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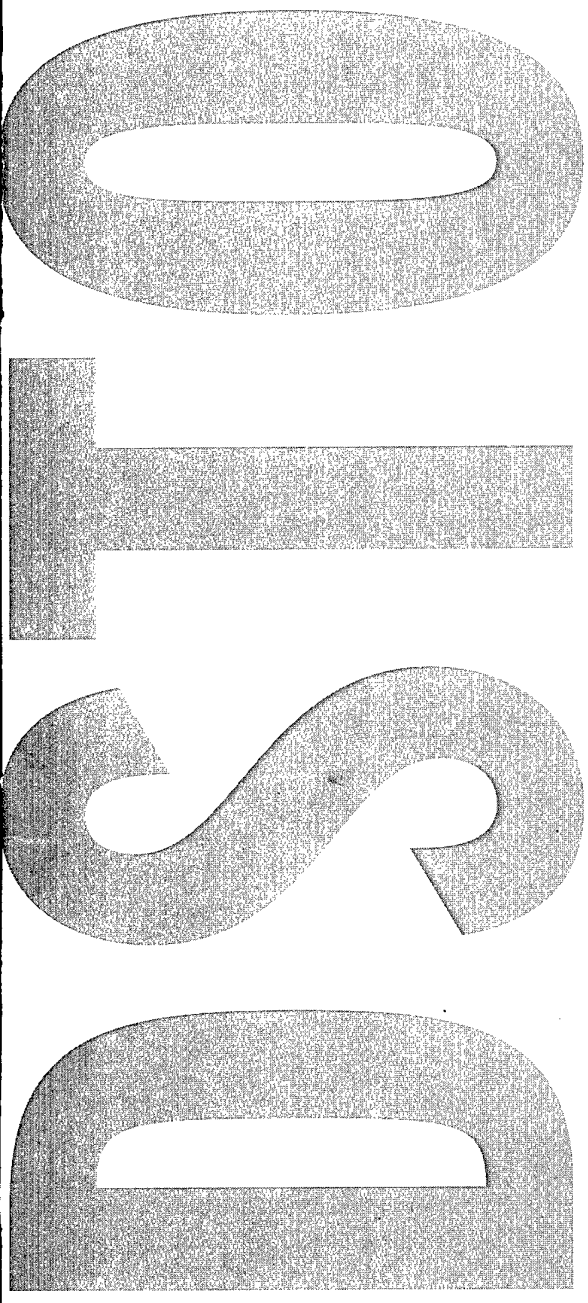

Army Recruit Health and Diet Survey

Christine Booth and Ross Coad

DSTO-RR-0215

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Combatant Protection and Nutrition Branch
Aeronautical and Maritime Research Laboratory

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ABSTRACT

During 1998, 200 Army recruits took part in a health and diet survey. Most (90%) were Regular Army recruits and recent high school graduates, the remainder being Army Reservists. Fourteen percent of recruits were female. Recruits completed a questionnaire, had their weight and height recorded and donated a fasting blood sample for measurement of cholesterol, fasting triglycerides, apolipoprotein B, ferritin, homocysteine and vitamins. The group comprised of apparently healthy young adults, mostly in the ideal body weight range, with a high rate of participation in organised sports and a high rate of smoking (26%). The dietary intake by these recruits, which was similar to that of other young adults in the general Australian population, was too high in fat and unbalanced with respect to the recommended core food groups. Recruits were at risk of eating insufficient calcium, magnesium and zinc. Female recruits were at risk of eating insufficient iron. Biochemistry results revealed a significant prevalence of folate, thiamin and riboflavin deficiency for males and females and iron deficiency amongst the females. Up to half of the recruits had at least one risk factor for cardiovascular disease, namely elevated cholesterol, triglycerides, apolipoprotein B or homocysteine concentration. Nutrition education should be targeted at lowering the prevalence of cardiovascular risk factors amongst Army personnel and addressing the special dietary needs of female personnel.

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Army Recruit Health and Diet Survey

Executive Summary

During the period, March - May 1998 Army recruits arriving at 1 Recruit Training Battalion (RTB) were invited to take part in a health and diet survey. Approximately 200 recruits took part in the survey during their first day at the Kapooka Army Base. The majority (90%) were Regular Army recruits and recent high school graduates, the remainder being Army Reservists. Fourteen percent of recruits were female. Participating recruits completed a health and diet questionnaire, had their weight and height recorded and donated a fasting blood sample for measurement of cholesterol, fasting triglycerides, apolipoprotein B, homocysteine, ferritin and vitamins (total antioxidant capacity, folate, thiamin, riboflavin and vitamin B6).

The group comprised of apparently healthy young adults, mostly in the ideal body weight range, with a high rate of smoking (26%) and high participation in organised sports. The dietary intake by recruits prior to commencement of training was similar to that of other young adults in the general Australian population. The average diet of the group was too high in fat and unbalanced with respect to the recommended core food groups. Male and female recruits were at risk of eating insufficient calcium, magnesium and zinc and female recruits were at risk of eating insufficient iron. Biochemistry results revealed a significant prevalence of folate, thiamin and riboflavin deficiency for males and females and iron deficiency amongst the females. Up to half of the recruits had at least one risk factor for cardiovascular disease, namely elevated cholesterol, triglycerides, apolipoprotein B or homocysteine concentration.

The authors recommend that nutrition education be targeted at lowering the prevalence of cardiovascular risk factors amongst Army personnel and addressing the special dietary needs of female personnel. Education strategies need to build an awareness of the association between lifestyle factors and increased risk of cardiovascular disease as well as improving the eating habits of personnel.

The authors further recommend that a uniform through-career approach to nutrition education should be adopted at Policy level and that such a program should be routinely monitored by use of surveys such as that reported here.

AUTHORS

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Christine graduated from the University of Queensland (UQ) with BSc(Hons) and PhD (1992) in biochemistry (enzymology - cofactors and vitamins). She has also obtained qualifications in education (Dip Ed, UQ) and dietetics (Grad Dip Nutr Diet, QUT). She is a member of the Australasian Association of Clinical Biochemists, American Association of Clinical Chemists, Dietitians' Association of Australia, Nutrition Society of Australia (Secretary Tas branch), the Australian Institute of Food Science and Technology and Tasmania's Food Advisory Council. Christine has held research positions within UQ and QUT and a supervising scientist position within Chemical Pathology at Royal Brisbane Hospital. In her four-years employment as senior chemist at the Defence Nutrition Research Centre Christine has been investigating the nutritional status of soldiers and the effects of long-term combat rationing on health and military performance.

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Ross has been employed at the Defence Nutrition Research Centre (DNRC) since 1988, working in the fields of chemistry, food technology, microbiology and nutrition. He has a BAppSc (University of Tasmania) in Chemistry and Geography, and an AssocDip in Laboratory Technology (Riverina-Murray Institute of Higher Education). He is a Member of the Royal Australian Chemical Institute and a Member of the Nutrition Society of Australia. Ross is currently supervisor of DNRC's chemistry/biochemistry/nutrition laboratory.

Contents

1. Introduction

Food consumption data are important for the planning and evaluation of food policy, including nutrition education programs. Poor nutritional status has a negative impact upon operational readiness.

The present study focused on determining the adequacy of the dietary intake of Army recruits prior to commencing their training with a view to highlighting any problem areas which may become the basis for future nutrition intervention programs. A food frequency method was chosen to determine the usual intake of foods by recruits and biochemical measures were chosen to determine their micronutrient status and heart disease risk.

Studies conducted in Australian Army and Navy messes by the Defence Nutrition Research Centre (DNRC) during the 1980's indicated that ADF personnel were eating sufficient micronutrients (vitamins and minerals) but were eating excessive salt and fat. Problems identified at the time included a low rate of attendance at messes, provision of food from commercial fast-food outlets and over consumption of food by sedentary and active ADF members [1,2,3].

One decade on, Forbes-Ewan evaluated the nutritional needs of recruits and existing dietary practices at the Army Recruit Training Centre, and recommended changes which included altering the layout of the mess, provision of low-fat menu alternatives and revising the timings of reserve and PT periods [4]. Other nutrition initiatives in which DNRC has been involved, include design of new Ration Scales for Army and a publication, "Nutrition: A Commanders Guide" [5]. The effectiveness of these nutrition initiatives has not since been evaluated.

The US military is sufficiently concerned about modifiable cardiovascular (CV) risk factors amongst active-duty service personnel to have implemented nutrition and health promotion initiatives during the 1980's [6,7]. To measure the effectiveness of these initiatives the US military established a nutrition assessment program, which includes surveys of fixed dining facilities and records the foods available and actual consumption by personnel [8]. Data from recent military institutional feeding studies have shown the benefits of changes implemented in service messes. Service personnel eating in messes are more likely to eat the recommended servings of fruit and vegetables than the general US population [9] and over the past decade have reduced their fat intake and lowered their serum cholesterol [8]. Evaluation of US Navy health promotion efforts in two longitudinal cohort studies of life-style factors, an eight year study (n=640) and an eleven year study (n=1576), demonstrated significant positive effect on fitness and health behaviours [10]. However, the authors comment that further efforts are needed to improve the consumption of certain fruits and vegetables [9] and to further lower CV risk factors [8].

Authors of the Prospective Army Coronary Calcium Study [11] and the Air Force/Texas Coronary Atherosclerosis Prevention Study [12] believe that military populations with apparently average lipid profiles can benefit from primary-

prevention lipid modification. Gotto [13] suggests that the under treatment of dyslipidaemia continues to be a problem and Farrace et al [14] points out that in the (US) Air Force community, cardiovascular pathology had been reported as the primary reason for grounding pilots. A survey of 1268 Finnish service personnel found a 10% prevalence of the metabolic syndrome (a cluster of central obesity, hypertension, dyslipidaemia and hyperinsulinaemia), which was six fold higher amongst cigarette smokers compared with non-smokers [15]. These reports emphasise the need for continuous monitoring of service personnel lifestyle factors and ongoing effort to effect change. Furthermore Lauder et al in 1999 [16,17] and McNulty in 1997 [18,19] identified a significant rate of disordered eating amongst (US) service personnel brought about by "many reported military and professional factors"[17]. Up to 30% of service personnel may be at risk of poor nutrition as a result of disordered eating.

Because there is little information about the nutritional status and prevalence of CV risk factors amongst healthy young ADF personnel, it may be a comforting misconception to believe that all is well. Therefore this present study was thought timely.

2. Methods and Materials

2.1 Subjects

During the period, March - May 1998 Army recruits arriving at 1st Recruit Training Battalion (1 RTB, now ARTC) were invited to take part in a health and diet survey. Approximately 200 recruits took part in the survey during their first day at the Kapooka Army Base. Most recruits (90%) were school leavers aged between 17 and 25 years (range 17 to 36 years). Three recruits were university graduates and 13 had graduated from a college of higher education. Participating recruits completed a health and diet questionnaire, had their weight and height recorded and donated a fasting blood sample for measurement of cholesterol and vitamins. The final data set included 184 recruits (159 males and 25 females). The experimental procedures were approved by the Australian Defence Medical Ethics Committee (ADMEC protocol 133/97). Written consent was obtained from each participant after the details of the study were explained to him or her. Copies of the information and consent forms are included in Appendix A.

2.2 Reference Group

Data collected from a previous survey of blood donors was used to assess the nutritional status of the recruits [20]. The survey population included first-time blood donors attending the Brisbane Street Centre of the Red Cross Blood Transfusion Service during 1995. The population consisted of adults aged 17 to 65 years (n=1776). For the present analysis, data collected from subjects aged 17 to 30 years (n=879, 491 females, 388 males, average age 23.1, SD 3.8) were selected. During the same year (1995), a smaller group was selected from staff and students of the Royal Brisbane Hospital and

Queensland University of Technology for determination of normal reference intervals (138 adults aged 20 - 68 years, average age 39, 76 female, 62 males). Subjects accepted into the reference group had no adverse medical history, had an acceptable weight-for-height [21] and were assessed by a dietitian to have a healthy diet. Subjects were non-smokers and took neither nutritional supplements nor medications within two weeks of blood donation. Furthermore, reference subjects were social drinkers only, and did not drink alcohol within 48 hours of blood donation. All reference subjects had a normal biochemistry profile (iron studies, lipid profile, electrolytes and liver-function tests).

2.3 Health and diet questionnaire

A copy of the questionnaire is included in Appendix B. The questionnaire consisted of 15 demographic and medical questions and a 152-food semi-quantitative food frequency questionnaire (FFQ). The FFQ had been validated against a three day food diary [22].

2.4 Biochemical analysis

Vitamin B6 (pyridoxal 5'-phosphate) and riboflavin status were assessed by use of a functional enzyme method [23]. Vitamin B6 acts as a coenzyme for the enzyme erythrocyte aspartate transaminase (EAST). The activity of this enzyme is increased by the *in vitro* addition of vitamin B6. The EAST activity coefficient (EASTAC), expressed as a percentage, was calculated as the stimulated activity minus the unstimulated activity divided by the unstimulated activity times 100. In a similar fashion, the erythrocyte glutathione reductase activity coefficient (EGRAC), which was used as a measure of riboflavin status, was calculated by measuring the enzyme activity before and after in vitro addition of its coenzyme, flavin adenine dinucleotide. Red blood cell thiamin was measured by microbiological assay using the chloramphenicol-resistant strains of bacteria, *Lactobacillus fermentum* [24]. The assay is based on the nutritional need of *L. fermentum* for thiamin. Total plasma homocysteine was defined as the sum of all homocysteine species in plasma, including homocysteine, homocystine, mixed disulfides, and protein-bound forms. All these forms were converted to homocysteine by reduction with sodium borohydride then measurement by High Performance Liquid Chromatography with fluorescence detection according to the method of Allena et al [25]. Plasma lipids (cholesterol and triglycerides) were measured by enzymatic assays [26, 27] and an automated chemistry analyser (Roche Cobas Bio) with manufacturer-supplied reagents. High density lipoprotein (HDL) cholesterol was measured by the same technique following precipitation of low-density lipoprotein (LDL) and very low-density lipoprotein with polyethylene glycol. Ferritin and apolipoprotein B were measured by particle-enhanced nephelometric assay (Behring BNA) using manufacturer-supplied reagents [28, 29]. Total antioxidant capacity (TAOC) was measured by incubation of plasma with 2,2'-azino-di-[3-ethylbenzthiazoline sulfonate] (ABTS®) in the presence of a peroxidase and hydrogen peroxide to produce the radical cation ABTS®$^{+}$. This colorimetric assay used reagents supplied by Randox Laboratories, UK.

Quality control material (normal level) was prepared in one batch by separating the RBCs from the blood of a single donor (supplied by the Red Cross Blood Transfusion Service, Launceston, Tasmania). Aliquots of the packed cells and plasma were stored at -80°C. Quality control material and standards for the automated methods were supplied by the manufacturers (Roche and Dade Behring). Homocysteine reference material was supplied by the European Research Network for evaluation and improvement of screening, Diagnosis and treatment of Inherited Disorders of Metabolism (ERNDIM) Foundation (Maastricht, Netherlands). Shewart mean and range plots were used for quality control [30]. Control limits were calculated from data obtained after five batch analyses of the control material and were determined to provide an acceptable precision (probability of false rejection of 0.01). The laboratory participated in two external quality assurance schemes, the ERNDIM special assays (homocysteine) program and the RCPA-AACB Chemical Pathology QAP special lipids program.

Subjects fasted overnight. The next morning before breakfast, a venous blood sample was drawn into a 10 mL tube containing lithium heparin, a 10 mL plain tube containing clotting activator and a serum separator and a 5 mL tube containing sodium EDTA. Samples were immediately placed into a 4°C fridge. Within one hour of collection, the plasma and buffy coat were removed and the RBCs were washed twice with isotonic saline solution. The separated RBCs and plasma were then transported frozen to the laboratory. Aliquots of RBCs were diluted in sodium acetate buffer (0.2 mol/L), pH 5.0 for thiamin analysis. The remaining cells were haemolysed by five fold dilution into 0.2% (vol:vol) Triton X-100 and the cell debris was removed by centrifugation (1500 X g for 10 min at 4°C). Supernatants, stored at -80°C, were used later for EASTAC and EGRAC assays. Plasma and serum samples were stored at -80°C.

2.4.1 Biochemical at risk groups:

Subjects were scored for CV risk factors (cholesterol + LDL-cholesterol + HDL-cholesterol + apolipoprotein B + triglycerides + homocysteine) according to clinical cut-off values (Table 1). The possible CV risk score ranged from 0 to 18. Subjects were also scored for vitamin (red cell thiamin + EASTAC + EGRAC, score range 0 - 3). In each case a high score signifies a higher risk.

2.5 Dietary intake data analysis

Nutrient intake was calculated using the DIET/1 NUTRIENT calculation software (Xyris Software, Brisbane, Australia), which used the NUTTAB 92 database, a database of Australian foods. This database does not include values for folates, vitamin B6 or vitamin E.

Goldberg et al [31] reported that a ratio of energy intake (EI) to Basal Metabolic Rate (BMR) of 1.10 represents the lower 95% confidence limit for a plausible level of energy intake in relation to BMR when derived from a seven day food record for an individual. Individuals reporting energy intakes less than 1.10 of calculated BMR [32]

and individuals who had completed the FFQ incorrectly were excluded from dietary data analyses. The final sample size for dietary analyses was 107 (91 males, 16 females). Such a high exclusion rate casts doubt on the quality of the data used in the following analyses and so caution must be used in their interpretation (see Discussion, p 16).

2.5.1 Dietary at risk groups:

Food risk was calculated by comparing each individual's intake of the major food groups against the "Core Food Groups " of the National Health and Medical Research Council (NHMRC)[33] Based on their average number of food serves in each of the core food groups each person was rated either "0" for meeting the core food group recommended serves or "1" for being outside the recommendation (fruit + vegetables + dairy products + meat + cereal products, score range 0 - 5). In a similar fashion vitamin intake risk scores (vitamin C + riboflavin + thiamin + niacin + vitamin A, range 0 - 5) and mineral intake risk scores (calcium + magnesium + iron + zinc, range 0 – 4) were calculated using Recommended Dietary Intake (RDI) cut-offs [34]. For binomial regression analysis, food risk scores were divided into groups 0 – 2 and 3 – 5 and other risk scores were divided into 0 and > 0.

Table 1 *Calculation of risk factors using biochemical measurements*[a]

	Risk = 0	Risk = 1	Risk = 2	Risk = 3
Total Antioxidant Capacity (mmol/L) [35]	≥1.60	<1.6		
Total Cholesterol (mmol/L)	≤5.2	5.3 - 6.3	6.3 - 8.4	>8.4
Triglycerides (mmol/L) [36]	≤1.80	1.8 - 2.6	2.7 - 4.1	>4.1
HDL-Cholesterol (mmol/L)	≥0.9	0.6- 0.9	0.4- 0.59	<0.4
LDL-Cholesterol (mmol/L)	≤3.50	3.6- 4.3	4.30- 6.00	>6.00
Apolipoprotein B (g/L)	≤1.30	1.31-1.60	1.61-2.00	>2.00
Ferritin (g/L) [37]	>15.0	10-15	<10	
Total Homocysteine (μmol/L) [38]	<10.0	10-20	21-30	>30
Red Cell Thiamin (nmol/L) [24]	≥190	<190		
Erythrocyte Glutathione Reductase Activity Coefficient (%) [39]	≤40	>40		
Erythrocyte Aspartate Transaminase Activity Coefficient (%) [23]	≤120	>120		

[a] *Cut-off values for lipids provided by the Royal Brisbane Hospital, Chemical Pathology Laboratory, Brisbane. Values based on increased risk for heart disease. References for other cut-off values are indicated in parentheses.*

2.6 Statistical analysis

Statistical analyses were performed with SPSS (Statistical Package for the Social Sciences, version 9.0, 1999, SPSS, Inc., Chicago, IL). Descriptive statistics, including means, medians, standard deviations, 2.5th and 97.5th percentiles were used to compare dietary intake with the RDI [34] and the National Nutrition Survey [40] and to compare biochemical measurements with clinical cut-offs.

Data were checked for outliers and non-homogeneity of the population by use of pair wise scatter plots, box plots and Q-Q plots. Where required, data were transformed (natural log) to normalise the distributions. Significance was accepted at $p < 0.05$ and in regression analyses an r^2 value ≥ 0.25 with $p < 0.05$. Multiple linear and binomial logistic regression analyses were used to assess associations between variables.

Comparison of means was achieved by use of the independent t test and Levene's test for equality of variances. Differences between frequency distributions were tested using the non-parametric Kolmogorov Smirnov test.

The distribution of nutrient intakes below the RDI was determined, and combined with probability statistics to calculate the number of subjects likely to have reported intakes below their individual requirements. This approach recognises that the RDI overestimates nutrient requirements of almost all individuals in the population [41].

2.6.1 Identifying dietary factors

The aim was to reduce the amount of information by removing duplication represented by correlations among the measured dietary components (food groups and nutrients). The method employed was principal component analysis. The benefit of principal component analysis is that a large set of measured variables (19 food groups and 18 nutrients) can be replaced with a smaller number of dietary factors. Each factor contains the essential information in a collection of measured variables, and numerical values assigned to each factor that can be employed in the characterisation of at risk groups. The suitability of this method depends on the measured variables being scaled, having linear trends in all pairwise plots of the variables and in the absence of odd values or outliers.

Because of the more than ten fold range within each variable, a model which examines ratios rather than differences was used. The application of principal component analysis to ratio data was achieved by transforming the data to a natural logarithmic scale. Principal component analysis utilises product-moment correlations between pairs of variables. There is no meaning to these correlations if they are computed from data drawn from different populations. Scatter plots were used to identify non-homogeneity in the variables. Gender, age and weight were shown to have no effect on population homogeneity. Using the cleaned data set, principal component analysis was achieved by use of the SPSS Data Reduction - Factor Analysis module. Eigenvalues greater than 0.7 were used to identify groupings of interest and the components were rotated to find the most highly correlated groups and to identify the factors. Individual

records (ie subjects) were scored according to how well the combined variables fitted the factors identified.

3. Results

3.1 Health questionnaire

The questionnaire revealed an apparently healthy group of young people with a high rate of smoking (26%) and high participation in organised sports (80%). Although 62% of recruits had more than two standard drinks in the week prior to the survey, the reported average daily intake of alcohol was 0.5 standard drinks. Vitamin or nutritional supplements were taken by 13% of recruits. The incidence of upper respiratory tract infection was 26% in the fortnight preceding the survey and in the preceding year 61% reported having one or two colds, 11% reported three or four colds and 1% reported having more than four colds. Some recruits (12%) had taken a course of antibiotics within two months of the survey. Eight recruits (4%) had surgery (requiring general anaesthetic) in the six months before the survey. The average body mass index of recruits was 21 (SD = 2, range 15 to 27) and only three recruits had a BMI > 25. Eighteen recruits (10%) reported a family history of heart disease.

3.2 Dietary intake data:

Figure 1 presents a picture of the overall dietary balance by presenting the distribution of food risk scores. Figures 2 and 3 present the mean intakes of vitamins and minerals, respectively. Nutrient intake was not associated with age, gender, BMI, education nor any of the biochemistry measures.

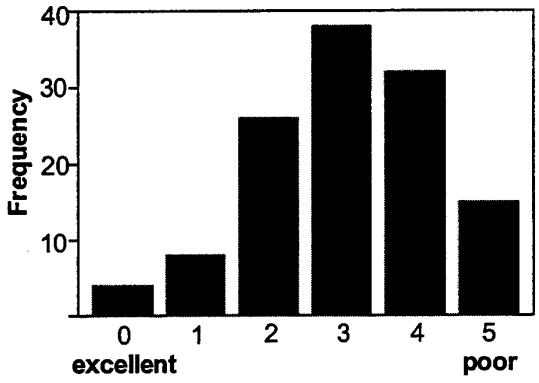

Figure 1 *Distribution of food risk scores*

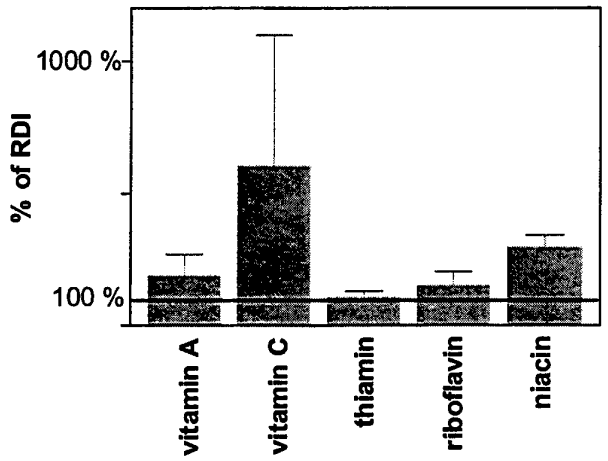

Figure 2 Mean intake of vitamins

The columns extend from 0 to the mean of the values and the bars represent the SD. Results are presented as a proportion of RDI.

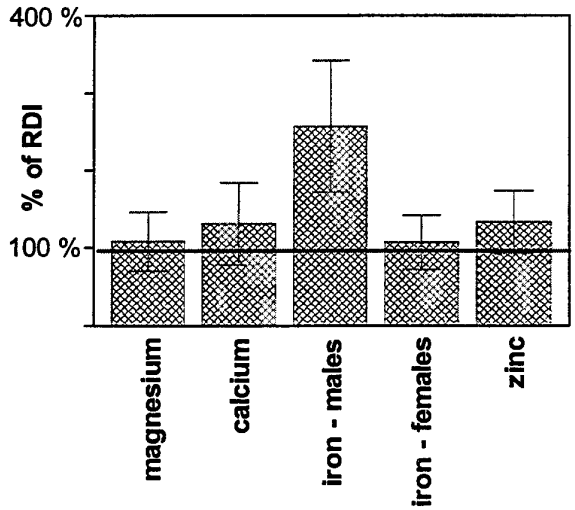

Figure 3 Mean intake of minerals

The columns extend from 0 to the mean of the values and the bars represent the SD. Results are presented as a proportion of RDI.

Table 2 compares the mean daily energy and nutrient intakes of recruits with the results from the 1995 National Nutrition Survey. The National Nutrition Survey data are presented as the dietary intake of individuals aged 19 years and over who reported a ratio of EI to BMR > 0.9 and the dietary intake of all subjects aged 19 to 24 years. Table 3 presents an estimate of the adequacy of micronutrient intake. Table 4 presents the mean dietary intake, by food groups, of the recruits.

Table 2 Mean Daily Energy and Nutrient Intakes Compared with the National Nutrition Survey and RDI[a]

	Sex[b]	Recruits Intake[c]	National Nutrition Survey Intake[d]		RDI[e]
			Aged 19 and over EI≥ 0.9 BMR	Aged 19-24	
Energy (MJ)	M	12.0 ± 3.0	11.8	13.3	9.8 - 11.2
	F	10.2 ± 3.0	8.4	8.4	8.5 - 9.7
Protein (g)	M	127 ± 34	116	128	55
	F	107 ± 29	81	78	45
Carbohydrate (g)	M	321 ± 105	321	376	
	F	289 ± 82	233	243	
Fat (g)	M	116 ± 33	106	119	
	F	93 ± 50	77	75	
Alcohol (g)	M	6.3 ± 7.2	20	15	No more than 40 [42]
	F	3.7 ± 4.1	9	7	No more than 20 [42]
Fibre (g)	M&F	29 ± 12	25	23	30 [43]
Magnesium (mg)	M	423 ± 149	404	390	320
	F	405 ± 157	310	273	270
Calcium (mg)	M&F	1214 ± 498	919	929	800
Iron (mg)	M	18 ± 6	17	18	7
	F	15 ± 5	13	12	14
Zinc (mg)	M&F	16 ± 5	13	14	12
Vitamin A (μg retinol equivalents)	M&F	1413 ±616	922	1065	750
Vitamin C (mg)	M&F	241 ± 198	102	135	40
Thiamin (mg/1000kJ)	M&F	0.21 ± 0.05	0.15	0.2	0.1
Riboflavin (mg/1000kJ)	M&F	0.30 ± 0.11	0.19	0.2	0.15
Niacin (mg niacin equivalents/1000kJ)	M&F	4.72 ± 0.79	4.09	4.4	1.6

[a] The data collected in the present study was by use of a FFQ and data collected during the National Nutrition Survey was by a 24 hour recall method. [b]Males n = 107, Females n = 16, Age range 17 – 36 years, average age 21 ± 3.5 years, central 95% = 17 – 30.5 years.[c] Mean ± S.D. [d] Mean daily intake of persons aged 19 and over. Energy intake to BMR ratio 0.9 or greater. [e] For RDI refer to [34]. Other references indicated within parentheses.

Table 3 Dietary Assessment of Micronutrient Adequacy

Nutrient	Sex	Mean Intake/RDI (%)	Proportion below RDI (%)	Probability Estimate of Inadequacy[a] (%)
Vitamin A equivalents	M&F	188	9	3
Thiamin	M&F	209	0	0
Riboflavin	M&F	197	4	1
Niacin equivalents	M&F	295	0	0
Vitamin C	M&F	602	2	1
Calcium	M&F	152	18	10
Magnesium	M	132	26	7
	F	150	19	10
Iron	M	254	0	0
	F	110	50	19
Zinc	M&F	136	19	6

[a] *The distribution of nutrient intakes below the RDI was determined, and combined with probability statistics to calculate the number of subjects likely to have intakes below their individual requirements. This approach recognises that the RDI overestimates nutrient requirements of almost all individuals in the population [41].*

Table 4 Mean daily dietary intake by Food Group[a]

	Mean	Median	SD	Minimum	Maximum
Alcoholic beverage (10g ethanol)	0.5	0.4	0.56	0.01	3.7
Non-alcoholic beverages (100 mL)	6.9	6.0	3.9	1.4	20.0
Cereals (½cup raw, 2 slices, 2 biscuit)	4.9	4.3	2.7	1.9	22.5
Dairy (250 mL milk, 30 g cheese)	2.8	2.4	1.6	0.1	8.1
Egg (1 whole)	0.3	0.3	0.36	0	3
Oils & butter (1 tablespoon)	1.3	1.1	1.0	0.02	6.6
Fish (120 g)	0.27	0.12	0.28	0	1.7
Fruit (1 whole, 2 small)	1.7	1.4	4.5	0	8.4
Fruit juice (250 mL)	1.0	0.57	1.4	0	8.0
Pulses (½ cup)	0.2	0.01	0.26	0	1.3
Meat (120 g, ¼ chicken)	1.9	1.8	0.9	0.2	5.1
Nuts (½ cup)	0.24	0.13	0.27	0	1.3
Confectionary (50 g bar)	0.53	0.36	0.59	.03	4.2
Vegetables (½ cup)	5.1	4.7	2.8	0.4	16.6

[a] *Food group intakes are expressed as number of serves. Serving size is indicated in parentheses.*

3.3 Dietary intake factors and risk scores

Principle component analysis identified nine food group factors and four micronutrient factors. Table 5 details the micronutrient factors. The micronutrient factors were used for subsequent regression analyses. The factors were found to represent; 1, high meat and low dairy consumption; 2, high dairy and low meat consumption; 3, high fruit and fruit juice consumption and low dairy consumption and 4, high alcohol and low cereal consumption. Factors 1 and 3 correlated with energy intake ($r = 0.73$, $p < 0.001$; $r = 0.45$, $p < 0.001$). Factor 1 correlated with food risk score ($r = 0.28$, $p < 0.001$), factor 3 inversely correlated with food risk ($r = -0.429$, $p < 0.001$) and factor 4 correlated with vitamin intake risk score ($r = 0.30$, $p = 0.002$). Dietary factors did not correlate with biochemical risk scores or demographic variables.

Table 5 Micronutrient Factors

Component	Total Eigenvalue	% of Variance	Cumulative %
1 High meat – low dairy	9.269	57.9	57.9
2 High dairy – low meat	1.451	9.07	67.0
3 High fruit – high fruit juice	1.433	9.0	76.0
4 High alcohol – low cereal	0.952	5.95	81.9

3.4 Biochemistry data

Table 6 presents biochemical measures compared with clinical cut-offs and distributions of the biochemical data are presented for the recruit, reference and blood donor groups in Table 7. The distribution of results for homocysteine concentration were not different between the recruits and reference populations (Kolmogorov-Smirnov $Z = 1.259$, $p = 0.084$). However the frequency distributions for total cholesterol ($Z = 2.424$, $p < 0.001$), apolipoprotein B ($Z = 1.613$, $p = 0.011$), thiamin ($Z = 2.316$, $p < 0.001$) and EGRAC ($Z = 3.416$, $p < 0.001$) were different for the recruit and reference populations.

Table 6 Biochemical Assessment of Nutrient Adequacy

	Mean value	Clinical Cut-off[a]	Proportion outside clinical range (%, *n*)
TAOC (mmol/L)	1.71± 0.19	≥1.60 [35]	28.6%, *52*
Total Cholesterol (mmol/L)	4.5 ± 1.03	≤5.2	24.6%, *45*(5.4%, *10* severe[b])
Triglycerides (mmol/L)	1.02 ± 0.40	≤1.30 [36]	9.8%, *18*
HDL-Cholesterol (mmol/L)	1.08 ± 0.28	≥0.9	2.2%, *4*(1.7%, *3* severe)
LDL-Cholesterol (mmol/L)	2.99 ± 0.93	≤3.50	24%, *44* (11.5%, *21*severe)
Apolipoprotein B (g/L)	1.05 ± 0.31	≤1.30	19%, *35* (4.4%, *8* severe)
Apolipoprotein B:LDL-C	0.23 ± 0.05	<0.26 [36]	30%, *55*
Ferritin (g/L)	80.2 ± 56.1	>15.0 [37]	4.4%, *8* (1.3%, *7* severe)[c]
Total Homocysteine (μmol/L)	13.5 ± 11.5	<10.0 [38]	55.7%, *101* (7.1%,*13* severe)
Red Cell Thiamin (nmol/L)	283 ± 97	≥190 [24]	13.2%, *24*
EGRAC (ie riboflavin)	26.1 ± 16.6	≤40 [39]	17%, *31*
EASTAC (ie Vitamin B6)	74.9 ±21.1	≤120 [23]	0

[a] Cut-off values for lipids provided by the Royal Brisbane Hospital, Chemical Pathology Laboratory, Brisbane. Other references indicated within parentheses. [b]Based on risk score greater than 1 (see Table 1). [c] Of the eight subjects with low plasma ferritin concentrations, four were female (ie 25% of female subjects)

Table 7 Distribution of the biochemical measurements for reference, recruit and blood donor groups[a].

	Reference Group			Recruit Group			Blood Donor Group		
	Median	2.5th %	97.5th %	Median	2.5th %	97.5th %	Median	2.5th %	97.5th %
Hcys (nmol/L)	11.0	4.5	23	11.5	4.0	48.6			
Folate (nmol/L)	608	229	1097	NA[b]	NA	NA	436	188	986
Thiamin (nmol/L)	316	181	578	269	143	510	308	126	509
EASTAC (%) (ie vitamin B6)	117	50	211	77	36	116	103	20	243
EGRAC (%) (ie riboflavin)	13	0	35	24	0	61	15	0	44
Ferritin (g/L)	75	7	455	87	19	299			
Cholesterol (mmol/L)	5.0	3.3	7.0	4.4	2.9	6.9			
Apo B_{100} (g/L)	0.84	0.55	1.47	1.03	0.55	1.66			
Triglycerides (mmol/L)				0.92	0.49	2.00			
TAOC (mmol/L)				1.71	1.43	2.12			

[a] Results from a survey of blood donors and reference subjects conducted by the principal author using the same laboratory methods as the present study [20]. [b] Folate results were not released at the time of publication..

Table 8 presents the mean values for the biochemical measurements for the three groups according to gender. Males and females in the reference group were found to have different results for homocysteine ($t = 4.189$, $p < 0.001$), apolipoprotein B ($t = 3.527$, $p = 0.001$), EGRAC ($t = 3.045$, $p = 0.003$), cholesterol ($t = 2.36$, $p = 0.020$) and ferritin ($t = 8.700$, $p < 0.001$). Males and females in the recruit group were found to have different results for ferritin ($t = 4.836$, $p < 0.001$). Females generally had poorer ferritin and riboflavin status but better cholesterol, apolipoprotein B and homocysteine status than males.

Table 8 Comparison of mean biochemical values for subjects in reference, donor and recruit groups[a]

	Reference Group			Blood Donor Group			Recruit Group[c]		
	M	F	M&F	M	F	M&F	M	F	M&F
Hcys (nmol/L)	12.8	10.0	11.3	NA	NA	NA	13.2	13.3	13.2
Folate (nmol/L)	656	603	626#	490	463	475#	NA	NA	NA
Thiamin (nmol/L)	328	338	333#	317	309	313#	279	276	279#
EASTAC (%)	121	121	120#	115	106	111#	77	68	76#
EGRAC (%)	11*	16@	14	15*	18*	16	25*	30@*	25
Ferritin (g/L)	184	54	114	NA	NA	NA	112	60	105
Cholesterol (mmol/L)	5.2	4.8	5.0	NA	NA	NA	4.5	4.5	4.5
Apo B[b] (g/L)	1.04	0.84@	0.92	NA	NA	NA	1.05	1.04@	1.05

[a] *Significant differences between groups are indicated (*,@,#). For variables where there were significant gender differences, males were compared with males and females with females, only.*
[b] *Apolipoprotein B (Apo B).*
[c] *Values are based on a different subset of the data than Table 6, resulting in some differences in overall means.*

No associations were found between age and biochemical measurements in the recruit population. Weak correlations were found for age and both apolipoprotein B ($r = 0.443$, $p < 0.001$) and cholesterol ($r = 0.342$, $p < 0.001$) in the reference group. Age was not considered to be a major determinant in observed differences between the recruit, reference and donor groups.

Some differences were found in the mean biochemistry results for the recruit, donor and reference groups. Compared with the reference group, recruit males had poor riboflavin status ($t = 8.512$, $p < 0.001$), female recruits had poor riboflavin status ($t = 3.577$, $p = 0.001$) and higher apolipoprotein B ($t = 3.179$, $p = 0.002$) and both male and female recruits had poor thiamin ($t = 5.486$, $p < 0.001$) status. Compared with the reference population the male donors had poor riboflavin status ($t = 7.385$, $p < 0.001$) and both male and female donors had poor thiamin ($t = 2.289$, $p = 0.022$), vitamin B6 ($t = 2.874$, $p = 0.004$) and folate ($t = 6.624$, $p < 0.001$) status.

Compared with the blood donors recruits had poorer thiamin (male and females, $t = 4.325$, $p < 0.001$), and riboflavin (males, $t = 7.385$, $p < 0.001$; females, $t = 4.150$, $p < 0.001$) and better vitamin B6 (males and females, $t = 10.304$, $p < 0.001$) status.

Figure 4 presents the distribution of results (total cholesterol, apolipoprotein B, homocysteine, red cell thiamin and EGRAC) for the reference and recruit groups.

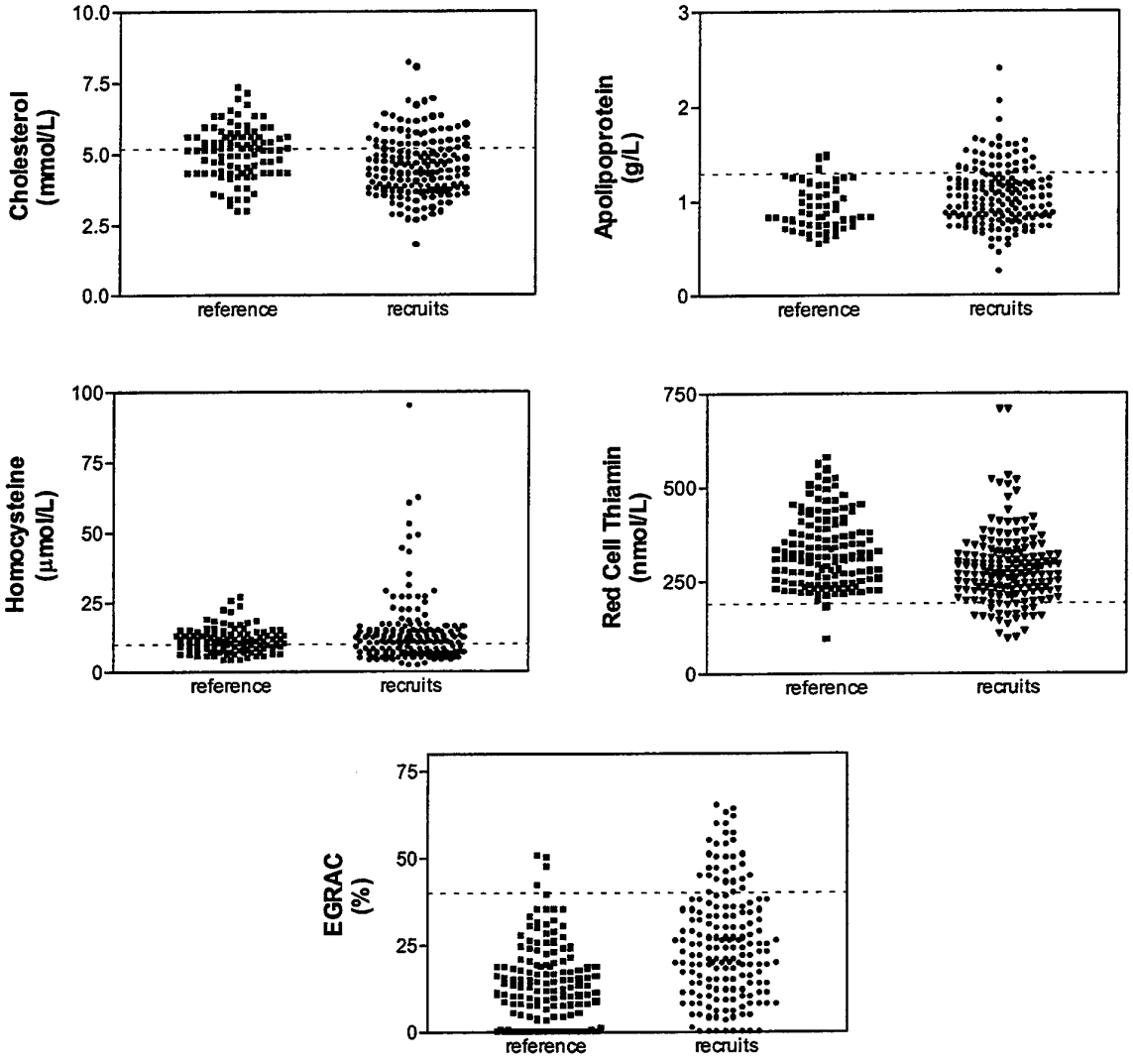

Figure 4 Comparison of biochemical values for subjects in reference and recruits groups

Clinical cut-off values are indicated by dotted lines. In the case of cholesterol, apolipoprotein B, homocysteine and EGRAC elevated results are problematic and in the case of thiamin, low results are problematic. With the exception of the homocysteine results ($p = 0.08$) the distributions presented here are significantly different between the reference and recruit groups. Outliers (eg homocysteine > 30 µmol/L) were excluded from statistical comparisons.

4. Discussion

4.1 Dietary Intake

The average daily diet of the recruits provided 12000 kJ (males) and 10000 kJ (females) as protein (18%), carbohydrate (44%), fat (36.5%) and alcohol (1.5%). This represents an average diet which is too high in fat according to the National Goals and Targets for Improving Health [43]. Figure 1 shows that the recruits' diet is biased towards an unbalanced eating pattern. Despite apparently poor dietary habits, the recruits were at low risk of eating insufficient vitamins (Figure 2). However, it must be noted that the Australian Food Composition tables do not include data for folate, vitamin B6 or vitamin E and estimates of the intakes of these vitamins were not made. Some recruits (male and female) were at risk of eating insufficient calcium (10%), magnesium (10%), and zinc (6%) and females were at risk of eating insufficient iron (19%) (Table 3, Figure 3).

The dietary intake of the recruits was compared with the dietary intake of adults of the same age recorded during the 1995 National Dietary Survey. Although the National Dietary Survey provides insufficient data to allow statistical comparison and the two surveys used different dietary assessment tools, some observations can be made. The energy and macronutrient intakes (protein, carbohydrate, fat) of recruits appears similar to the general public, their intake of vitamins and minerals might be higher and their alcohol consumption might be lower than the general public. This is potentially positive, because it suggests that the recruits eat better than the general public. Such a finding is consistent with this group (recruits) being selected for their high level of physical fitness and good body mass index.

Dietary intake factors and risk scores: Principal component analysis was used in an effort to identify particular eating patterns which may be associated with biochemical risk factors. Unfortunately the eating patterns, which were identified (Table 5), were not found to be associated with the population demographic variables nor any of the biochemical risk factors and therefore, cannot be used as the basis for future intervention/education programs. The analysis is presented here as an interesting rather than a major finding of this study. Recruits' food intake could be described in terms of four patterns, high meat and low dairy, high dairy and low meat, high fruit and high fruit juice, and high alcohol and low cereal. Recruits with the high meat-eating pattern were most likely to have an unbalanced eating pattern (ie not eat according to the core food groups recommendations) and the high fruit eaters were most likely to have a good dietary pattern. Recruits with the highest alcohol intakes were likely to have the poorest vitamin intake.

There were some problems with the use of the FFQ as evidenced by the number of records (41%), which could not be included in the data analysis. Goldberg et al stated that unidirectional bias due to under-reporting of food intake can be a problem for dietary studies [31]. However, in addition to the usual under-reporting several FFQ were completed inappropriately. The possibility that the FFQ was too difficult for

many to complete accurately needs to be considered. Furthermore, some caution is needed in interpreting the significance of the dietary data, because the FFQs included in the analysis may not represent the eating habits of the 184 participants in the Cohort.

4.2 Biochemistry data

The biochemistry data presented here was compared with suggested clinical cut-off values, with a highly selected reference group and with a group of blood donors in the same age range. The latter data were collected by the principal author in a survey conducted during 1996 [20]. The surveys used the same analytical techniques. Lack of reliable reference values and standardised analytical techniques can make it difficult to assess vitamin status. The survey, conducted during 1996 was designed to estimate reference ranges for red cell folate, red cell thiamin, EASTAC and EGRAC. The reference subjects were selected according to the recommendations of the Scandinavian Committee on Reference Values [44].

In clinical practice it is usual to compare an observed patient's value with the corresponding normal reference interval (the central 95% of the reference population). Such a comparison conveys information about the similarity of the patient's values to the given set of reference values. This contrasts with clinical decision cut-offs, which are based on the analysis of data from several population groups (healthy persons and patients with relevant diseases). For the vitamin measurements (red cell thiamin, red cell folate, EASTAC, EGRAC) the reference values (ie central 95 percent) are consistent with clinical cut-offs described in the literature. Hence a statistical comparison of the recruit and reference results can be used to assess the significance of vitamin deficiency in the recruit group.

Significant prevalence of riboflavin, thiamin and folate deficiencies were identified in the recruit group. For each of the vitamins the prevalence of the deficiency in the recruit group was more than in the group of blood donors (Tables 7 and 8). Thiamin has been considered to be one of the marginally adequate nutrients in the Australian diet. Certainly, poor thiamin status has been identified in homeless people [45] and a high incidence of Wernicke-Korsakoff syndrome has been recorded [46]. It was believed that thiamin enrichment of flour to the concentration of 6.4 mg/kg, which commenced in 1991, would alleviate the problem of poor thiamin status in the Australian population [46]. However, the finding of significant prevalence of thiamin deficiency amongst first-time blood donors and Army recruits suggests that the benefits of this public health measure requires reassessment.

One in four female recruits had reduced iron stores (note to Table 6). This finding, coupled with the apparently poor dietary intake of iron by female recruits, suggests that female soldiers are at risk of iron deficiency. This comes as no surprise. A 1995 review of iron status in Australia identified teen-aged girls, women of child-bearing years, elderly, blood donors, Aborigines and female vegetarians to have the highest rates of iron deficiency. In fact national surveys identified approximately 4% of all Australian females as iron deficient [47]. The present finding might suggest a higher

rate of iron deficiency amongst Army recruits and this might be consistent with evidence presented in the literature that athletes are at high risk of developing iron deficiency [48].

The antioxidant status of 29% of recruits was shown to be less than optimal. Reactive oxygen species (ROS) are generated during normal metabolic processes and in particular during immune system attack of invading micro-organisms. They are also induced during vigorous physical activity such as military training and on operations. Although vitally important to human well being, ROS production needs to be kept under control. Evidence is accumulating that oxidative stress contributes to the pathogenesis of chronic diseases such as atherosclerosis and that it slows recovery from a period of vigorous physical activity. The body stores antioxidants which can be mobilised to neutralise excessive production of ROS. The antioxidants may be water-soluble within cells or extracellular fluids, fat-soluble within cellular membranes, may be endogenously produced or obtained in the diet. Antioxidants include intracellular enzymes and plasma proteins as well as dietary factors (vitamins, trace elements, polyphenols, flavonoids, glucosinolates and procyanides) and metabolites (bilirubin and urate). Because it is difficult to separate out the contributions of the various antioxidant systems, the measurement of the total antioxidant capacity (TAOC) may be the most relevant measurement to assess antioxidant status. A lower than normal TAOC can therefore result from either a primary reduction in antioxidant resistance or a secondary reduction as a result of increased antioxidant stress [49]. The method used in the present study is influenced by urate, albumin, ascorbate, glutathione, vitamin E and bilirubin. One criticism of the method concerns the non-stoichiometric response of the assay to the different antioxidants [50]. A further problem is that of defining an appropriate clinical cut-off. Our laboratory has not established an optimal reference interval for the assay. In the present study a manufacturer's reference has been used. This cut-off was established after vitamin supplementation of a selected reference group. Subjects received a combination of selenium, retinol, ascorbic acid, vitamin E and bioflavonoids daily for one month at doses similar to the RDI.

Possibly the most important finding concerns folate status. As with thiamin last decade [51], poor folate status has been recognised as an Australian public health issue in the present decade [52, 53, 54]. Inadequate dietary intake of folate has been found to increase the risk of spina bifida and other neural tube defects and the evidence is convincing that an increased intake of folate can prevent most neural tube defect cases [55]. Elevated homocysteine, which has been identified as an independent risk factor for peripheral, cerebral and coronary vascular disease, is inversely related to folate status [56]. Moderately elevated homocysteine concentrations may be the first biochemical marker of insufficient intracellular folate.

There is evidence that the 2.5th percentile cut-off underestimates folate deficiency [38]. An optimal homocysteine reference interval, based on targeting people who are likely to be folate replete, is preferable to the population-based reference range using the central 0.95 interval. Recent studies suggest that the cut-off for a healthy plasma homocysteine concentration (ie minimal risk for cardiovascular disease) may fall below 10-15 μmol/L [57, 58, 59, 60]. More than half (56%) of recruits had homocysteine values

> 10 μmol/L . Although the mean homocysteine concentrations for the reference and recruit groups were not different, the distribution of homocysteine concentrations was skewed towards higher values in the recruit group (Figure 4). The folate content of Australian foods, and consequently an estimation of the availability of folate in the Australian food supply, has not been described. The National Nutritional Survey [40], which used a combination of Australian and foreign food composition databases, estimated the mean daily intake of folate by adult males to be 307 μg and by adult females to be 233 μg. This is considerably less than the daily folate intake of 350 μg estimated to be needed to maintain normal plasma homocysteine concentrations [60] .

Apart from elevated homocysteine other cardiovascular risk factors were identified amongst the recruits (Table 6). One in four had elevated cholesterol, 19% had elevated apolipoprotein B and 10% had elevated triglyceride concentration. Of these results, Apolipoprotein B is possibly the best predictor of risk. A predominance of small, dense LDL (LDL-III) in plasma is predictive of coronary risk [14, 61] and the concentration of apolipoprotein B tends to increase with increased concentration of LDL particles. The ratio of apolipoprotein B to LDL-cholesterol provides an estimate of the absolute number of LDL particles, which is known to be an independent risk factor for coronary heart disease. Griffin et al [36] recommend that elevated fasting plasma triglyceride concentration (>1.5 mmol/L) in the presence of elevated apolipoprotein B to LDL-cholesterol ratio (>0.26) is highly predictive of the presence of small dense LDL particles. Five percent of recruits had both elevated plasma triglyceride concentration and elevated apolipoprotein B to LDL-cholesterol ratio.

The prevalence of biochemical vitamin deficiency casts doubt on the interpretation of dietary intake data, which suggests that vitamin deficiency is unlikely. The lack of correlation between dietary data and biochemical measurements was not unexpected. Because reports of past intake are known to be biased toward the present and many foods are only seasonally available, the questionnaire may capture an atypical snapshot of consumption rather than the intended view of usual consumption. In contrast, the biochemical measures were selected to provide a picture of long-term nutrient status. The FFQ is best used to describe dietary patterns or food habits and to identify groups of individuals at extremes of food intake, not nutrient intake [62].

Generally, regardless of the dietary intake tool, measurement error in dietary data has been suspected of significantly attenuating the diet-deficiency association [63]. Other workers have demonstrated that the calculated amount of a specific micronutrient consumed did not adequately predict status as measured by several biochemical indices [64]. Nutritional status is dynamic and changes with dietary and lifestyle habits and physiological state. For example, alcohol intake, cigarette smoking, use of oral contraceptives, and exercise training can increase the requirements for specific vitamins [65, 66, 67].

5. Conclusions

Army recruits surveyed during 1997 were found to be an asymptomatic healthy group of young adults, mostly in the ideal body weight range, who reported a high participation rate in organised sports, high rate of cigarette smoking and low rate of reported alcohol consumption. They reported an average dietary intake similar to adults of the same age in the general population, namely too high in fat and unbalanced with respect to recommended core food groups. Male and female recruits were at risk of consuming insufficient calcium, magnesium and zinc and female recruits were at risk of eating insufficient iron.

Although recruits appeared to be consuming sufficient vitamins, long-term biochemical measures indicated that the recruit group was at risk of thiamin, riboflavin and folate deficiencies. Up to half the recruits were at risk of folate deficiency. Female recruits were at risk of iron deficiency. Total antioxidant status of nearly a third of recruits was less than optimal, perhaps reflecting the poor fruit and vegetable intake of the group.

Risk factors for cardiovascular disease, which were identified, included elevated concentrations of homocysteine, cholesterol, LDL-cholesterol, triglycerides and apolipoprotein B. Few recruits (2%) had reduced concentrations of HDL-cholesterol ("protective" cholesterol). A small group of recruits (5%) was identified with both increased plasma triglyceride concentration and elevated apolipoprotein B to LDL-cholesterol ratio, which is highly predictive of future cardiovascular disease.

The estimated dietary intake of foods and nutrients by recruits did not predict the apparent prevalence of vitamin deficiency and cardiovascular risk factors. This is not unexpected because, the FFQ tool is best used to identify trends in eating patterns rather than individual nutrient intakes. This lack of correlation between estimated dietary intake and biochemical measures highlights the need to include blood tests as part of nutritional status monitoring. Furthermore non-dietary factors such as cigarette smoking and level of physical activity may be contributing to the observed biochemical status.

6. Recommendations

Based on the preceding research findings the following recommendations are made.

- The effectiveness of nutrition education offered during recruit training needs to be assessed. The survey revealed that some recruits have risk factors for cardiovascular disease. Nutrition education strategies need to build an awareness of the association between lifestyle factors (including diet) and increased risk of cardiovascular disease.
- Although there were few female recruits included in this survey, the report highlights that female recruits are at risk of iron deficiency and females are at particular risk regarding folate deficiency. The special nutritional needs of female

recruits needs to be considered. The authors recommend further study of the special dietary needs of female Army recruits

- Any approach to nutrition education should include food services (in barracks and in the field), institutional practices (e.g. timing of meal breaks, access to commercial food suppliers) and formal course content. All instructors (physical trainers, health personnel, section leaders) need to give a uniform message with respect to food and nutrition.
- A uniform through-career approach to nutrition education should be considered at Policy level.
- There should be on-going monitoring of ADF personnel nutrition status and cardiovascular risk factors. Such monitoring should include surveys such as that presented here as well as evaluation of food services provided in barracks and in the field.

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1. Consent and Information Forms

DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

Defence Nutrition Research Centre
Combatant Protection and Nutrition Branch
76 George St Scottsdale Tas 7260

NUTRITIONAL STATUS OF SOLDIERS

Information & consent forms for participants

Dr Christine Booth (Chief Investigator)
Tele: 03 6352 2033
Fax : 03 6352 3044
Email: christine.booth@dsto.defence.gov.au

DSTO AUSTRALIA

CONSENT FORM

VITAMIN STATUS OF SOLDIERS
Task No: DST 97/126

I, ... give my consent to participate in the project mentioned above on the following basis:

- I have had explained to me the aim of this research project, how it will be conducted and my role in it. I am happy to participate.

I understand that I have agreed to have my vitamin (thiamin, folic acid, vitamin B6, riboflavin, homocysteine, antioxidants), cholesterol (triglycerides, LDL-cholesterol, HDL-cholesterol) and iron status monitored for up to five years. This will involve completion of a medical and dietary questionnaire and the donation of a fasting blood sample (20 mL) at the start of my training course at 1RTB, at the end of my first year and then on an annual basis. I understand that the protocol of taking and handling my blood sample will conform to conventional medical practice and that the risk to myself of a deleterious outcome will be no higher than for a routine medical examination.

I understand that my consent to participate in this study will be recorded on my personnel file. In so doing, I am giving the investigators (task DST 97/126) permission to access my contact address and phone number for the purpose of sending the questionnaire forms and arranging a medical appointment once per year for up to 5 years.

- I understand that I am participating in this project in a voluntary capacity and can withdraw at any time without penalty or detriment to my career and without compromise to my medical care.

- I am co-operating in this project on condition that:
  - no other tests will be performed without my consent;
  - the information I provide will be kept confidential;
  - the information will be used only for this project;
  - the research results will be made available to me at my request and
  - any published reports of this project will preserve my anonymity.

I have been given a copy of the information sheet and this form, signed by me and by the principle researcher, Dr Christine Booth.

.....
SUBJECT DATE

.....
CHRISTINE BOOTH DATE

DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

Defence Nutrition Research Centre
Combatant Protection and Nutrition Branch
76 George St Scottsdale Tas 7260

INFORMATION SHEET

VITAMIN STATUS OF SOLDIERS

Task No: DST 97/126

The present study aims to monitor your vitamin, iron and cholesterol status during your training and early years (up to five) of army service. Blood fats (cholesterol, triglycerides and HDL-cholesterol), folic acid (including homocysteine), riboflavin, thiamin, vitamin B6, iron (ferritin) and total antioxidant status will be measured at the beginning of your training at 1RTB, again at the end of your first year and then on an annual basis. Your usual dietary intake will also be estimated at these times. No other tests will be performed without your consent.

The dietary intake of B-group vitamins (thiamin, folic acid, vitamin B6 and riboflavin) may not be sufficient for many Australians. A recent survey of young blood donors found one in four had mild B-group vitamin deficiency. The B-group vitamins are important for your body to be able to use dietary carbohydrates and proteins and therefore are essential for optimal physical fitness. Prolonged deficiency of thiamin can result in neurological problems, including memory loss and is common amongst alcoholics who eat poorly. Deficiency in folic acid can result in a form of anaemia (decreased red cell count), called pernicious anaemia. Folic acid deficiency during pregnancy can increase the risk of the infant being born with spina bifida. Vitamin B6, B12 and folic acid deficiencies can increase the risk of heart disease and thrombosis (abnormal blood clotting) by increasing the concentration of a substance in your blood, called homocysteine. An elevated homocysteine level is an independent risk factor for heart disease. Your B-group vitamin status and homocysteine levels will be measured.

A further risk factor for heart disease is elevated cholesterol. In particular elevated LDL-cholesterol (so called "bad" cholesterol) and decreased HDL-cholesterol ("good" cholesterol) can increase the risk of heart disease. Both LDL-cholesterol and HDL-cholesterol are influenced by diet , particularly the type and quantity of fat. Your total cholesterol, LDL-cholesterol, HDL-cholesterol and triglyceride levels will be measured.

Other nutrients, which have a key role in physical fitness are iron and the antioxidants. Antioxidants, which include vitamin C, vitamin E, vitamin A, carotenoids, selenium and other non-nutrient food components, are important in protecting the body tissues from the damage caused by free radicals. During hard physical training, it is particularly important to maintain a good antioxidant environment in the muscle tissues. A combination of infection, poor diet and hard physical work can lead to oxidant stress. Your antioxidant status will be measured.

Severe vitamin deficiencies are rare in Australia. However, even mild vitamin deficiency may impair immune function and make you more susceptible to infections such as upper-respiratory infection. It should also be pointed out that over-supplementation with vitamins can also adversely affect immune system function and that nutritional supplements are no substitute for a healthy balanced diet.

The direct benefit to you from participation in this study is that you will have information on the adequacy of your current diet and nutritional status for measured fats, vitamins and iron. The benefit overall of the research will be the gathering of information, which can be used to tailor ADF nutritional policy to meet the specific needs of active soldiers.

You will be asked to provide information about what you eat, how much and how often as well as some demographic details. An appointment will be made to collect a small blood sample (20 mL) by an experienced phlebotomist (blood collector) from your non-dominant arm using a sterile needle with appropriate infection control procedures.

The risk to you of deleterious outcomes during and/or after the study will be no higher than for routine medical examination. The phlebotomist will place a tourniquet around your upper arm then draw a blood sample from the inside of your arm into a syringe. Apart from a small prick when the needle pierces the skin, little discomfort is experienced by most people. However, if the procedure makes you feel faint, you should remain sitting and place your head between your knees. By applying pressure on the puncture site after the needle is withdrawn, you should prevent any bruising. The use of sterile technique by the phlebotomist will prevent the risk of infection.

All consumables used to sample blood (eg. needle, gloves, swabs, tape) will prior to use, be stored under sterile conditions; and when in use they will be handled with gloves at all times. Protocols conforming to conventional medical practice and standards of handling human tissue will be followed in the collection and handling of blood at all times.

You will be asked to consume no food for approximately 12 hours before the 'fasting' blood sample is collected. Usually this means not eating food from 21.00 the night before donating the blood sample. The appointment, which will be conducted whilst you are 'on duty', will take no longer than 30 minutes. At your first appointment, a qualified dietitian/nutritionist will assist you in the completion of the survey form. After analysis of the data you will be provided with feedback on this dietary information as well as blood chemistry status. Where there are abnormal results you will be advised to seek medical advice. If you require further nutritional advice, you may contact the dietitian (Dr Christine Booth) at the Defence Nutrition Research Centre.

Your participation in this research is voluntary and refusal to be involved will entail no detriment to your career. You need not answer all the survey questions. You may discontinue at any time without penalty. The information collected will be kept confidential and nothing will be published which will identify individual participants. The information will only be used for the stated aim, above.

Should you have any complaints or concerns about the manner in which this research is conducted, please do not hesitate to contact the chief investigator:

Dr Christine Booth, DSTO-Defence Nutrition Research Centre

76 George St, Scottsdale TAS 7620
Ph : 03 6352 2033, Fax: 03 6352 3044
Email: christine.booth@dsto.defence.gov.au

OR you may contact the Australian Defence Medical Ethics Committee at the following address:

Executive Secretary, Australian Defence Medical Ethics Committee
Office of Surgeon General Australian Defence Force
CP4-6-45, Campbell Park Offices
CANBERRA ACT 2601
Ph : 06-2663921 DNATS 8 66 3921, Fax: 06 2664982 DNATS 8 66 4982

CONSENT FORM

VITAMIN STATUS OF SOLDIERS
Task No: DST 97/126

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  - the information will be used only for this project;
  - the research results will be made available to me at my request and
  - any published reports of this project will preserve my anonymity.

I have been given a copy of the information sheet and this form, signed by me and by the principle researcher, Dr Christine Booth.

.....
SUBJECT DATE

.....
CHRISTINE BOOTH DATE

2. Health & Diet Questionnaire

Health & Diet Survey

DR CHRISTINE BOOTH (CHIEF INVESTIGATOR)
TEL: 03 6352 6609
FAX : 03 6352 3044
EMAIL: christine.booth@dsto.defence.gov.au

Today's date [/ /] Your service number [ ]

Your Age [ ] years Male ☐ Female ☐

Your Health

How often do you exercise? *(gym, jogging, walking, team sports?)* Average [ ] hrs/week

Have you had vitamin/mineral supplements in the last 2 weeks? Yes ☐ No ☐

Have you taken any antibiotics in the last 2 months? Yes ☐ No ☐

Do you regularly (most days) take medication, vitamin supplements, or herbal preparations? Yes ☐ No ☐

⇓

Product Name	Brand	Dosage (mg)	Doses taken per day

Have you had hayfever, a cold, sore throat or flu in the last 4 weeks? Yes ☐ No ☐

How many times did you have a cold, sore throat or flu in the last year?

0 ☐

1-2 ☐

3-4 ☐

4+ ☐

Have you had major surgery in the last 6 months that required a general anaesthetic? Yes ☐ No ☐

Do you smoke? Yes ☐ No ☐

Have you had more than 2 average drinks in one session in the last week? *(average drink = 1 pot of beer, 1 glass wine, 1 nip/shot of spirits)* Yes ☐ No ☐

Do you have a family history of heart disease, thrombosis or high blood cholesterol? (brothers, sisters, parents, uncles, aunts or grandparents who have serious heart disease at less than 60 year of age?) Yes ☐ No ☐

Your Diet

Please read the following example of how to complete the diet table.

The table shows:

4 slices of white bread are eaten daily
1 egg is eaten a week
4 apples are eaten each week
1 cup of whole milk is drunk daily

Food	Amount	Frequency									Comments
		Less than 1 a	1 a month	1 a week	2 a week	3 a week	4 a week	5 a week	1 a day	More than 1 a day	
CEREALS											
Bread - White	2 slices ~~2 slices~~ *4 slices*								√		
Egg	1			√							
Apple	1						√				
Milk, fresh **Specify**: *ie skim/light/whole*	250 mL (1 cup)									√	

You can change the serve size if you eat a larger serve size.

Notes
If there are foods you usually eat missing from the table, please add them at the end of the table.

The following abbreviations are used in the table:

Tblspn = tablespoon	cm = centimetres	tspn = teaspoon
oz = ounce	pkt = packet	g = gram
mL = millilitres		

Note: Food frequency form (118 items) has not been included in this Appendix.

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Army Recruit Health and Diet Survey

Christine Booth and Ross Coad

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19. ABSTRACT

During 1998, 200 Army recruits took part in a health and diet survey. Most (90%) were Regular Army recruits and recent high school graduates, the remainder being Army Reservists. Fourteen percent of recruits were female. Recruits completed a questionnaire, had their weight and height recorded and donated a fasting blood sample for measurement of cholesterol, fasting triglycerides, apolipoprotein B, ferritin, homocysteine and vitamins. The group comprised of apparently healthy young adults, mostly in the ideal body weight range, with a high rate of participation in organised sports and a high rate of smoking (26%). The dietary intake by these recruits, which was similar to that of other young adults in the general Australian population, was too high in fat and unbalanced with respect to the recommended core food groups. Recruits were at risk of eating insufficient calcium, magnesium and zinc. Female recruits were at risk of eating insufficient iron. Biochemistry results revealed a significant prevalence of folate, thiamin and riboflavin deficiency for males and females and iron deficiency amongst the females. Up to half of the recruits had at least one risk factor for cardiovascular disease, namely elevated cholesterol, triglycerides, apolipoprotein B or homocysteine concentration. Nutrition education should be targeted at lowering the prevalence of cardiovascular risk factors amongst Army personnel and addressing the special dietary needs of female personnel.

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