	0.23	0.02
	45-54	0.24	0.02	0.30	0.01
	55-64	0.34	0.04	0.41	0.03
	65-74	0.31	0.03	0.43	0.06
	75+	0.34	0.07	0.60	0.06
All age groups	**³25**	**0.25**	**0.02**	**0.31**	**0.03**
Education	Post-graduate qualifications	0.36	0.03	0.27	0.02
	Trade certificate, bachelors degree, etc.	0.24	0.02	0.31	0.05
	Secondary school or less	0.25	0.04	0.32	0.02
Smoking status	Never	0.27	0.02	0.35	0.04
	Former	0.28	0.03	0.31	0.02
	Current	0.14	0.01	0.16	0.01
Cholesterol ranges	< 5.5 mmol/L	0.23	0.02	0.27	0.03
	5.5 to < 6.5 mmol/L	0.30	0.03	0.32	0.03
	≥6.5 mmol/L	0.25	0.03	0.42	0.04
Physical activity intensity	Vigorous	0.30	0.06	0.35	0.04
	Moderate	0.23	0.03	0.31	0.04
	Light	0.25	0.01	0.31	0.04
	None	0.23	0.03	0.28	0.02
Physical activity beneficial to health	Sufficient	0.27	0.03	0.33	0.04
	Insufficient but not sedentary	0.24	0.02	0.30	0.04
	Sedentary	0.22	0.02	0.28	0.02
Body mass index	Underweight	0.21	0.05	0.35	0.10
	Normal	0.27	0.03	0.37	0.03
	Overweight	0.26	0.03	0.31	0.03
	Obese	0.21	0.02	0.20	0.02
Alcohol intake	None	0.29	0.04	0.32	0.02
	≤60 drinks/month	0.27	0.03	0.32	0.04
	>60 drinks/month	0.18	0.03	0.17	0.03
Vitamin use during previous 24 hrs	Yes	0.24	0.03	0.37	0.04
	No	0.26	0.03	0.28	0.03
Diabetes status	Normal	0.25	0.02	0.31	0.03
	IFG or IGT	0.26	0.03	0.33	0.07
	Diabetes Mellitus	0.27	0.04	0.29	0.02

Significantly lower mean levels of ***lutein/zeaxanthin*** (Table 4.4.4) were observed among:

- younger males (25-34 years old) compared with older males (55-74 years old)
- younger females (25-34 years old) compared with older females (55-75+ years old)
- males and females categorised as *current* smokers compared with *former* and *never* smokers
- males and females with cholesterol level *<5.5 mmol/L* compared with those with cholesterol level between *5.5 to <6.5 mmol/L* and *≥6.5 mmol/L* levels
- females categorised as *obese* compared with females with *normal* and *underweight* body mass index and
- females who consumed *>60 alcoholic drinks/month* compared with those who consumed *≤60 alcoholic drinks/month* and *non*-drinkers.

Table 4.4.4 Mean serum lutein/zeaxanthin (mmol/L) and Standard error (SE) by sex and by selected characteristics, (weighted to Queensland population)

		Serum Lutein/Zeaxanthin			
		Males		Females	
Characteristics	**Categories**	**Mean**	**SE**	**Mean**	**SE**
Age group (10yr)	25-34	0.35	0.03	0.39	0.02
	35-44	0.39	0.04	0.42	0.02
	45-54	0.44	0.03	0.46	0.03
	55-64	0.50	0.05	0.54	0.02
	65-74	0.55	0.03	0.55	0.02
	75+	0.46	0.05	0.63	0.03
All age groups	**[3]25**	**0.43**	**0.03**	**0.47**	**0.02**
Education	Post-graduate qualifications	0.45	0.05	0.40	0.04
	Trade certificate, bachelors degree, etc.	0.42	0.04	0.46	0.02
	Secondary school or less	0.45	0.02	0.49	0.02
Smoking status	Never	0.45	0.03	0.50	0.03
	Former	0.44	0.03	0.45	0.02
	Current	0.34	0.03	0.36	0.03
Cholesterol ranges	< 5.5 mmol/L	0.37	0.03	0.41	0.02
	5.5 to < 6.5 mmol/L	0.47	0.03	0.51	0.02
	≥6.5 mmol/L	0.51	0.03	0.57	0.03
Physical activity intensity	Vigorous	0.43	0.03	0.45	0.03
	Moderate	0.43	0.04	0.47	0.02
	Light	0.45	0.03	0.47	0.03
	None	0.38	0.03	0.47	0.02
Physical activity beneficial to health	Sufficient	0.43	0.04	0.47	0.03
	Insufficient but not sedentary	0.44	0.03	0.45	0.03
	Sedentary	0.38	0.03	0.47	0.02
Body mass index	Underweight	0.37	0.05	0.53	0.06
	Normal	0.44	0.03	0.49	0.02
	Overweight	0.43	0.04	0.47	0.03
	Obese	0.41	0.03	0.40	0.03
Alcohol intake	None	0.40	0.03	0.50	0.03
	≤60 drinks/month	0.44	0.03	0.46	0.03
	>60 drinks/month	0.40	0.04	0.36	0.04
Vitamin use during previous 24 hrs	Yes	0.43	0.04	0.52	0.03
	No	0.43	0.03	0.45	0.02
Diabetes status	Normal	0.42	0.03	0.47	0.02
	IFG or IGT	0.45	0.02	0.47	0.04
	Diabetes Mellitus	0.42	0.03	0.42	0.02

Significantly lower mean concentrations of ***lycopene*** (Table 4.4.5) were observed among:

- older males (45-75+ years old) compared with younger males (25-44 years old)
- older females (55-75+ years old) compared with younger females (25-44 years old)
- females with a *secondary or less* educational qualification compared with those with *trade certificate and bachelors degree qualification*
- males who were categorised as *former* smokers compared with *never* smokers
- females with *none* and *light* physical activity compared with those with *vigorous* physical activity
- females with *sedentary* physical activity beneficial to health compared with those with *sufficient* physical activity beneficial to health
- males and females categorised as *obese* compared with those with *overweight* and *normal* body mass index
- males and females categorised as *non*-drinkers compared with those who consumed $\leq$ *60 drinks/month* and
- males and females with *diabetes mellitus* and *IFG/IGT* compared with those with *normal* blood glucose levels.

Table 4.4.5 Mean serum lycopene (mmol/L) and Standard Error (SE) by sex and by selected characteristics, (weighted to Queensland population)

		Serum Lycopene (mmol/L)			
		Males		Females	
Characteristics	**Categories**	**Mean**	**SE**	**Mean**	**SE**
Age group (10yr)	25-34	0.71	0.05	0.60	0.03
	35-44	0.64	0.07	0.63	0.05
	45-54	0.55	0.04	0.53	0.03
	55-64	0.52	0.02	0.50	0.03
	65-74	0.44	0.03	0.41	0.06
	75+	0.27	0.02	0.36	0.01
All age groups	**[3]25**	**0.58**	**0.03**	**0.54**	**0.02**
Education	Post-graduate qualifications	0.66	0.10	0.57	0.04
	Trade certificate, bachelors degree, etc.	0.59	0.02	0.58	0.03
	Secondary school or less	0.52	0.04	0.49	0.03
Smoking status	Never	0.63	0.03	0.54	0.03
	Former	0.53	0.02	0.57	0.02
	Current	0.54	0.08	0.48	0.05
Cholesterol ranges	< 5.5 mmol/L	0.55	0.02	0.52	0.02
	5.5 to < 6.5 mmol/L	0.60	0.05	0.55	0.02
	≥6.5 mmol/L	0.63	0.04	0.57	0.04
Physical activity intensity	Vigorous	0.64	0.04	0.62	0.03
	Moderate	0.57	0.04	0.56	0.04
	Light	0.56	0.03	0.51	0.02
	None	0.56	0.04	0.49	0.02
Physical activity beneficial to health	Sufficient	0.60	0.03	0.57	0.02
	Insufficient but not sedentary	0.55	0.05	0.53	0.02
	Sedentary	0.55	0.04	0.49	0.02
Body mass index	Underweight	0.52	0.11	0.53	0.02
	Normal	0.62	0.04	0.57	0.03
	Overweight	0.60	0.02	0.56	0.03
	Obese	0.48	0.03	0.48	0.01
Alcohol intake	None	0.48	0.06	0.47	0.02
	≤60 drinks/month	0.61	0.03	0.57	0.02
	>60 drinks/month	0.54	0.07	0.48	0.08
Vitamin use during previous 24 hrs	Yes	0.55	0.05	0.56	0.03
	No	0.60	0.03	0.53	0.02
Diabetes status	Normal	0.62	0.03	0.58	0.03
	IFG or IGT	0.49	0.05	0.46	0.03
	Diabetes Mellitus	0.39	0.04	0.34	0.04

4.4.2 Discussion regarding interpretation of serum carotenoids findings

The following associations between serum carotenoids and selected characteristics have been reported in the literature:

Selected characteristics	Association with serum carotenoids
Gender	Higher concentrations in women (except for lycopene) than men[54,55]
Age	Higher concentrations associated with older age groups (except lycopene)[55,56]
Educational level	Small positive correlations between carotenoids and educational level[49]
Smoking status	Plasma levels of α-carotene, β-carotene, lutein, zeaxanthin and β-cryptoxanthin lower in smokers than in non smokers[55,57,58] The relation between smoking and lycopene not consistent; serum lycopene not significantly lower in smokers than non smokers[55] African American female smokers show lower serum lycopene concentration than non-smokers[59]
Cholesterol	Lower serum concentrations of the major carotenoids generally associated with lower total cholesterol[55]
Physical activity	Higher levels in vigorously active study participants compared with sedentary participants[49]
Body mass index	Body mass index negatively associated with serum lycopene[56] Serum β-carotene levels negatively associated with both general and central adiposity[60]
Alcohol consumption	Lower serum levels of α-carotene, β-carotene, β-cryptoxanthin, lutein and zeaxanthin, generally associated with greater alcohol consumption[55]
Vitamin use	Higher levels in vitamin users than non vitamin users[48]
Diabetes status	Compared with persons with normal glucose tolerance, mean concentrations of β-carotene, lycopene, β-cryptoxanthin lower in persons with diabetes[48]

The results of this Queensland study were consistent with published data in the following areas:

- lower serum carotenoid concentrations in younger participants (except lycopene)
- lower serum carotenoid concentrations in current smokers (except lycopene)
- lower serum carotenoid concentrations in obese participants

- lower serum carotenoid concentrations associated with greater consumption of alcohol (except lycopene)
- lower serum concentrations of α-, β-carotenoids (females only) and lycopene in subjects with diabetes compared with subjects with normal blood glucose and
- lower concentrations of β-cryptoxanthin, lutein/zeaxanthin and lycopene among subjects with cholesterol concentration <5.5 mmol/L.

Prevalence of deficient or low levels of serum carotenoids were not estimated because no recommended cut off levels are available in the literature.

4.5 Serum Ferritin

Serum ferritin determinations were included in the blood analysis because of several concerns:

- Low serum ferritin has been associated with iron deficiency anaemia[61].
- In a prospective study of risk factors on the incidence of acute myocardial infarction (AMI) among Finnish men, a 2.2 times greater risk of AMI was observed among men with elevated serum ferritin[62].
- Elevated serum ferritin concentrations has been associated with increased risk of myocardial infarction in an elderly population[63].
- Iron deficiency and iron overload have pathologic consequences. Low iron stores affect erythropoeisis, and iron overload is associated with heart disease [62,63] and haemochromatosis [64].
- Iron present in the body, beyond what is immediately needed for functional purposes is stored as soluble protein complex ferritin or haemosiderin.
- Elevated serum ferritin has also been associated with haemochromatosis, (a genetic disorder resulting in excess accumulation of iron in the organs of the body[64].
- Although serum ferritin is a sensitive indicator of depleted iron stores, it has been reported to be within normal limits in iron deficiency states during times of acute infection and inflammation. Serum transferrin receptor level is an equally good indicator of iron status, and is not affected by infection or inflammation, but the test is expensive and not routinely available for use in Australia[65].
- Serum ferritin assay is the only method which can provide a semi-quantitative indication of the levels of storage iron but its application is limited by methodological and biological variation[66].
- There are few data related to iron stores among the adult Australian population.

4.5.1 Findings for serum ferritin

4.5.1.1 Mean serum ferritin

Across all categories of selected characteristics, serum ferritin was significantly more than twice as high for men than for women (Table 4.5.1).

In addition, mean serum ferritin concentrations were observed to be significantly higher for the following categories of participans:

- males aged 45 to 64 years compared with those aged 25 to 34 years
- females aged 45 and older compared with those aged 25 to 34 years
- males with a *secondary school or less* educational qualification compared with those with *post-graduate* qualifications
- males with *≥6.5 mmol/L* cholesterol level compared with those with *<5.5 mmol/L* cholesterol level
- females with cholesterol range *5.5 to <6.5 mmol/L*, and *≥6.5 mmol/L* compared with those with *<5.5 mmol/L* cholesterol levels
- males engaged in *none*, *light*, or *moderate* physical activity compared with those engaged in *vigorous* physical activity
- females engaged in *none*, and *light*, physical activity compared with those engaged in *vigorous* physical activity
- males in *sedentary* physical activity beneficial to health category compared with those in *sufficient* physical activity beneficial to health
- males and females categorised as *overweigh*t, and *obese* compared with those categorised as *underweight*
- males who consumed *>60 drinks/month* compared with those who *did not* consume alcohol and
- females who are categorised as having *IFG/IGT* and *diabetes mellitus* compared with those with *normal* blood glucose levels.

There appeared to be no significant differences in mean serum ferritin with regard to:

- educational status (females only)
- smoking (males and females)
- physical activity beneficial to health (females only)
- alcohol consumption (females only)
- vitamin use (males and females only) and
- diabetes status (males only).

Table 4.5.1 Mean serum ferritin (mg/L) and Standard Error (SE) by sex and by selected characteristics, (weighted to Queensland population)					
		Serum Ferritin			
		Males		Females	
Characteristics	**Categories**	**Mean**	**SE**	**Mean**	**SE**
Age group (10yr)	25-34	171.0	10.5	52.6	2.4
	35-44	210.2	19.5	61.1	4.2
	45-54	278.8	22.0	82.9	9.7
	55-64	274.8	6.1	138.1	5.4
	65-74	214.5	21.2	152.8	12.2
	75+	204.4	31.0	120.2	4.2
All age groups	**³25**	**224.3**	**8.3**	**88.9**	**4.5**
Education	Post-graduate qualifications	188.0	18.0	77.8	20.1
	Trade certificate, bachelors degree, etc.	224.3	11.2	77.7	5.3
	Secondary school or less	237.3	6.8	102.2	3.5
Smoking status	Never	218.9	13.9	91.2	8.8
	Former	248.6	9.8	89.0	5.2
	Current	197.1	17.4	78.8	3.6
Cholesterol ranges	< 5.5mmol/L	206.9	5.3	75.1	3.6
	5.5 to < 6.5 mmol/L	223.2	15.4	90.0	2.7
	≥ 6.5 mmol/L	270.4	23.3	127.5	8.3
Physical activity	Vigorous	183.6	13.6	69.3	9.0
	Moderate	223.8	10.2	81.9	4.7
	Light	233.1	11.5	97.3	4.8
	None	260.1	15.0	97.9	8.6
Physical activity beneficial to health	Sufficient	214.7	5.0	82.9	4.8
	Insufficient but not sedentary	222.3	13.4	91.6	5.1
	Sedentary	260.7	14.2	97.9	8.6
Body mass index	Underweight	135.1	37.6	64.2	5.6
	Normal	196.5	13.4	77.4	6.1
	Overweight	217.4	16.4	101.0	9.6
	Obese	294.9	11.7	106.4	7.3
Alcohol intake	None	194.5	16.9	91.4	6.8
	≤60 drinks/month	225.7	10.6	86.0	5.4
	>60 drinks/month	243.8	6.1	117.3	17.9
Vitamin use during previous 24 hrs	Yes	209.2	21.7	93.9	4.8
	No	227.2	9.1	83.6	4.1
Diabetes status	Normal	218.7	11.4	77.2	3.0
	IFG or IGT	247.0	21.7	119.1	14.0
	Diabetes Mellitus	243.4	13.8	154.0	29.6

4.5.1.2 Prevalence of low serum ferritin levels

For this study, a cut off point of serum ferritin <12 μg/L was used as an indication of low iron stores (without anaemia)[61].

Across all categories of selected characteristics, more women (7.2%) were observed to have low serum ferritin than men (0.3%) (Table 4.5.2). Because of the low prevalence of low serum ferritin in males in this study, findings on prevalence of low serum ferritin have been presented for female participants only. A significantly higher prevalence of low serum ferritin was observed among:

- females aged 35 to 54 years compared with those aged 54 to 74 years
- females with *post-graduate* education compared with those *with trade certificate bachelors degree* or *secondary school or less* educational qualifications
- females who *never* smoked compared with *current* and *former* smokers
- females who engaged in *vigorous* physical activity compared with those with *light* physical activity and
- females with *normal* blood glucose compared with those with *IFG/IGT* and *diabetes mellitus*.

There were no significant differences in the prevalence of low serum ferritin among females according to body mass index, alcohol consumption or vitamin use.

4.5.1.3 Prevalence of elevated serum ferritin levels

Klipstein-Grobusch et al [67] used a cut off point of >200 μg/L for elevated serum ferritin for men and women, while Ford and Cogswell[68], defined elevated levels of serum ferritin as >300 μg/L for men and >150 μg/L for women. For the present study, elevated serum ferritin was defined as >300 μg/L for males, and >200 μg/L for females (Table 4.5.3).

A significantly higher prevalence of elevated serum ferritin, was observed among the following categories of Queensland study participants:

- older males (45-64years and 75+ years) compared with younger males (25-34 years)
- older females (35+ years) compared with younger females (25-34 years)
- males categorised as *never* and *former* smokers compared with *current* smokers
- females categorised as *current* smokers compared with *never* smokers
- females with a *post-graduate* educational qualification compared with those with *trade certificate and bachelors degree* qualifications
- females with cholesterol level $\geq$*6.5 mmol/L* compared with females with <*5.5 mmol/L* and *5.5 to* < *6.5 mmol/L* cholesterol levels
- females categorised as *underweight* and *normal* compared with those who were *overweight* and *obese* and
- females with *IFG or IGT* compared with those with *diabetes*.

There appeared to be no significant differences in elevated serum ferritin for:

- education (males only)
- cholesterol level (males only)
- physical activity (males and females)
- body mass index (males only)
- alcohol intake (males and females)
- vitamin use (males and females) and
- diabetes status (males only).

Table 4.5.2 Prevalence of low serum ferritin (<12 mg/L) by sex and by selected characteristics, (weighted to Queensland population)					
		Serum Ferritin			
		Males		Females	
Characteristics	**Categories**	**Percent**	**SE**	**Percent**	**SE**
Age group (10yr)	25-34	-	-	11.3	5.4
	35-44	-	-	9.4	0.9
	45-54	0.4	0.5	8.4	2.0
	55-64	1.2	1.1	1.6	0.7
	65-74	-	-	1.9	1.1
	75+	-	-	2.9	3.1
All age groups	**[3]25**	**0.3**	**0.2**	**7.3**	**1.2**
Education	Post graduate qualification	-	-	19.0	3.3
	Trade certificate, bachelors degree, etc.	0.2	0.2	7.4	1.2
	Secondary school or less	0.6	0.7	5.4	1.7
Smoking status	Never	-	-	9.4	1.3
	Former	0.8	0.5	4.6	1.3
	Current	-	-	3.0	1.9
Cholesterol ranges	< 5.5 mmol/L	-	-	7.7	1.5
	5.5 to < 6.5 mmol/L	0.5	0.5	8.5	1.1
	≥6.5 mmol/L	0.4	0.4	3.7	2.1
Physical activity	Vigorous	1.0	1.0	12.6	3.4
	Moderate	-	-	9.0	2.6
	Light	-	-	4.1	2.0
	None	0.5	0.5	6.5	1.6
Physical activity beneficial to health	Sufficient	0.3	0.3	9.2	1.9
	Insufficient but not sedentary	-	-	5.0	1.7
	Sedentary	0.5	0.5	6.5	1.6
Body mass index	Underweight	-	-	8.3	4.5
	Normal	-	-	9.9	1.6
	Overweight	0.6	0.4	4.7	1.3
	Obese	-	-	5.2	1.2
Alcohol intake	None	-	-	6.5	1.6
	≤60 drinks/month	0.4	0.3	7.2	1.4
	>60 drinks/month	-	-	12.4	8.6
Vitamin use during previous. 24 hrs	Yes	1.3	1.0	8.5	1.4
	No	-	-	6.8	1.5
Diabetes Status	Normal	0.4	0.2	8.4	1.2
	IFG or IGT	-	-	2.6	0.9
	Diabetes Mellitus	-	-	-	-

Table 4.5.3 Prevalence of elevated serum ferritin (males >300 mg/L, females > 200mg/L) by sex and by selected characteristics, (weighted to Queensland population)					
		Serum Ferritin			
		Males		Females	
Characteristics	**Categories**	**Percent**	**SE**	**Percent**	**SE**
Age group (10yr)	25-34	16.3	4.7	0.7	0.7
	35-44	28.9	6.3	3.2	1.8
	45-54	40.6	5.5	9.2	2.7
	55-64	47.5	4.7	18.4	1.1
	65-74	29.6	5.1	22.3	3.2
	75+	48.6	6.7	15.1	2.3
All age groups		**32.5**	**3.1**	**9.0**	**0.5**
Education	Post-graduate qualifications	24.7	8.7	7.4	3.1
	Trade certificate, bachelors degree, etc.	32.5	4.2	5.9	0.8
	Secondary school or less	35.3	2.6	12.4	1.0
Smoking status	Never	33.4	4.3	10.1	1.2
	Former	36.3	4.2	8.8	1.2
	Current	23.6	3.8	5.1	1.8
Cholesterol ranges	< 5.5mmol/L	32.1	4.1	6.5	0.8
	5.5 to < 6.5mmol/L	26.0	2.9	8.7	1.6
	≥6.5mmol/L	43.4	6.6	16.8	1.9
Physical activity	Vigorous	32.2	7.2	6.1	2.4
	Moderate	34.8	3.7	8.7	1.6
	Light	32.8	3.8	9.8	1.6
	None	28.8	5.4	9.8	1.8
Physical activity beneficial to health	Sufficient	33.4	2.0	8.6	0.9
	Insufficient but not sedentary	33.5	5.7	9.0	0.8
	Sedentary	28.9	5.3	9.8	1.8
Body mass index	Underweight	32.9	23.7	2.0	0.8
	Normal	30.6	3.3	6.6	1.7
	Overweight	28.4	6.5	11.3	2.6
	Obese	43.5	6.6	13.6	2.1
Alcohol intake	None	29.7	7.6	9.3	1.7
	≤60 drinks/month	32.6	3.8	8.3	0.7
	>60 drinks/month	33.9	2.1	17.6	6.0
Vitamin use during previous 24 hrs	Yes	39.4	2.7	9.2	1.9
	No	29.2	3.6	8.6	1.0
Diabetes Status	Normal	29.4	4.5	6.1	0.9
	IFG or IGT	42.3	8.5	18.3	4.6
	Diabetes Mellitus	48.1	4.2	20.7	7.5

4.5.2 Discussion regarding interpretation of serum ferritin findings

A review of the literature showed the following associations between serum ferritin and selected characteristics.

Selected characteristics	Association with serum ferritin
Gender	Concentrations higher in males than females[66]
Age	Concentrations increase with age[68]
Educational level	Education inversely related to serum ferritin concentration among females but not males[68]
Smoking status	Current and former smoking associated with elevated serum ferritin[68]
Cholesterol	Concentrations increase with increased cholesterol concentration[68]
Physical activity	Decreased levels in women who participated in vigorous physical activity compared with the sedentary[69]
Body mass index	Concentrations increase with increasing body mass index[66,68,70]
Alcohol consumption	Concentrations increase with increased alcohol consumption[63,66,68]
Vitamin use	Iron supplements had a significant positive influence on iron status in pre-menopausal women and in non blood donors but no effect in post-menopausal women or in blood donors[71]
Diabetes status	Mean levels of serum ferritin, a pro-oxidant were higher in people with NIDDM than those without diabetes[68] Concentration of blood glucose increased with increasing concentration of serum ferritin[72]

The data from these studies and the present study indicate that confounding factors which need to be addressed with regard to analysis of serum ferritin include, age, education level, smoking status, serum cholesterol, physical activity, body mass index, alcohol intake and diabetes status.
Other possible covariates which would need to be considered include, infection/inflammation, blood donation, chronic diseases, use of aspirin, liver disease and other malignant disease.

The results of the current study raise several interesting questions: Why is serum ferritin concentration level influenced significantly by educational status in males and not females? Why is low serum ferritin concentration more prevalent among persons with normal glucose levels than those with diabetes? Could those with diabetes be taking more vitamin/mineral supplements than those without diabetes? Why is serum ferritin influenced by alcohol intake in males but not females? (Perhaps men who

consume alcohol have liver disease which may result in elevated serum ferritin?) Further analysis is required to investigate these findings.

4.6 Additional dietary questions

Several additional questions related to dietary intake were added to the Queensland AusDiab study.

- Two questions regarding intake of vegetables and fruit were included for comparability with the 1995 National Nutrition Survey and the Well Persons Health Check. Responses to these short questions could then be validated against red cell folate and serum carotenoid levels and if strong associations are found, the questionnaire could be an extremely valuable indicator of folate and carotenoid status in future health and nutrition surveys.
- Three questions were asked regarding type of milk consumed, trimming fat from meat and types of oils or fats used in cooking. These questions could be compared with risk factors such as obesity and lipid levels. These questions were also included in the 1995 National Nutrition Survey.
- One question related to frequency of consumption of take-away or fast foods was included. This question was not included in the 1995 National Nutrition Survey
- One question regarding intake of vitamin/mineral supplements was included as an indication of supplement use in the population and to assist with the interpretation of results on blood levels of folate and carotenoids. This question was also included in the 1995 National Nutrition Survey.
- As with the nutritional biomarkers, the formula on page 7 was used to compare differences in group means.

4.6.1 Findings of dietary intake short questions

The response to the short dietary questions were tabulated against the nutritional biomarkers (red cell folate, plasma homocysteine, serum carotenoids and serum ferritin) and three selected characteristics namely sex, age group and cholesterol categories. Responses to short questionnaires were tabulated against physical activity characteristics.

4.6.1.1. What type of milk do you usually consume? (ONE type of milk only.)

More males consumed whole or full cream milk than females while more females consumed low fat or skim milk (Table 4.6.1). More younger males (25 to 34 year olds and 35 to 44 year olds) consumed whole milk, while more older males and females used low fat and skim milk.

Slightly more people in the higher cholesterol category reported consuming whole milk than those in the lowest cholesterol category. Slightly more people in the lowest cholesterol category consumed skim than the highest cholesterol category.

Table 4.6.1 Percent of persons who reported type of milk consumed* and standard error (SE) by selected characteristics, (weighted to Queensland population)

		Type of milk consumed									
Characteristics		**Whole or full cream milk**		**Low or reduced fat milk**		**Skim Milk**		**Soy Milk**		**Don't drink milk**	
	Categories	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**
Sex	Male	53.0	6.1	25.3	4.1	12.9	2.7	5.3	1.0	3.5	0.9
	Female	38.0	3.8	31.2	3.3	19.7	1.2	6.7	0.9	4.4	0.7
Age group (10yr)	25-34	57.7	4.1	20.7	2.8	10.7	3.1	7.5	2.0	3.4	1.0
	35-44	55.4	5.9	24.5	6.0	14.8	2.2	3.2	1.0	2.1	0.8
	45-54	37.1	4.8	34.2	3.9	17.6	3.2	6.2	1.6	5.0	0.9
	55-64	30.1	2.2	33.4	2.7	25.2	3.1	7.2	1.8	4.1	1.1
	65-74	35.5	5.0	33.5	5.8	18.7	1.5	7.2	1.6	5.0	1.5
	75+	39.3	5.7	31.1	5.4	15.9	3.0	6.0	3.5	7.7	2.9
	All ages	**45.5**	**4.9**	**28.3**	**3.5**	**16.3**	**1.8**	**6.0**	**0.6**	**3.9**	**0.4**
Cholesterol ranges	<5.5 mmol/L	45.9	5.0	27.4	2.8	17.9	3.0	5.9	1.0	2.9	0.5
	5.5 < 6.5 mmol/L	43.6	6.6	29.1	4.4	16.5	1.6	5.9	1.6	4.8	1.2
	≥6.5 mmol/L	47.4	3.9	29.2	4.8	11.6	1.0	6.4	1.0	5.4	2.5

* Respondents were instructed to indicate ONE choice only

Mean blood levels of nutritional indicators and responses to types of milk consumed are shown in Figure 4.6.1, 4.6.2, 4.6.3 and Table 4.6.2 (in Appendix B).

Figure 4.6.1 shows that:

- α-carotene and β-cryptoxanthin levels were significantly higher for those who consumed soy milk compared to those who consumed whole milk
- β-carotene and lutein/zeaxanthin levels were significantly higher among those who consumed soy milk compared to those who consumed whole milk and skim milk and
- no significant difference in lycopene level was observed among soy milk drinkers compared with those who consumed whole milk, low fat milk or skim milk.

Figure 4.6.1 Mean Serum Carotenoids by type of milk usually consumed

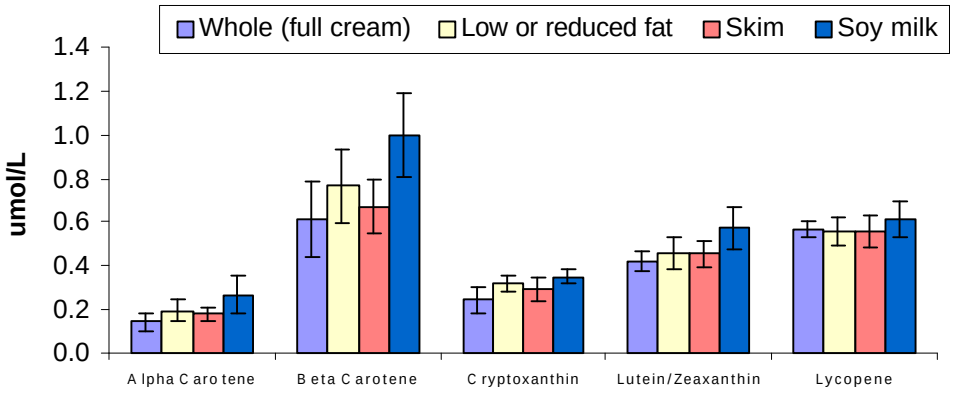


Figure 4.6.2, Figure 4.6.3 (and Table 4.6.2 in Appendix B) show that:

- red cell folate level was significantly higher in those who consumed soy milk compared with those who consumed whole milk and reduced fat milk;
- serum ferritin level was significantly lower in those who consumed soy milk compared with those who consumed whole milk and reduced fat milk and
- no significant difference in homocysteine level was observed among those who consumed soy milk compared with those who reported using whole milk, low fat milk or skim milk (not shown).

Figure 4.6.2 Mean Red Cell Folate by type of milk usually consumed

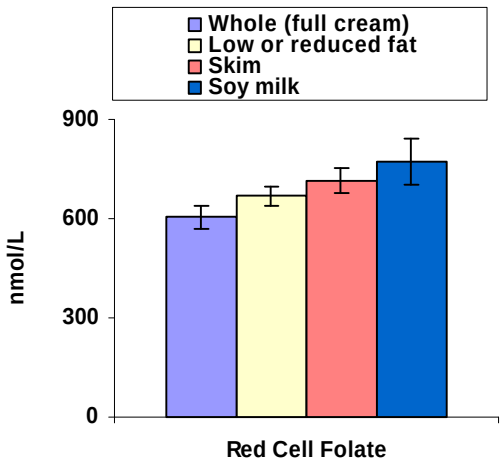
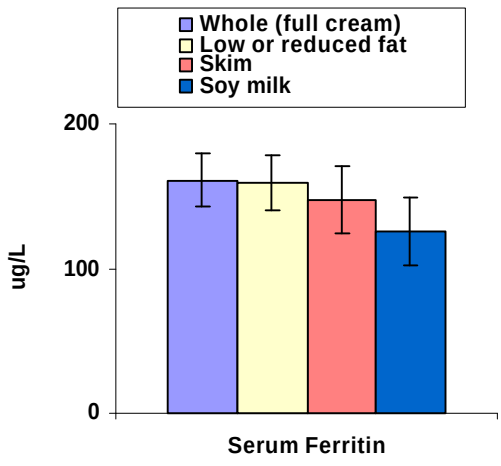


Figure 4.6.3 Mean Serum Ferritin by type of milk usually consumed



4.6.1.2 How often is the meat you eat trimmed of fat (either before or after cooking) (Never/rarely, Sometimes, Usually, Don't eat meat)

Table 4.6.3 indicates that more of those who reported *never/rarely* trimming fat off meat (before or after cooking) were males than females. More younger participants (25-34years olds) did not report trimming fat off their meats than older participants (75+ year olds) and more participants who have elevated cholesterol levels did not trim fat off their meat compared with those in the *<5.5mmol/L cholesterol* category. In general, more than 60% of the study participants reported *usually* trimming fat off meat.

Table 4.6.3 Percent of persons who reported trimming of fat from meat by selected characteristics (weighted to Queensland population)

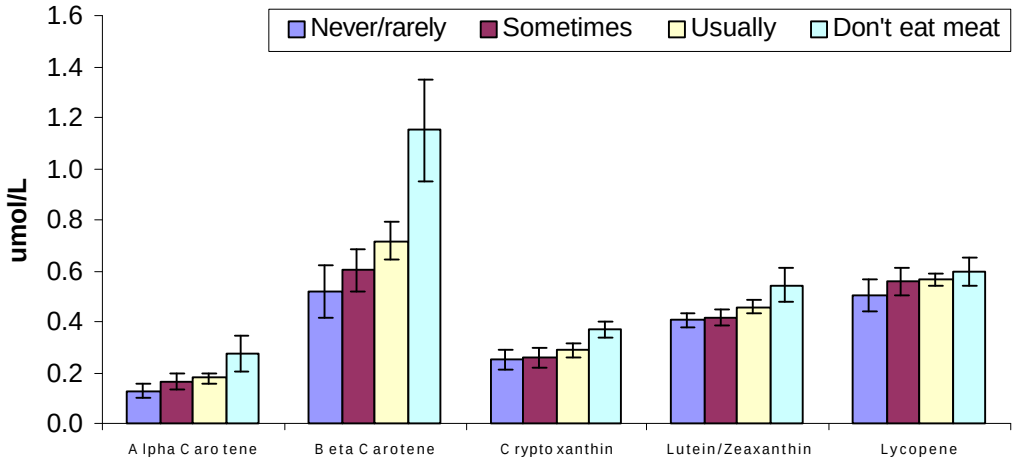
		Frequency with which meat is trimmed of fat							
Characteristics		**Never/rarely**		**Sometimes**		**Usually**		**Don't eat meat**	
	Categories	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**
Sex	Male	10.7	2.6	20.6	1.7	67.3	2.7	1.4	0.4
	Female	5.2	1.2	13.8	2.3	77.8	2.7	3.2	0.5
Age group (10yr)	25-34	12.3	1.8	21.4	2.4	64.6	2.7	1.7	1.2
	35-44	7.9	3.2	16.6	1.9	72.4	3.0	3.1	1.0
	45-54	8.4	2.7	16.1	1.7	73.2	3.4	2.3	0.4
	55-64	4.5	0.8	14.4	3.8	79.0	3.6	2.0	0.9
	65-74	3.4	1.5	14.7	3.1	79.7	3.3	2.2	1.3
	75+	4.4	0.8	16.7	2.6	75.9	3.1	3.1	1.6
	All ages	**7.9**	**1.9**	**17.2**	**1.8**	**72.6**	**2.6**	**2.4**	**0.4**
Cholesterol ranges	< 5.5 mmol/L	7.6	1.6	16.9	1.7	72.9	1.8	2.6	0.6
	5.5 < 6.5 mmol/L	6.9	3.0	17.1	3.4	74.5	5.3	1.5	0.6
	≥6.5 mmol/L	10.3	1.6	17.9	2.6	68.8	2.2	3.0	1.3

Figures 4.6.4, 4.6.5, 4.6.6 and Table 4.6.4 (in Appendix B) provide the mean blood nutritional indicators by responses to the question regarding trimming fat from meat.

Figures 4.6.4 indicates:

- β-carotene level was significantly higher among those who reported *don't eat meat* compared with those who *never*, *sometimes* or *usually* trim fat off meat
- β-cryptoxanthin level was significantly higher among those who *don't eat meat* compared with those who *never* or *sometimes* trim fat off the meat and
- no significant difference in serum α-carotene, lutein/zeaxanthin, and lycopene was observed among those who *don't eat meat* compared with those who *never, sometimes*, or *usually*, trim fat off their meat before or after cooking.

Figure 4.6.4 Mean Serum Carotenoids by frequency meat is trimmed of fat



Figures 4.6.5 and 4.6.6 indicate that:

- red cell folate level was significantly higher among those who reported *don't eat meat* compared with those who reported *never*, or *sometimes* trim fat off meat
- serum ferritin level was significantly lower among those who reported *don't eat meat* compared with those who reported *never*, *sometimes* or *usually* trim fat off the meat and
- no significant difference in plasma homocysteine level was observed among those who *don't eat meat* compared with those who reported *never*, *sometimes* or *usually* trim fat off the meat (not shown)

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Figure 4.6.5 Mean Red Cell Folate by frequency meat is trimmed of fat

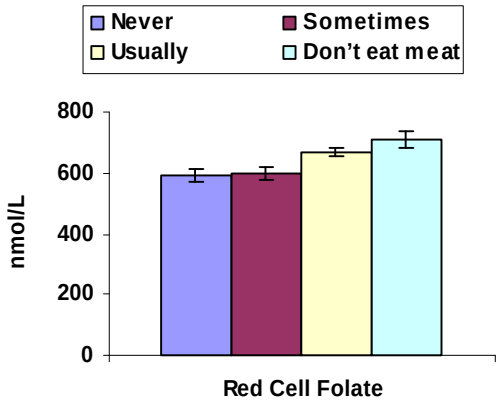
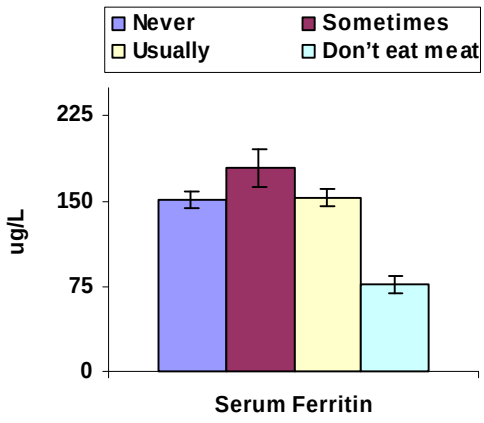


Figure 4.6.6 Mean Serum Ferritin by frequency meat is trimmed of fat



4.6.1.3 How many serves of vegetables do you usually eat each day? Include fresh, frozen or tinned vegetables. (a 'serve' = ½ cup cooked vegetables or 1 cup of salad vegetables)

Table 4.6.5 shows that on average, only 20.1% of males reported eating *4 to 5 serves* or more of vegetables each day, while 34.8% of females reported eating *4 to 5 serves* or more of vegetables each day.

More older people (45 year olds and older) tend to eat *4 to 5 serves* or more of vegetables each day than younger people (25-34 year olds). The findings in this survey are similar to that reported in the Omnibus Survey 2001[18] for intake of vegetables. In this study, approximately 72% (all ages) of respondents reported eating 3 servings of vegetables or less.

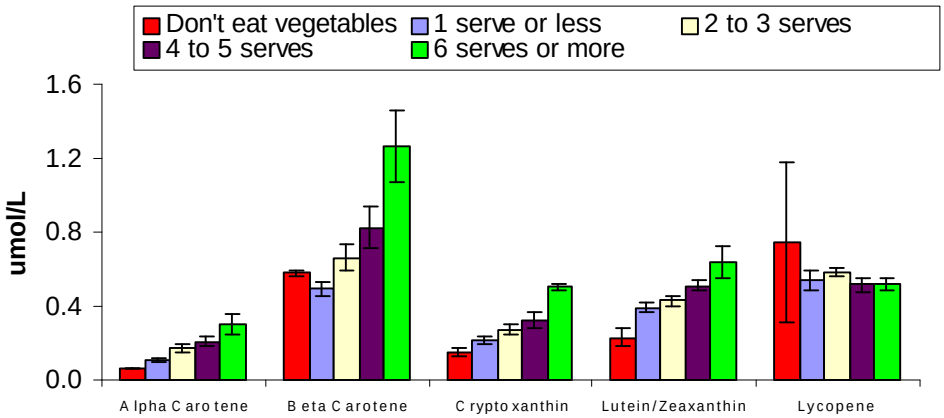
Table 4.6.5 Percent of persons who reported usually eating vegetables (in serves per day) by selected characteristics (weighted to Queensland population)

		Number of serves of vegetables usually eaten									
Characteristics		**1 serve or less**		**2 to 3 serves**		**4 to 5 serves**		**6 serves or more**		**Don't eat vegetables**	
	Categories	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**
Sex	Male	20.6	1.8	58.7	1.9	19.1	0.9	1.0	0.4	0.6	0.4
	Female	12.6	1.7	52.6	2.7	30.7	2.6	4.1	0.5	-	
Age group (10yr)	25-34	19.8	3.7	63.7	4.4	15.0	5.4	1.1	0.7	0.5	0.5
	35-44	17.4	3.2	54.8	3.5	25.2	3.1	2.0	0.8	0.5	0.5
	45-54	16.5	2.2	52.9	1.5	27.0	2.5	3.6	0.9	-	-
	55-64	12.3	1.2	51.4	1.8	32.1	1.9	4.2	0.7	-	-
	65-74	11.9	0.6	54.6	3.2	30.6	3.1	2.5	0.6	0.4	0.4
	75+	18.7	6.1	47.3	4.4	30.1	3.7	3.8	1.0	-	-
	All ages	**16.6**	**1.7**	**55.6**	**1.6**	**25.0**	**1.7**	**2.6**	**0.3**	**0.3**	**0.2**
Cholesterol ranges	< 5.5 mmol/L	16.4	1.9	56.4	1.6	24.4	2.5	2.6	0.6	0.2	0.2
	5.5 to < 6.5 mmol/L	17.4	2.4	55.0	2.2	25.4	2.0	2.0	0.4	0.2	0.2
	≥ 6.5 mmol/L	15.7	1.8	54.6	1.7	25.7	1.5	3.4	1.0	0.6	0.6

Figure 4.6.7 and Table 4.6.6 (Appendix B) indicate that:

- in general, all of the carotenoids (except lycopene) increased in level with reported increase in the number of serves of vegetables usually consumed
- α-carotene, β-carotene, β-cryptoxanthin and lutein/zeaxanthin concentrations were significantly lower in those who reported *don't eat vegetables* compared with those who reported eating *2 to 3 serves, 4 to 5 serves* and *6 serves or more* of vegetables each day and
- there was no significant difference in serum lycopene concentration between those who reported *don't eat vegetables* and those who reported eating vegetables (i.e. *1 serve or less* to *2 to 6 serves or more*).

Figure 4.6.7 Mean Carotenoids by number of serves of vegetables usually eaten each day



Figures 4.6.8 and 4.6.9 (and Table 4.6.6 in Appendix B) show that:

- red cell folate levels were significantly lower among those who reported *don't eat vegetables* and those who reported *eat 1 or less serve of vegetables* compared with those who reported eating *6 serves of vegetables or more* each day
- serum homocysteine levels were significantly higher among those who reported *don't eat vegetables* compared with those who reported eating vegetables (i.e. *1 serve or less, 2 to 3 serves, 4 to 5 serves and 6 or more serves)* each day and
- serum ferritin levels were not significantly different between those who reported *don't eat vegetables* and those who eat vegetables (ie *1 serve or less, and 2 to 6 serves or more*) (not shown).

Figure 4.6.8 Mean Red Cell Folate by number of serves of vegetables usually eaten each day,

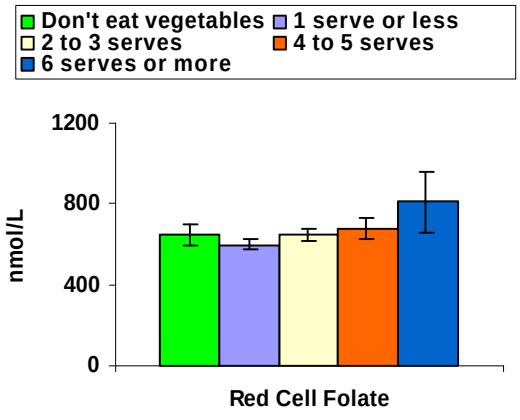
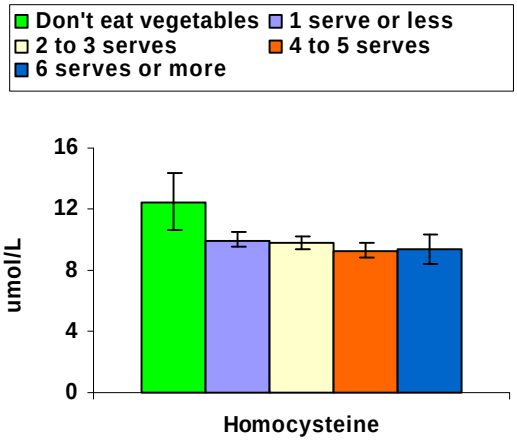


Figure 4.6.9 Mean Homocysteine by number of serves of vegetables usually eaten each day



4.6.1.4 How many serves of fruit do you usually eat each day? Include fresh, frozen and tinned vegetables. (a 'serve' = 1 medium piece or 2 small pieces of fruit or 1 cup of diced pieces.)

More males reported eating less than one serve of fruit each day than females (Table 4.6.7). More younger participants (25 to 34 year olds and 35 to 44 year olds) reported eating less than 1 serve of fruit each day than older participants (65 to 75+ year olds). In general, between 39-56% of the study participants eat *2 to 3 serves* of fruits each day. Approximately 40% of study participants (all ages) reported eating less than the NHMRC recommended 2 serves of fruits each day[73].

Table 4.6.7 Percent of persons reporting number of serves of fruits usually eaten each day by selected characteristics, (weighted to Queensland population)

		Number of fruits eaten each day									
Characteristics		**1 serve or less**		**2 to 3 serves**		**4 to 5 serves**		**6 serves or more**		**Don't eat fruit**	
	Categories	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**
Sex	Male	45.9	3.8	41.5	3.0	9.5	2.1	1.5	0.4	1.6	0.5
	Female	35.1	3.8	50.6	2.7	10.7	2.0	1.7	0.4	1.9	0.9
Age group (10yr)	25-34	50.2	2.9	39.9	2.1	5.7	2.0	1.9	0.7	2.3	1.1
	35-44	47.9	5.4	39.4	5.8	9.6	1.9	1.2	1.1	1.8	0.6
	45-54	38.4	2.9	49.2	2.5	10.5	1.9	0.4	0.3	1.5	0.8
	55-64	31.3	2.9	52.1	2.6	12.6	2.4	2.4	0.8	1.5	0.8
	65-74	26.1	4.6	55.5	3.3	13.6	2.6	2.8	0.6	1.9	1.6
	75+	25.9	5.3	55.5	4.7	16.5	3.0	2.1	1.0	-	-
	All ages	**40.4**	**3.5**	**46.1**	**2.8**	**10.1**	**1.8**	**1.6**	**0.3**	**1.7**	**0.7**
Cholesterol ranges	< 5.5 mmol/L	39.3	3.2	48.2	2.9	9.2	1.5	1.4	0.3	1.8	0.6
	5.5 to < 6.5 mmol/L	41.1	5.7	44.1	5.1	11.3	2.1	1.7	0.4	1.8	0.7
	≥ 6.5 mmol/L	42.4	4.4	43.7	4.5	10.6	2.7	2.0	0.9	1.3	1.0

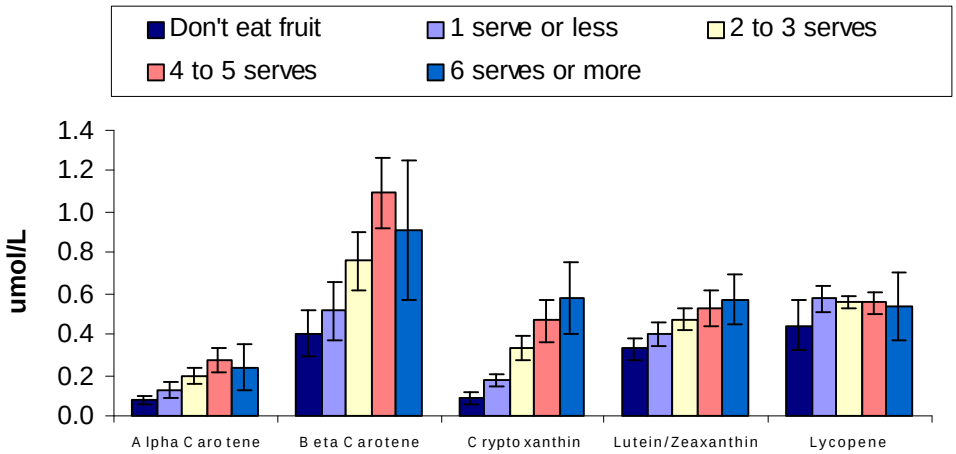
Figures 4.6.10, 4.6.11 and 4.6.12 (and Table 4.6.8 in Appendix B) show mean serum carotenoids, red cell folate and homocysteine levels by reported number of serving of fruit eaten each day.

Figure 4.6.10 shows that:

- all of the carotenoids (except lycopene) increased by increase in reported number of serves of fruit usually consumed
- α-carotene and β-cryptoxanthin levels were significantly lower among those who reported *don't eat fruit* compared with those who reported eating *1 serve or less*, *2 to 3 serves*, *4 to 5 serves*, and *6 serves or more* of fruit each day
- β-carotene and lutein/zeaxanthin levels were significantly lower for those who reported *don't eat fruit* compared with those who reported eating *2 to 3 serves*, *4 to 5 serves, and 6 serves or more* of fruit each day and

- serum lycopene concentration showed no significant difference between those who reported *don't eat fruit* and those who reported eating *1 serve or less, 2 to 3 serves, 4 to 5 serves, and 6 serves or more* of fruit each day.

Figure 4.6.10 Mean Carotenoids by number of serves of fruit usually eaten each day



Figures 4.6.11 and 4.6.12 show that:

- red cell folate was significantly lower for those who reported eating *1 serve of fruit or less* or *don't eat fruit* compared with those who reported eating *6 serves or more* of fruit and
- plasma homocysteine and serum ferritin concentrations were not significantly different for those who *don't eat fruit* compared with those who reported eating *1 serve or less, 2 to 3 serves, 4 to 5 serves, and 6 serves or more* of fruit each day (not shown for serum ferritin).

Figure 4.6.11 Mean Red Cell Folate by number of serves of fruit usually eaten each day

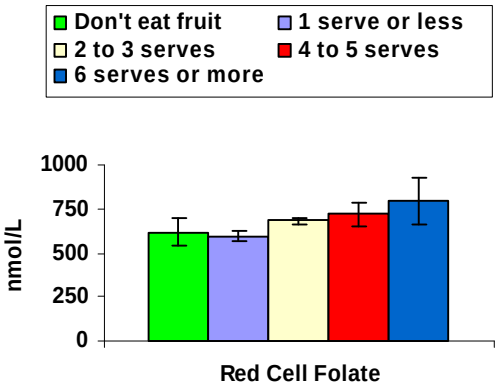
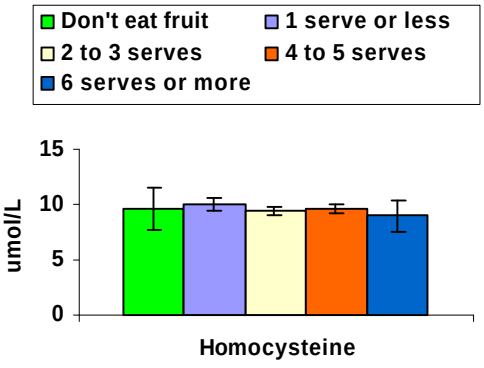


Figure 4.6.12 Mean Homocysteine by number of serves of fruit usually eaten each day



4.6.1.5 How many days a week do you eat take-away or 'fast foods' (such as fish and chips, hamburgers, fried chicken, pizza, sausage rolls, meat pies)?

Table 4.6.9 shows that that more males reported eating take away food three or more times per week than females. More young participants (25 to 34 year olds) than older participants (55-64 years old and 65-74 years old) reported eating take away food three or more times per week. In general, up to 37% of the study participants (all ages) report eating take away foods *1 to 2 times* or *3 or more* times per week.

Table 4.6.9 Percent persons who reported eating take away food (number of times per week) by selected characteristics (weighted to Queensland population)

Characteristics		Number of times per week take away food is eaten							
		3 or more times per week		1 to 2 times per week		Less than once a week		Never eat take away	
	Categories	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**	**Percent**	**SE**
Sex	Male	10.8	1.2	35.2	3.3	43.9	3.5	10.1	1.5
	Female	2.5	0.5	26.3	4.0	56.5	4.5	14.7	2.5
Age group (10yr)	25-34	13.3	2.1	44.3	1.3	40.9	2.5	1.6	0.6
	35-44	6.9	1.5	38.8	3.9	49.0	5.3	5.4	2.1
	45-54	6.9	0.9	28.4	2.7	54.5	3.0	10.2	1.6
	55-64	1.7	1.0	21.8	5.4	62.8	3.6	13.7	3.8
	65-74	0.4	0.4	12.7	2.7	54.4	5.0	32.5	3.6
	75+	0.9	0.9	6.5	2.0	42.5	1.8	50.1	2.3
	All ages	**6.6**	**0.8**	**30.7**	**3.0**	**50.3**	**3.0**	**12.4**	**1.8**
Cholesterol ranges	< 5.5 mmol/L	5.8	1.0	33.6	2.3	48.8	2.8	11.8	1.8
	5.5 < 6.5 mmol/L	7.7	1.0	29.9	5.0	49.9	4.4	12.5	1.9
	≥ 6.5 mmol/L	7.0	1.4	24.0	1.7	55.0	2.6	14.0	2.5
Diabetes Status	Normal	7.5	0.8	34.1	3.3	49.4	3.8	9.0	1.4
	IFG or IGT	3.9	1.6	20.9	2.4	53.4	3.3	21.8	4.4
	Diabetes Mellitus	3.0	1.7	18.1	4.1	50.4	4.0	28.5	4.0

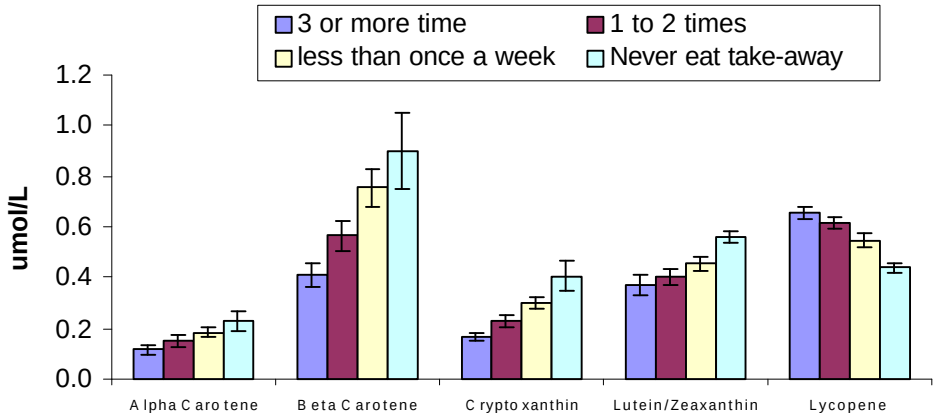
Figures 4.6.13, 4.6.14 and 4.6.15 (and Table 4.6.10 in Appendix B) show mean serum carotenoid, red cell folate and homocysteine levels by reported number of times per week eating take away food was reported.

Figure 4.6.13 shows that:

- in general, all of the carotenoids (except lycopene) increased with decreased reported eating of take away food
- α-carotene level was significantly higher among those who reported *never eat take away* food compared with those who reported eating take away *3 or more times* per week

- β-carotene and β-cryptoxanthin levels were significantly higher among those who reported *never eat take away* compared with those who reported eating take away food *3 or more times* or *1 to 2 times* per week
- lutein/zeaxanthin level was significantly higher among those who reported *never eat take away* compared with those who reported eating take away food *3 or more times, 1 to 2 times, or less than once* per week and
- in contrast, lycopene level was significantly lower among those who reported *never* eating take away food compared with those who reported eating take away foods *3 or more times, 1 to 2 times,* or *less than once* per week.

Figure 4.6.13 Mean Serum Carotenoids by number of times per week eat take-away or fast food



Figures 4.6.14 and Figure 4.6.15 show that:

- red cell folate was significantly higher among those who reported *never eat take away* compared with those who reported eating take away *3 or more times* or *1 to 2 times* per week
- plasma homocysteine was significantly higher among those who reported *never* eat take away food, compared with those who eat take away *less than once* per week and
- no significant difference was observed in serum ferritin concentration among those who reported *never* eat take away compared with those who reported eating take away food *3 or more* times, *1 to 2* times or *less than once* per week (not shown).

Figure 4.6.14 Mean Red Cell Folate by number of times per week eat take-away or fast food

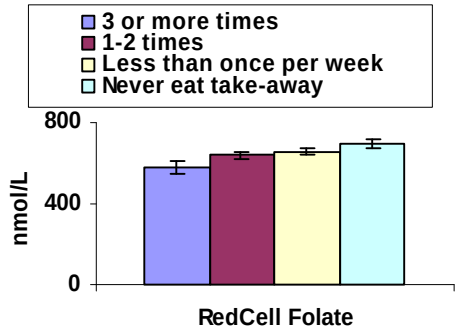
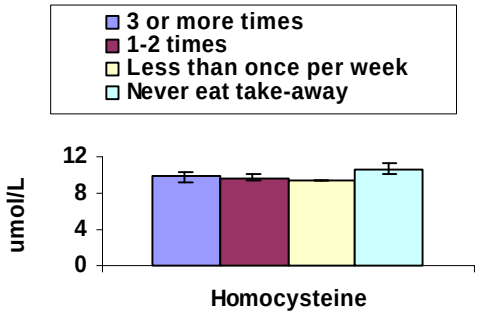


Figure 4.6.15 Mean Homocysteine by number of times per week eat take-away or fast food



4.6.1.6 Did you take any vitamin or mineral supplement yesterday?

Multivitamin, Multivitamin with Iron, Vitamin A, Vitamin B, Vitamin C, Vitamin E, b-Carotene, Calcium, Folic Acid/Folate, Iron, Zinc, Don't take supplements

Approximately 24.2% males and 34.5% females reported taking multivitamin or other vitamins on the previous day (Table 4.6.11). More younger people did not use multivitamin or other vitamin supplements than older people. On the day prior to the examination, approximately 70% of the study participants (all ages) reported using no vitamins/mineral supplements.

Table 4.6.11 Percent Multivitamin or mineral supplement* use by selected characteristics (weighted to Queensland population)

		Multivitamin *		Other vitamins		No vitamin	
Characteristics	**Categories**	**%**	**SE**	**%**	**SE**	**%**	**SE**
Sex	Male	8.1	0.8	15.9	2.1	76.0	2.6
	Female	10.4	1.1	24.2	2.0	65.4	2.9
Age group (10yr)	25-34	10.0	2.7	11.0	4.5	78.9	7.0
	35-44	9.0	1.1	16.9	1.4	74.1	1.3
	45-54	8.5	1.5	22.7	2.2	68.8	2.1
	55-64	11.1	2.1	29.6	2.4	59.3	3.7
	65-74	7.2	1.5	25.6	2.2	67.2	2.8
	75+	9.6	2.1	28.1	2.5	62.3	3.2
	All ages	**9.2**	**0.8**	**20.1**	**1.8**	**70.7**	**2.3**
Cholesterol ranges	< 5.5 mmol/L	11.0	1.1	17.7	2.1	71.3	2.6
	5.5 < than 6.5 mmol/L	8.3	1.1	22.4	1.6	69.4	2.3
	≥ 6.5 mmol/L	6.0	1.2	22.6	3.0	71.4	3.9

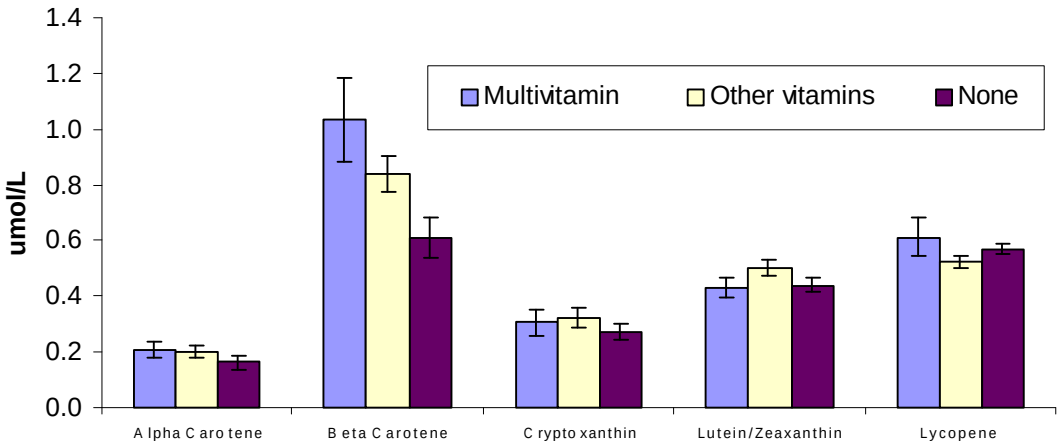
* includes both respondents who indicated 'MULTIVITAMIN' and those who indicated 'MULTIVITAMIN WITH IRON'

Figures 4.6.16, 4.6.17, 4.6.18 and 4.6.19 (and Table 4.6.12 in Appendix B) show nutritional indicator levels by the reported use of multi vitamin supplements on the day prior to the examination.

Figure 4.6.16 shows that:

- α-carotene and β-carotene levels were significantly higher for those who reported taking *multivitamins* and *other vitamins* compared with those who reported taking no vitamin and
- no significant difference in serum β-cryptoxanthin, lutein/zeaxanthin and lycopene levels were observed among those who reported taking *multivitamin* and *other vitamins* compared with those who reported taking no vitamin supplements.

Figure 4.6.16 Mean Serum Carotenoids by vitamin or mineral supplement use



Figures 4.6.17, 4.6.18, and 4.6.19 showed that:

- red cell folate levels were significantly higher among those who reported using *multivitamin* and *other vitamins* compared with those who *did not use* vitamin supplements
- serum ferritin was not significantly different among *multivitamin* and *other vitamin* users compared with those who *did not use* vitamin supplements and
- plasma homocysteine was significantly lower among those who reported using multivitamin supplements compared with those who did not report using multivitamin supplements.

Figure 4.6.17 Mean Red cell Folate by vitamin or mineral supplement use

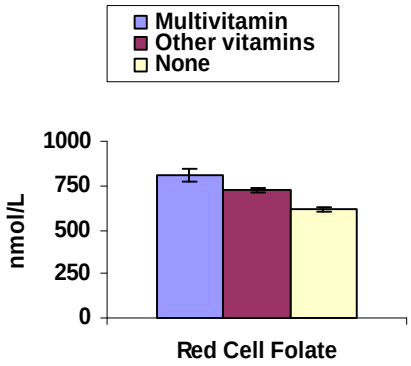


Figure 4.6.18 Mean Serum Ferritin by vitamin or mineral supplement use

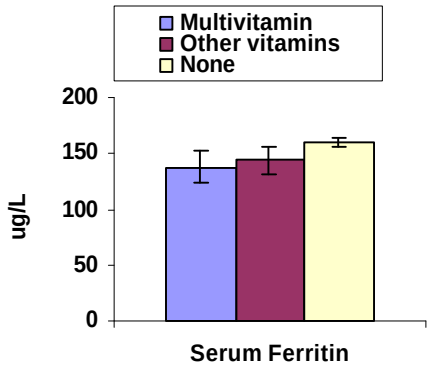
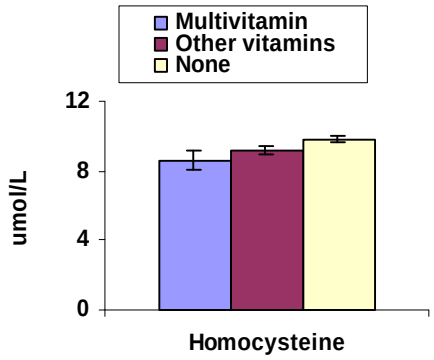


Figure 4.6.19 Mean Homocysteine by vitamin or mineral supplement use



4.6.1.7 When cooking, how often do you or the person who cooks your food, use the following? (Choose any of the following which apply to you)

Tables 4.6.13 to 4.6.19 show frequency with which different types of oil were reported as used for cooking. More study participants reported "*usually*" using olive oil and canola oil than other oils or fats. Few adults reported using animal fats such as lard or dripping in cooking.

Table 4.6.13 Percent of persons who reported using Olive oil, by selected characteristics (weighted to Queensland population)

		Frequency Olive oil is used									
Characteristics	**Categories**	**Never**		**Sometimes**		**Usually**		**Don't know**		**Not stated**	
		%	SE	%	SE	%	SE	%	SE	%	SE
Sex	Male	18.4	2.8	28.5	1.8	46.3	3.0	2.6	0.8	4.2	1.9
	Female	15.0	3.0	29.1	2.4	50.4	2.8	0.1	0.1	5.4	2.2
Age group (10yr)	25-34	13.8	2.4	34.0	5.2	47.4	3.1	2.0	1.3	2.9	1.1
	35-44	14.8	3.5	31.4	0.8	52.0	4.1	1.2	0.6	0.8	0.4
	45-54	17.7	4.7	24.2	1.4	54.3	5.7	0.8	0.4	3.0	1.5
	55-64	14.4	4.0	27.7	4.0	51.2	3.2	0.5	0.4	6.3	2.9
	65-74	18.7	3.0	28.2	4.6	41.2	3.3	1.2	0.8	10.8	3.3
	75+	33.3	9.0	17.6	3.0	25.5	6.0	4.1	3.0	19.5	6.4
	All ages	**16.7**	**2.7**	**28.8**	**2.0**	**48.4**	**2.7**	**1.4**	**0.4**	**4.8**	**1.9**
Cholesterol ranges	< 5.5 mmol/L	15.5	2.8	30.4	2.9	49.7	2.7	0.7	0.3	3.7	1.4
	5.5 to < 6.5 mmol/L	19.6	2.4	27.5	1.9	45.2	2.8	2.2	1.2	5.5	2.2
	≥6.5 mmol/L	14.8	3.2	26.7	0.9	50.2	4.4	1.8	0.9	6.5	2.4

Table 4.6.14 Percentage of persons who reported using Canola oil, by selected characteristics (weighted to Queensland population)

		Frequency Canola Oil is used									
Characteristics	**Categories**	**Never**		**Sometimes**		**Usually**		**Don't know**		**Not stated**	
		%	SE	%	SE	%	SE	%	SE	%	SE
Sex	Male	33.9	4.5	36.1	1.2	19.7	2.2	1.8	0.8	8.4	2.3
	Female	37.4	3.2	30.6	3.2	20.0	1.3	1.0	0.4	11.0	3.6
Age group (10yr)	25-34	35.5	4.3	42.4	3.8	15.7	2.7	0.7	0.7	5.6	1.6
	35-44	44.0	4.2	32.9	2.0	17.5	2.2	1.2	0.5	4.5	1.5
	45-54	34.4	4.7	31.9	2.8	21.5	2.4	1.2	0.4	10.9	3.2
	55-64	30.0	5.5	30.7	1.7	21.6	2.9	2.3	1.2	15.3	5.6
	65-74	30.6	3.8	28.4	4.0	22.5	2.8	1.5	1.2	17.0	5.4
	75+	29.3	9.8	19.1	4.1	31.0	5.3	3.2	0.8	17.3	2.3
	All ages	**35.7**	**3.7**	**33.4**	**2.0**	**19.8**	**1.5**	**1.4**	**0.3**	**9.8**	**2.9**
Cholesterol ranges	< 5.5 mmol/L	38.3	3.9	32.3	2.8	19.7	2.6	1.3	0.5	8.4	2.7
	5.5 to < 6.5 mmol/L	32.9	3.4	34.6	1.2	21.7	1.0	1.0	0.4	9.8	3.1
	≥6.5 mmol/L	33.1	5.5	34.0	2.8	17.2	2.5	2.3	0.8	13.4	3.7

Table 4.6.15 Percent of persons who reported using Vegetable oil, by selected characteristics (weighted to Queensland population)											
		Frequency Vegetable oil is used									
Characteristics	**Categories**	**Never**		**Sometimes**		**Usually**		**Don't know**		**Not stated**	
		%	SE	%	SE	%	SE	%	SE	%	SE
Sex	Male	38.4	4.0	35.3	2.4	13.5	1.8	2.3	0.5	10.5	3.0
	Female	47.0	5.7	30.5	2.9	8.0	1.2	0.6	0.4	14.0	4.3
Age group (10yr)	25-34	44.5	7.9	39.4	4.0	7.2	3.7	1.5	0.8	7.4	2.1
	35-44	46.0	3.4	37.1	2.2	11.9	1.9	1.3	0.7	3.6	1.4
	45-54	40.7	3.9	35.1	4.1	10.8	1.8	1.1	0.7	12.3	3.0
	55-64	37.2	6.7	28.5	4.4	12.7	3.4	0.9	0.9	20.7	6.0
	65-74	41.1	7.4	20.7	4.0	11.9	1.9	1.7	0.9	24.5	7.2
	75+	44.9	4.3	15.5	1.7	12.7	2.8	3.0	1.9	24.0	6.2
	All ages	**42.7**	**4.6**	**32.9**	**2.1**	**10.7**	**1.4**	**1.4**	**0.2**	**12.3**	**3.6**
Cholesterol ranges	< 5.5 mmol/L	44.2	4.3	34.8	2.2	9.4	2.0	1.5	0.4	10.1	2.4
	5.5 to < 6.5 mmol/L	39.6	5.3	32.6	2.1	14.0	3.2	1.3	0.5	12.5	4.0
	≥ 6.5 mmol/L	44.0	6.5	28.1	2.7	8.7	1.2	1.4	0.8	17.8	6.2

Table 4.6.16 Percent of persons who reported using Butter, by selected characteristics (weighted to Queensland population)											
		Frequency Butter is used									
Characteristics	**Categories**	**Never**		**Sometimes**		**Usually**		**Don't know**		**Not stated**	
		%	**SE**	**%**	**SE**	**%**	**SE**	**%**	**SE**	**%**	**SE**
Sex	Male	44.6	4.0	39.7	2.8	4.3	1.0	1.0	0.4	10.4	3.5
	Female	42.9	4.4	40.0	1.9	4.9	1.0	0.4	0.4	11.8	3.5
Age group (10yr)	25-34	41.0	4.0	47.3	2.8	4.2	1.7	0.7	0.7	6.8	1.3
	35-44	45.8	4.1	45.6	2.6	4.8	1.1	0.8	0.6	3.0	1.1
	45-54	45.9	5.6	37.3	4.0	5.1	1.4	-	-	11.7	3.5
	55-64	40.7	5.1	34.9	3.1	5.4	0.8	0.9	0.9	18.1	5.3
	65-74	43.2	5.9	31.7	4.7	3.7	1.1	1.0	0.7	20.4	5.6
	75+	46.6	7.0	22.2	5.3	4.6	2.7	1.0	1.1	25.6	8.1
	All ages	**43.7**	**4.2**	**39.8**	**2.3**	**4.6**	**1.0**	**0.7**	**0.4**	**11.1**	**3.5**
Cholesterol ranges	<5.5mmol/L	44.9	3.7	40.5	1.3	4.3	0.8	0.6	0.4	9.7	3.0
	5.5 to < 6.5 mmol/L	42.7	4.9	39.9	3.1	5.3	1.6	0.6	0.4	11.5	3.3
	≥6.5 mmol/L	42.1	5.5	38.0	3.9	4.4	1.1	1.0	0.6	14.5	4.7

Table 4.6.17 Percent of persons who reported using Margarine, (weighted to Queensland population)

		Frequency Margarine is used									
Characteristics	**Categories**	**Never**		**Sometimes**		**Usually**		**Don't know**		**Not stated**	
		%	SE	%	SE	%	SE	%	SE	%	SE
Sex	Male	42.0	2.0	37.0	2.7	9.6	1.3	0.9	0.3	10.5	3.4
	Female	46.2	3.2	32.2	2.5	9.5	1.5	0.0	0.0	12.1	3.9
Age group (10yr)	25-34	46.0	3.6	38.0	3.1	8.7	2.4			7.3	1.9
	35-44	49.0	2.5	40.0	3.2	5.9	1.1	0.8	0.6	4.2	1.9
	45-54	45.2	4.3	33.0	2.7	9.7	1.7			12.0	3.6
	55-64	37.3	4.7	31.8	5.8	12.0	2.1	1.3	0.9	17.5	6.3
	65-74	38.7	5.8	27.6	4.2	12.1	1.7	0.4	0.4	21.1	6.2
	75+	38.0	4.0	24.1	8.1	16.7	5.9	1.0	1.1	20.2	5.8
	All ages	**44.1**	**2.4**	**34.6**	**2.3**	**9.6**	**0.7**	**0.5**	**0.1**	**11.3**	**3.5**
Cholesterol ranges	< 5.5 mmol/L	46.9	1.9	34.5	1.8	8.5	0.9	0.3	0.2	9.8	2.6
	5.5 < 6.5 mmol/L	41.9	3.1	36.0	3.0	11.1	1.0	0.7	0.4	10.3	3.4
	≥6.5 mmol/L	40.1	2.7	32.3	4.4	10.0	1.9	0.6	0.6	17.0	6.1

Table 4.6.18 Percent of persons who reported using Dairy blend, (weighted to Queensland population)

		Frequency Dairy blend is used									
Characteristics	**Categories**	**Never**		**Sometimes**		**Usually**		**Don't know**		**Not stated**	
		%	SE	%	SE	%	SE	%	SE	%	SE
Sex	Male	74.3	4.3	9.9	2.3	1.8	0.4	2.6	0.8	11.4	3.6
	Female	70.4	5.7	11.9	1.6	2.4	0.6	0.4	0.2	14.9	5.0
Age group (10yr)	25-34	76.1	4.4	13.7	2.9	0.5	0.4	0.9	0.6	8.8	2.6
	35-44	81.0	5.0	10.7	3.9	3.8	0.8	0.8	0.6	3.6	1.7
	45-54	72.4	4.4	10.9	3.6	1.8	0.7	1.1	0.5	13.8	4.0
	55-64	64.3	3.8	9.6	2.6	2.7	0.8	2.4	1.1	21.0	6.8
	65-74	60.0	7.5	10.7	1.9	3.0	1.3	2.3	1.3	24.0	7.0
	75+	63.5	7.9	3.3	1.3	0.4	0.4	3.9	1.4	28.9	8.8
	All ages	**72.3**	**5.0**	**10.9**	**1.7**	**2.1**	**0.4**	**1.5**	**0.5**	**13.2**	**4.2**
Cholesterol ranges	< 5.5 mmol/L	75.5	4.1	10.5	1.7	1.8	0.6	1.1	0.5	11.0	3.1
	5.5 to <6.5 mmol/L	70.6	4.7	11.4	2.4	2.8	0.9	1.8	0.9	13.4	4.5
	≥6.5 mmol/L	66.6	7.9	11.0	2.6	1.8	0.6	1.9	1.0	18.7	6.5

Table 5.6.19 Percent of persons who reported using Lard or dripping, by selected characteristics (weighted to Queensland population)											
		Frequency of Lard or dripping used									
Characteristics	**Categories**	**Never**		**Sometimes**		**Usually**		**Don't know**		**Not stated**	
		%	SE	%	SE	%	SE	%	SE	%	SE
Sex	Male	82.8	3.2	4.8	1.2	0.2	0.2	0.8	0.3	11.4	3.6
	Female	81.2	5.2	2.6	0.8	0.9	0.5	0.0	0.0	15.3	5.3
Age group (10yr)	25-34	85.0	2.4	5.0	1.2	1.1	0.7	0.5	0.4	8.4	2.5
	35-44	93.1	2.9	2.3	0.9	0.3	0.3	0.5	0.4	3.8	1.7
	45-54	78.5	4.6	6.0	0.6	1.0	0.7			14.5	4.1
	55-64	77.1	6.1	1.9	1.1	-	-	0.5	0.5	20.6	6.8
	65-74	71.8	6.0	3.0	1.8	-	-	0.6	0.6	24.6	7.3
	75+	68.2	9.1	0.6	0.7	-	-	1.0	1.1	30.3	9.7
	All ages	**82.0**	**4.0**	**3.6**	**0.4**	**0.6**	**0.3**	**0.4**	**0.2**	**13.4**	**4.3**
Cholesterol ranges	< 5.5 mmol/L	84.9	3.1	2.8	0.7	0.5	0.3	0.3	0.2	11.6	3.5
	5.5 to < 6.5 mmol/L	81.4	4.1	4.7	1.0	0.8	0.6	0.2	0.2	13.0	4.4
	≥6.5 mmol/L	75.2	6.0	4.2	1.0	0.3	0.4	1.3	0.9	19.0	6.6

No significant differences in cholesterol levels were observed between groups of participants who reported using different types of fats.

4.6.1.8 Conclusion

The present report provides an overview of data related to nutritional status indictors collected as part of a population-based diabetes and cardiovascular disease risk factor study (AusDiab). These data provide opportunities to explore a wide range of relationships between biochemical, anthropometric and dietary/nutrient intake variables and diabetes status and cardiovascular disease risk factors. The data were collected from over 1600 adults in urban centres in Queensland and although there was a disappointingly low response rate in the study (30%), the data were carefully collected and of research quality. Thus, determination of associations between these nutritional status indicators and risk factors for diabetes and cardiovascular disease will be of value to medical practitioners, nutritionists, and public health policy makers.

Interested researchers are encouraged and invited to access these data sets and further explore such relationships and publish results in peer-reviewed journals.

5.0 References

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7.0 Appendix A

Definitions of some variables used in the tables

Educational status:

Educational status is determined from questions 6 and 7 of the General Questionnaire. Three levels of educational status were defined:

Secondary or less: did not complete secondary school, or since leaving secondary school, have not completed a trade certificate, degree or any other educational qualifications

Trade certificate or bachelors degree: possess nursing and teaching qualifications, trades and technicians certificate, associate diploma undergraduate diploma or bachelors degree

Post graduate qualification: possess post-graduate diploma, masters or doctorate degrees.

Smoking status:

This is derived from questions 40-45 of the General Questionnaire. Three categories of smoking were defined:

Current smoker: smoke at least daily, at least weekly, or less often than weekly

Ex-smoker: less than daily for at least the last three months, but used to smoke daily

Never-smoker: smoked < 100 cigarettes over lifetime.

Physical activity intensity:

This is based on questions 51, 57 & 59 from the General Questionnaire. Number of times subjects did vigorous activity is from Q57. Total times active is calculated by adding questions 51, 57 (weighted by 2) & 59. Four levels of physical activity were defined:

Vigorously active: vigorous activity at least 3 times in past week

Moderately active: vigorous activity less than 3 times and total times active at least 5 times in past week

Lightly active: vigorous activity less than 3 times and greater than 0 but < 5 times in past week

None: vigorous activity and total times active both nil.

Physical activity beneficial to health:

This is based on questions 51, 52 & 57-60 from the general questionnaire. Three levels of physical activity beneficial to health were defined:

Sufficiently active: greater than 150 minutes 'physical activity time' in the previous week

Insufficient but not sedentary: less than 150 minutes 'physical activity time' in the previous week

Sedentary: No participation in physical activity in the previous week.

Physical activity time was calculated as the total time spent participating in physical activity in the previous week using the sum of walking, moderate activity plus double the time spent in vigorous activity (to reflect its greater intensity).

Questions based on household chores, gardening etc. were not used, as these questions are simply included to eliminate these activities from the total time spent performing physical activity.

Weight status:

Body mass index (BMI) is [weight (kg)/height $(m)^2$]. BMI is categorised into the following groups:

Obese: BMI ≥ 30

Overweight: BMI ≥ 25 to < 30

Normal: BMI ≥ 20 to < 25

Underweight: BMI < 20

In order to compare the prevalence of overweight and obesity with other Queensland studies, this study used the above BMI cut off points (Harvey and Hutchins[76]). Researchers should be aware that the World Health Organisation (WHO)[78] defined underweight as BMI < 18.5.

Vitamin/mineral supplements use during previous 24 hrs:

A question on vitamin or mineral intake was taken from the Queensland–specific Additional Dietary Questionnaire: *Did you take any vitamin or mineral supplement(s) yesterday (in tablet, capsule or drop form)?.* Respondents who indicated they took any vitamin or mineral supplements on the previous day counted as *yes*, while those who did not indicate any vitamin or mineral supplement use were counted as *no*.

Diabetes Status:

Diabetes status was a derived variable based on venous plasma glucose concentration classifications outlined in the "Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications; Part 1: Diagnosis and Classification of Diabetes Mellitus. Geneva: Department of Non-communicable Disease Surveillance, WHO 1999"

The definitions for diabetes status are as follows:

Those with known diabetes

- are participants who are receiving current treatment in the form of insulin or tablets (or both) or who have been told they have diabetes, plus
- those who are diet controlled AND have either fasting glucose ≥7.0 mmol/L **OR** 2hr post glucose ≥ 11.1 mmol/L.

Newly diagnosed with diabetes

- are classified as anyone who say they have never been told they have diabetes but have fasting glucose ≥7.0 mmol/L **OR** 2hr post glucose ≥ 11.1 mmol/L .

Impaired Glucose Tolerance (IGT)

- is defined as fasting plasma glucose <7.0mmol/L **AND** 2hr post glucose load between 7.8 and 11.0 mmol/L

Impaired Fasting Glycaemia (IFG)

- is defined as fasting plasma glucose between 6.1 and 6.9 mmol/L **AND** 2hr post glucose load <7.8mmol/L

Normal blood glucose status

- those who have fasting plasma glucose < 6.1 **AND** 2hr post plasma glucose <7.8mmol/L are classified as normal.

8.0 Appendix B

Table 4.6.2 Mean levels of nutritional indicators and standard error (SE) by type of milk* usually consumed (weighted to Queensland population)

Nutritional Indicator	Type of milk usually consumed									
	Whole or full cream		Low or reduced fat		Skim Milk		Soy milk		Don't drink milk	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
α-carotene μmol/L	0.14	0.02	0.19	0.03	0.18	0.02	0.27	0.04	0.14	0.03
β-carotene μmol/L	0.61	0.09	0.77	0.08	0.67	0.06	0.99	0.10	0.53	0.13
β-cryptoxanthin μmol/L	0.25	0.03	0.32	0.02	0.29	0.03	0.35	0.02	0.28	0.08
Lutein/Zeaxanthin μmol/L	0.42	0.02	0.46	0.04	0.45	0.03	0.57	0.05	0.46	0.05
Lycopene μmol/L	0.57	0.02	0.56	0.03	0.56	0.04	0.61	0.04	0.43	0.06
Homocysteine μmol/L	10.0	0.3	9.3	0.1	9.1	0.3	9.1	0.4	12.6	0.8
Serum Ferritin	161	9	159	9	148	12	126	12	151	18
Red Cell Folate nmol/L	603	17	668	15	714	19	772	36	609	54

* Participants were instructed to report ONE type of milk only.

Table 4.6.4 Mean levels of nutritional indicators and Standard Error (SE) by frequency meat is trimmed of fat (either before or after cooking), (weighted to Queensland population)

Nutritional Indicator	Frequency with which meat is trimmed of fat							
	Never/rarely		Sometimes		Usually		Don't eat meat	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
α-carotene μmol/L	0.13	0.03	0.16	0.03	0.18	0.02	0.27	0.07
β-carotene μmol/L	0.52	0.10	0.60	0.08	0.72	0.08	1.15	0.20
β-cryptoxanthin μmol/L	0.25	0.04	0.26	0.04	0.29	0.03	0.37	0.03
Lutein/Zeaxanthin μmol/L	0.41	0.03	0.42	0.03	0.46	0.03	0.54	0.06
Lycopene μmol/L	0.50	0.06	0.56	0.06	0.57	0.02	0.60	0.06
Homocysteine μmol/L	9.9	0.2	10.0	0.3	9.6	0.1	10.2	0.5
Serum Ferritinμg/L	151	9	179	16	153	8	77	8
Red Cell Folate nmol/ L	593	22	597	19	668	13	709	26

Table 4.6.6 Mean nutritional indicators and Standard Error (SE) by number of serves of vegetables usually eaten per day (weighted to Qld population)

	Number of serves of vegetables usually eaten each day									
Nutritional indicators	**1 serve or less**		**2 to 3 serves**		**4 to 5 serves**		**6 serves or more**		**Don't eat vegetables**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
α-carotene µmol/L	0.10	0.01	0.17	0.02	0.21	0.03	0.30	0.06	0.06	0.00
β-carotene µmol/L	0.49	0.03	0.66	0.07	0.83	0.12	1.27	0.19	0.58	0.01
β-cryptoxanthin µmol/L	0.22	0.02	0.27	0.02	0.32	0.04	0.50	0.02	0.15	0.02
Lutein/Zeaxanthin µmol/L	0.39	0.03	0.43	0.03	0.51	0.03	0.64	0.09	0.23	0.05
Lycopene µmol/L	0.54	0.05	0.59	0.02	0.52	0.04	0.52	0.03	0.75	0.44
Homocysteine µmol/L	10.0	0.2	9.8	0.2	9.3	0.3	9.4	0.5	12.5	1.0
Serum Ferritin µg/L	151	6	159	6	155	8	112	11	175	62
Red Cell Folate nmol/L	595	13	647	14	680	25	812	76	648	27

Table 4.6.8 Mean nutritional indicators and Standard Error (SE) by number of serves of fruit usually eaten each day (weighted to Qld population)

	Number of serves of fruit usually eaten each day									
Nutritional indicators	**1 serve or less**		**2 to 3 serves**		**4 to 5 serves**		**6 serves or more**		**Don't eat fruit**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
α-carotene µmol/L	0.13	0.02	0.19	0.02	0.27	0.03	0.24	0.06	0.08	0.01
β-carotene µmol/L	0.52	0.07	0.76	0.07	1.09	0.08	0.91	0.17	0.40	0.06
β-cryptoxanthin µmol/L	0.17	0.01	0.33	0.03	0.47	0.05	0.58	0.09	0.09	0.02
Lutein/Zeaxanthin µmol/L	0.40	0.03	0.47	0.03	0.53	0.04	0.57	0.06	0.33	0.03
Lycopene µmol/L	0.57	0.03	0.56	0.02	0.55	0.03	0.54	0.08	0.45	0.06
Homocysteine µmol/L	10.0	0.3	9.4	0.2	9.6	0.2	9.0	0.8	9.6	0.9
Serum Ferritinµg/L	161	8	154	6	151	5	144	20	148	17
Red Cell Folate nmol/L	596	13	681	10	718	33	794	65	618	39

Table 4.6.10 Mean nutritional indicators and Standard Error (SE) by number of times per week take-away or fast food eaten (weighted to Queensland population)

	Number of times per week take away food eaten							
Nutritional indicators	**3 or more times per week**		**1 to 2 times per week**		**Less than once a week**		**Never eat take away**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
α-carotene μmol/L	0.12	0.02	0.15	0.02	0.18	0.02	0.23	0.04
β-carotene μmol/L	0.41	0.05	0.57	0.06	0.75	0.08	0.90	0.15
β-cryptoxanthin μmol/L	0.17	0.02	0.23	0.02	0.30	0.03	0.41	0.06
Lutein/Zeaxanthin μmol/L	0.37	0.04	0.41	0.03	0.46	0.02	0.56	0.02
Lycopene μmol/L	0.66	0.02	0.61	0.03	0.54	0.03	0.44	0.02
Homocysteine μmol/L	9.9	0.6	9.7	0.3	9.4	0.1	10.7	0.6
Serum Ferritin μg/L	192	9	154	9	150	5	163	12
Red Cell Folate nmol/L	583	32	638	17	656	14	698	21

Table 4.6.12 Mean nutritional indicators and Standard Error (SE) by vitamin or mineral supplements use (weighted to Queensland population)

	Multivitamin (a)		**Other Vitamins**		**No Vitamin**	
Nutritional indicators	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
α-carotene μmol/L	0.21	0.03	0.20	0.02	0.16	0.02
β-carotene μmol/L	1.03	0.15	0.84	0.07	0.61	0.07
β-crypto-xanthin μmol/L	0.31	0.05	0.32	0.04	0.27	0.03
Lutein/Zeaxanthin μmol/L	0.43	0.04	0.50	0.03	0.44	0.03
Lycopene μmol/L	0.61	0.07	0.52	0.02	0.57	0.02
Homocysteine μmol/L	8.6	0.5	9.2	0.2	9.9	0.2
Serum Ferritin μg/L	138	14	144	12	160	4
Red Cell Folate nmol/L	805	38	722	15	613	12

(a): includes both respondents who indicated 'MULTIVITAMIN" and those who indicated "MULTIVITAMIN WITH IRON"