TITLE OF MINI-DISSERTATION:

THE DEVELOPMENT OF A QUESTIONNAIRE TO TEST DIETITIANS' PRACTICES AND KNOWLEDGE WITH REGARD TO DIETARY SUPPLEMENTS AND FORTIFIED FOODS

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ABSTRACT

Objective: To develop a questionnaire for evaluating dietitians' knowledge and practices with regard to the use of dietary supplements.

Methods and procedures: A cross-sectional validation study was carried out in two phases, namely 1) questionnaire planning and development and 2) test evaluation. The study sample comprised 48 nurses, 105 dietetic interns and 367 registered dietitians. An expert academic group comprising 9 dieticians with research and teaching experience rated the academic relevance and importance of knowledge questions in an item pool of 355 questions, in order to ensure *face* and *content* validity. *Criterion* validity was measured by testing the knowledge questions (KQs) on 48 nurses and 105 dietetic interns. Thereafter, questions were deleted based on their difficulty, discrimination, and alpha Cronbach values. The final questionnaire, which now included a test of 50 KQs, was mailed to registered dietitians (n=1450) in South Africa in order to determine *internal consistency* of the final KQs. A sample of 367 dietitians returned the questionnaires.

Results: *Criterion* validity of the KQs was indicated by a significant difference ($p < 0.000$) in the mean test scores between nurses (36.9; 95% CI 24.2-39.6) and dietetic interns (40.2; 95% CI 38.8-41.7). Item discrimination was attained by the deletion of NQs having a minimum correlation of 0.20 with overall test score. Furthermore, item difficulty was controlled for by removal of questions correctly answered by more than 80% (too easy) or fewer than 20% (too difficult). *Internal consistency* of the KQs, following completion by 367 dietitians, was 0.87 (alpha Cronbach). The mean knowledge score of dieticians ranged from 56.5% to 62.5%, with the oldest group (40+ years) having the highest score ($p=0.018$). Thirty-eight percent of dietitians recommended dietary supplements at least 3 times a week; 51% consumed them themselves; and 17% sold them to clients.

Conclusions: A valid and reliable questionnaire, which tests knowledge and practices of dietary supplements, was developed for dietitians.

INTRODUCTION

Nutrition-related chronic diseases are common in middle- to high-income countries and are very expensive to treat. Taking the United States of America (USA) as example, it has been calculated that Americans suffer a heavy burden of chronic diseases, which are potentially preventable. These include annually 14 million cases of heart disease, 1.2 million cases of preventable cancer, 28 million cases of chronic lung disease, 16 million cases of diabetes, and 2500 babies born with neural tube defects. It has been calculated that healthier dietary practices in the USA could save 71 billion dollars a year in lost productivity, medical costs and premature loss of life (McGinnis & Ernst, 2001).

The Council for Responsible Nutrition believe that vitamin and mineral supplements can offer improvements in basic nutrition, such as protection against cardiovascular diseases; neural tube defects; micronutrient deficiencies; anaemia in women and children; and improved immune function in the elderly (Dickinson, 2002). Additionally, it is calculated that a year's supply of micronutrient supplementation costs less than 3 visits to a doctor and much less than hospitalisation for a day (Chandra, 1997). The average estimated expenditure on supplements in the USA was 6.6 dollars per person

per month in 1995 (Eliason et al, 1996) and the market for dietary supplements was estimated at about 11.8 billion dollars in 1997 (Nesheim, 1999).

Furthermore the American Dietetic Association (ADA), who have recognised the fact that not all individuals are always able to meet their requirements, has also recently advocated the use of micronutrient supplementation. In the most recently published dietary goals for Americans the Association has stated: "Additional vitamins and minerals from fortified foods and/or supplements can help some people meet their nutritional needs as specified by science-based nutrition standards such as the Dietary Reference Intakes" (USDA, 2001).

Figures from middle- to high-income countries, apart from the USA, indicate that the use of dietary supplements has steadily been increasing since the 1980s (Conner et al, 2001; Lavy et al, 2000; Messerer et al, 2001). For example, in Sweden during 1980 to 1997, there was a 70% increase in the prevalence of dietary supplement users amongst both men and women. A recent survey undertaken in 6 European countries on 6000 adults randomly selected, found that 23% were currently taking a vitamin or mineral

supplement. Higher income groups were significant users (35%) as were the elderly and pregnant women (38%)(Anon, 2001).

Dietitians have traditionally been the primary advocates of a healthy balanced diet to meet all nutrient requirements. Indeed, with increasing knowledge regarding the preventative functions of many micronutrients, it is important to assess dietitians' knowledge and practices in this regard.

2. LITERATURE REVIEW

2.1 Definitions

According to the Office of Dietary Supplements (ODS 1998 as cited in Marriott, 2000) in the USA, dietary supplements are defined as: " a product intended to supplement the diet that contains one or more of the following dietary ingredients: (i) a vitamin; (ii) a mineral; (iii) a herb or other botanical compound; (iv) an amino acid; (v) a dietary substance for use by man to supplement the diet by increasing the total dietary intake; or (vi) a concentrate, metabolite, constituent, extract, or combination of any ingredient described in clauses (i)-(vi)". Following on from this definition, a dietary supplement has been operationally defined by the ODS as any substance which is consumed in addition to the regular diet. Food items that

are intended to be a sole source of nutrition, meal replacements or conventional foods, are not considered to be dietary supplements (Marriott, 2000). Furthermore, to simplify the description of dietary supplements, the ODS have grouped them into three categories: botanical ingredients; nutrient ingredients and other dietary substances. Thus botanical ingredients include all plant-derived materials. Nutrient ingredients include all essential and non-essential nutrient and food constituents that may have a dietary or nutrient role in humans. "Other dietary substances" comprise a group which are neither of plant origin nor alone could be viewed as "nutrients" within the general definition of the term.

In the South African context no formal definition has been published with regard to dietary supplements. The only reference to dietary supplements is found in the regulations governing the labelling and advertising of foodstuffs in Act No. 54 of 1972. The Directorate of Food Control of the Department of Health is currently developing regulations relating to dietary supplements, which they plan to publish in 2003 (Booyzen, 2001). Since there is no local definition, the ODS definition was adopted for the purpose of this study although the focus was on nutrient ingredients and specifically on vitamin and mineral supplements.

Fortification refers to a process whereby essential nutrients are added to foods for different purposes, namely: (i) to prevent or correct a demonstrated deficiency in a population or group; (ii) to compensate for loss of nutrients during processing; (iii) to compensate for natural variation; and (iv) to make substitute foods comply with those they are designed to resemble. These terms are defined in the Codex General Principles for the addition of essential nutrients to foods.

In South Africa, Act 54 of 1972 stipulates that micronutrients must be at levels of at least 15% of the RDA (Recommended Dietary Allowances) per serving, before a claim regarding that nutrient can be made.

Regulations relating to the fortification of maize meal and wheat flour were promulgated and adopted in 2003. According to this schedule specific definitions have been adopted, namely:

Enrichment: "the addition of one or more nutrient/s to a food whether or not it is normally contained in the food with the sole purpose of adding nutritional value to the food."

Food vehicle: ' means dry uncooked wheat flour, dry uncooked maize meal and bread prepared with and containing at least 90 % fortified wheat flour, excluding water."

Fortification: "means the addition of one or more micro-nutrients(s) by means of a fortification mix to a food whether or not it is normally contained in the food for the purpose of preventing or correcting a demonstrated deficiency of one or more in the general population and/or specific population group/s of South Africa as prescribed by the Department.

2.2 Health benefits of micronutrient supplements/fortification

The reasons why people use dietary supplements are complex, and include knowledge, social, psychological and economic considerations (Conner et al, 2001). Many dietary supplements are taken simply as part of a healthy lifestyle while others are taken specifically to reduce risk factors for chronic diseases such as heart disease (vitamin E, garlic, folic acid), cancer (selenium), birth defects (folic acid) and/or to enhance physical performance (creatine)(Hathcock, 2001).

Standard advice from dietitians and nutritionists is that if one eats a balanced diet you should be able to meet all your nutrient requirements. This health message has been rated as one of the most important health promotion messages advocated by dietitians (Vickery & Cotugna, 1990).

However, a significant number of studies worldwide have consistently reported that many people do not meet their daily nutrient requirements by diet alone (Erkkola et al, 1998; Labadarios et al, 2000; Monge-Rojas, 2001; Serra-Majem, 2001; Marshall et al, 2001). Since the eighties there have been many studies examining the extent of supplement usage in free-living populations (Vitolins et al, 2000; Stang et al, 2000; Kiely et al, 2001; Ervin & Kennedy-Stephenson, 2002; Troppmann et al, 2002). These studies have found that the most common supplements consumed are of the multivitamin type, with or without minerals such as iron or calcium. Use of dietary supplements has been found to be highest in the elderly and in adult women (Slesinski et al, 1996; Ervin et al, 1999). A number of these studies are reported in the next section.

2.3 Micronutrient intakes of groups determined from dietary surveys

In France, Mareschi et al, (1987) found that micronutrients whose intake is provided by the usual "French" diet are insufficient for some population groups. For example women were found to have low intakes of fluorine, zinc, iron and copper.

Hallfrisch and Muller (1993) evaluated 7-day dietary records of 564 participants of the Baltimore Longitudinal Study of Aging. They found that more than 40% of the elderly participants consumed less than two thirds of the Recommended Dietary Allowance (RDA) for iron, calcium, magnesium and zinc. Their conclusion was that many people in a middle-income well-nourished population do not consume adequate amounts of the above-mentioned nutrients, and that women are at greater risk.

Data from the 1987 Nationwide Food Consumption Survey in the USA were used to determine those at risk of calcium deficiency. Mean per capita calcium intake was 737mg and varied with various socio-demographic factors. For most groups of females the intake was considerably less than the RDA (Flemming & Heimbach, 1994)

Similar findings have been reported by Penington et al. (1989) and Pennington (1996) who examined the results of Total Diet Studies (1982-86 and 1986-91) in the USA. It was reported that intakes of calcium, magnesium, iron, zinc and copper were below recommended intakes for quite a number of age-sex groups. Similar findings were found in lactating women who had zinc, vitamins D and E intakes below the RDA at 3 months

postpartum. At 6 months postpartum calcium and folate levels were also below recommendations (Mackey et al, 1998).

Monge-Rojas (2001) examined the micronutrient of 12-19 year olds in Costa Rica. He found that micronutrients most at risk for inadequate intake were zinc, calcium, magnesium, and folate: more that 25% of the adolescents did not meet 50% of dietary reference intakes (DRIs) or recommended dietary intakes (RDAs) for these micronutrients.

A dietary survey of 118 pregnant women in Finland found that their usual diet, evaluated by two 5 day estimated records, comprised adequate nutrient intakes with the exception of vitamin D, folate and iron (Erkkola et al, 1998).

Serra-Majem (2001) examined vitamin and mineral intakes of 6 to 18 year olds from studies undertaken in 6 European countries. She found that children and adolescents are the group most likely to have higher risk of dietary inadequacies particularly in iron, folate, vitamins C, E, and B6.

Marshall et al. (2001) examined the diets of rural elderly living in Iowa. They found that the percentage of subjects with inadequate intakes was 75% for folate, 83% for vitamin D and 63% for calcium. Also 80% of subjects reported inadequate intakes of four or more nutrients.

In South Africa the National Food Consumption Survey (NFCS) undertaken on a representative sample of 1-9 year old children also found specific common micronutrient deficiencies. The most common deficiencies being vitamin A, riboflavin, vitamin B6, iron, calcium, and zinc (Labadarios et al, 2000).

2.4 Use of dietary supplements and fortified foods worldwide

2.4.1 Dietary supplements

Since the eighties there have been numerous studies examining the extent of supplement usage in free-living populations. This section presents some of the main findings in this regard. However it should be noted that the studies reported in this section did not consider those supplements routinely prescribed to children and adults during certain stages of the lifestyle, such as iron and folate prescribed during pregnancy; or vitamin A supplements provided as protective measures during infancy. The studies reported here include those whereby children and adults take nutrition supplements as a preventive or curative measure by choice. In most cases these would not be prescribed by a medical doctor but bought over the

counter. In this regard no studies on supplement use could be found on the sub-Saharan African continent.

Dietary and supplemental intakes were assessed in 270 free-living elderly respondents in Albuquerque by means of 3-day food records. Approximately 60% of both women and men ingested one or more supplements, with vitamin C and E being most commonly used. Generally dietary intakes in this group were adequate with the exception of calcium and vitamin D intakes which were frequently too low (Garry et al, (1982). A study of the elderly in California (n=51) found similar results, with 72% consuming micronutrient supplements. Nutrients, which were most likely, to fall below 100% RDA were: calcium, iron, thiamine, and riboflavin (Gray et al, 1983).

A telephone survey was conducted in the USA in the early eighties on 2991 adults in order to examine the use of dietary supplements in the population (Stewart et al, 1985). Forty percent of the population were using one or more supplements. The most widely consumed type was the single vitamin one, of which vitamin C was by far the most popular; namely, 90.6% of supplement users. Women of all ages used supplements more frequently

than men. However more men than women used magnesium, zinc, manganese, copper or iodine.

Kurinij et al. (1986) examined supplement use in 3 227 women who participated in the first National and Health and Nutrition Examination Survey (NHANES I). They found that 25% of women used dietary supplements regularly, while 67% of them consumed a multivitamin. Supplement users were generally white, had a higher education and income than non-supplement users.

In the NHANES II the use of supplements by children and teenagers was examined as well as dietary intakes from food. The number of regular users decreased with age until about age 13years. Generally children were more likely to receive supplements if they were white and had a high household income. Supplement users consumed more vitamin C than those who did not and supplement users had higher levels of vitamins C and A (Bowering & Clancy, 1986).

Looker et al. (1987) examined the iron status and dietary intakes of 1 to 19 year old supplement and non-supplement users in the NHANES II. Users ingested more fruits and vitamin C than non-users in several age-sex groups. Few differences were noted in iron status between the two groups.

Data from the National Health Interview Survey of 1987 was used to examine supplement use in adults. It was found that 51% of adults had consumed a supplement in the past year, while 23% did so daily. Whites and women were the most frequent users. Multivitamins, vitamin C, calcium, vitamin E and vitamin A were most commonly consumed (Subar & Block, 1990).

A more recent study of the elderly (n= 82) in Canada found that 43% of men and 62% of women reported using a nutrient supplement in the past year. Current use at the time of the interview was reported by 35% of the participants (Payette & Gray-Donald, 1991).

Mares-Perlman et al. (1993) reported on the supplement usage of 43 to 86 year old residents of Beaver Dam (n= 2152). Regular use of supplements was most prevalent among older men and women (40% and 48%). The impact of supplement usage on dietary intake was greatest in women, particularly for vitamins C, A, E, riboflavin and calcium.

A dietary survey undertaken in a representative sample of the Dutch population in Holland in 1987 and 1988 found that 17% of the population were using at least one dietary supplement on the day of the study. Use of

supplements was associated with age, season, gender, social class and use of alternative foods (Dorant et al, 1993).

Dietary and supplement usage were also evaluated in the Bogalusa Heart Study in 504 young adults. It was found that 10% of participants had taken a supplement during the past 24 hours (Zive et al, 1996). In the Malmo Diet and Cancer Study undertaken in Sweden, it was found that 19% of men and 31% of women took mineral supplements with iron supplements constituting about 45% of these (Elmstahl et al, 1996).

Supplement intake was evaluated in 11,643 adults who participated in the 1992 National Health Interview Survey Epidemiology Supplement in the USA. Forty-six percent of the sample reported supplement use in the past year and 24% reported daily use. Regular use was highest in whites, in women, in those at the poverty level and those older than 75 years (Slesinski et al, 1996).

Erkkola et al. (1998) reported on dietary supplement usage among pregnant Finnish women. They found that 70% of subjects used dietary supplements. With the exception of folate, iron and vitamin D intake, both users and nonusers had an adequate nutrient intake from their diet.

Kim and Keen (1999) examined supplement usage in 1 355 adolescent boys and girls in Korea. They found that 35.8% used supplements; with the most common supplements being vitamin C, multivitamins and calcium. When the intakes of nutrients from supplements and diet were combined, it was observed that the intakes of folate, niacin, vitamin C and iron exceeded levels proposed as upper safe levels.

A study on the use of dietary supplements in the USA population (NHANES III) indicated that approximately 40 % of the population took dietary supplements during the month prior to the study. Females were more frequent consumers (44%) than males (35%), as were whites (43%) compared with African Americans (29%). Children 1-5 years were also major supplement users (Ervin et al, 1999). Higher levels of education and income were positively related to supplement use. Of the supplement users, 67% took a single supplement while 46% took a combination of vitamins and minerals (Ervin et al, 1999).

A study on supplement usage by 130 adults aged 70 years and older in North Carolina found that 47% reported using one or more supplements. African Americans were significantly less likely to use a supplement than Native Americans and European Americans. For all nutrients studied except

iron and calcium, a greater proportion of those without a dietary deficiency took a supplement product than those with a deficiency (Vitolins et al, 2000).

A recent study by Ervin and Kennedy-Stephenson (2002) found that the highest prevalence of inadequate dietary intakes in adults over 60 years in NHANES III was for calcium and zinc. Dietary supplements improved intakes but nearly two-thirds of the elderly had combined intakes less than the requirement for calcium. One of the main reasons for this was the finding that participants consumed supplements with low levels of calcium.

Data on 423 adolescents from the 1994 Continuing Survey of Food Intakes of Individuals (CSFII) was used to examine supplement usage in this age group. Approximately one third of adolescents reported using supplements with 15.6% using them on a daily basis. The majority reported taking multivitamins and about one third reported taking individual vitamins or minerals. Usage was associated with gender, household size, and US region of residence (Stang et al, 2000).

Dietary supplement usage was evaluated in 1379 Irish adults. It was found that 23% of respondents regularly used supplements. Women were twice as likely as men to use supplements. The intakes of nutrients were

significantly higher in supplement users than in nonusers ($p < 0.01$). The percentage of female users who had mean iron intakes below the Average Requirement (AR) of 10mg decreased from 50 to 25 when the contribution from supplements was included (Kiely et al, 2001).

Troppmann et al. (2002) examined the dietary intakes of supplement users (SUs) versus non-supplement users (NSUs) of 1530 adults in Canada. They found that both SUS and NSUs had similar dietary intakes with mean iron, calcium and folate intakes less than the RDAs. Supplement users of multivitamins had higher iron, calcium, vitamin D and folate levels compared with NSUs. Of some concern however was the finding that many SUs exceeded the Upper Intakes (UIs) of safe intake. In the case of niacin it was 47% of SUs.

In summary, a review of the literature in this section has indicated that supplement usage is very common in middle- to high-income countries among persons of all age groups.

2.4.2 Fortified foods

Fortification has been used extensively in the 20th century to eliminate and to prevent nutrient deficiencies. Indeed, wise fortification of certain key

foods is known to assist in obtaining adequate nutrition by those who do not or cannot consume the desired and proper variety of foods (Stare, 1979). In both high and low-income countries fortification of food has proven to be an effective and low-cost way to increase the nutrient supply and to reduce the consequences of nutritional deficiencies (Torun, 1988; Dary et al, 2002).

Micronutrient deficiencies that are most prevalent in the world (even today) are iodine, vitamin A and iron, and together with protein-energy malnutrition are regarded as the "big four" nutritional disorders, particularly in low-income countries. Indeed, zinc and thiamine are also cause for concern in some countries (Latham 1997). On the other hand, certain micronutrient disorders have virtually disappeared as a result of fortification of food. For example, pellagra was virtually eliminated in the US in the thirties and forties by the fortification of cereal/ grain products (Park et al, 2000). In many low-income countries the iodation of salt has led to large improvements in the prevention of iodine deficiencies. Vitamin A fortification of staple foods have similarly shown evidence of improved vitamin A status and the reduction of serious deficiencies. One success story in this regard has been the fortification of sugar in Guatemala, which showed that the prevalence of vitamin A deficiency in children was significantly reduced (Latham, 1997).

In sub-Saharan Africa the majority of countries which fortify foods do so on a voluntary basis. Examples of such countries include Malawi, Kenya, Ghana and Botswana. Countries, which have introduced mandatory fortification, include Nigeria, Zambia, and South Africa.

The vehicles used for fortification of vitamin A include: monosodium glutamate, tea, sugar, tea, margarine, oil, and maize meal. Iodine has been added to bread, water, milk, and sauces, salt and even to water. However, it is recommended that iodine should only be added to salt. Iron is a more difficult micronutrient to add to foods due to the organoleptic changes it induces n the food vehicle(s) , and poor absorptive characteristics. Some vehicles that have been tried with varying degrees of success have been: rice, wheat flour, salt, sugar, bakery products, maize flour, chocolate milk and condiments (fish sauce) and processed foods (Latham, 1997). Few studies on successful interventions using fortification of food have been reported in sub-Saharan Africa. An exception to this is the iodation of salt in South Africa that became mandatory in 1995 (DOH, 2000)

In middle and high-income countries a number of studies have evaluated the benefits of fortification to health. In the UK, flour is fortified with calcium carbonate. An evaluation of the efficacy of this

programme showed that fortified flour contributed 16% to the calcium intake of adolescents. Without fortification, the percentage of children with intakes below the RDA would be more than double (Hackett et al, 1984). A more recent study on calcium fortification and effects on 379 adolescents in Northumbria showed that calcium fortification of flour is an important source of calcium (Moynihan et al, 1996). Fortification accounted for 13% of their calcium intake. When the contribution of calcium from fortification was removed, the proportion of subjects below the lower reference nutrient intake increased by more than four times. The investigators concluded that calcium fortification of flour remains an important source of calcium in the diet.

Anderson et al. (1986) reported that 26% of USA adults tested (n=42) had abnormal thiamine biochemical values. They believe that withdrawal of thiamine fortification of processed cereals would worsen this situation.

In studies of consumption of fortified foods in Germany between 1985 and 1996, a relatively constant consumption ratio of 62-68 different fortified products per 100 consumers was found. This has been accompanied

by a continuous increase in vitamin C and E intakes (Sichert-Hellert et al, 1999).

The European Consumer Study also indicated that a mean of 18% of consumers actively seek fortified foods; ranging from 15% usage in the UK to 27% in Poland. Sixty-two percent of consumers indicated that regular eating of fortified foods would improve their overall health (Anon, 2001).

2.5 Dietitians' views and practices regarding the use of dietary supplements and fortified foods

Dietitians in most middle and high-income countries are regarded as the main advocates and experts with regard to promoting a healthy diet and lifestyle. Indeed most countries have developed dietary guidelines aimed at encouraging a healthy diet (Moschandreas & Kafatos, 1999;Wearne& Day, 1999). However there is a paucity of data on the role of dietitians, with regard to the promotion of dietary supplements and use of fortified foods as part of a healthy lifestyle. Two such studies undertaken in the USA have reported that dietitians do not rate the prescription and use of dietary supplements very highly. Vickery & Cotugna (1990) found that when dietitians were requested to rate each of 25 health-promoting practices, they rated "taking of vitamin supplements" as the lowest in importance.

Similar findings regarding the prevention of cancer have been described. In this regard dietitians have been reported to believe that there is strong evidence for increasing the intake of fruit and vegetables, whole grains and fibre in order to reduce cancer risk, but that the evidence to support the use of dietary supplements is inadequate (Merlino & Price, 1992).

Nevertheless a survey on the supplementation patterns of dietitians undertaken in Washington State found that nearly 60% of dietitians used a nutritional supplement; the most common being combinations of multivitamins plus minerals and/or vitamin C only (Worthington-Roberts & Breskin 1984). Similarly, dietitians' practices with regard to functional foods and supplements in a study undertaken in Oregon reported that more than 80% of dietitians were confident (positive) about the effectiveness of functional foods and nutrient supplements in the prevention of illness and treatment of chronic diseases, and 89% were confident about their safety for these uses (Lee et al, 2000). Furthermore, a comparative study on the prescribing practices of dietitians and physicians with regard to nutritional supplements found that prescribing by dietitians led to fewer inappropriate outpatient prescriptions and to more comprehensive nutritional assessments, as

measured by relevant laboratory use and dietetic follow-up (Steigh et al, 1998).

To date no published data with regard to dietitians' knowledge and/or practices of micronutrient supplements in South Africa, could be found.

3. MOTIVATION FOR THE STUDY (Problem)

The practice of nutrition has evolved very significantly over the past decade, to the extent that the management of nutritional disorders has become highly specialised. This in turn implies that the safe and cost-effective use of nutritional products require specialised knowledge and experience. The dietitian is the only professional specifically trained for the management of nutritional disorders and by inference the appropriate professional to prescribe nutritional products, including supplements. A motion and recommendation for the appropriate legislation in this regard has served before the Professional Board for Dietetics in March 2002 (Labadarios, 2002).

"It is recommended that the dietitian be allowed to prescribe/ recommend (as appropriate) food products, food replacements/substitutes, vitamins, electrolytes and trace elements, medicines used in the management

of nutrition-related disorders and devices of the following: specialised feeds used in total enteral nutrition; specialised solutions used in total parenteral nutrition; all commonly available or specialised nutritional supplements (homeopathic and related remedies excluded); devices used in the management of nutrition related disease including feeding tubes and percutaneous endoscopic gastrostomy and jejunostomy devices; and antidiarrhoeals, motility agents, antiemetic agents and over the counter anorectics." (Labadarios, 2002).

Currently only medical doctors in South Africa are legally able to prescribe dietary supplements for preventative and/or therapeutic benefit of nutritional disorders. However, in practice many health professionals, including dietitians, follow this practice. The extent to which this is being undertaken is, however, uncertain since neither dietitians' knowledge nor their practices in this regard, have been evaluated. The same applies to the practice of using and recommending fortified foods, since these are essentially vehicles for micronutrients.

In order to make recommendations and enact legislation with respect to fortification of foods for the population at large, the National Food Consumption Survey (NFCS) was undertaken in South Africa in 1999

(Labadarios et al. 2000). The survey population comprised of all children aged 1-9 years. A total of 156 census enumerator areas were included in the survey, 82 of which were urban and 74 non-urban. A total of 3120 children were included in the sample and data was obtained on 2894, a 93% response rate. Dietary data was obtained from the caregivers of the children employing, among others, the 24-hour recall and quantified food frequency dietary methodology. The mean energy intake of these children at the national level ranged from 4200-5800kJ. Younger children in rural areas had the lowest such intake. The mean intake for calcium, iron and zinc was significantly lower than the dietary reference intake for each age group studied. A large percentage of children were also found to have an inadequate intake of folate, vitamins A, E, riboflavin, niacin, B6, B12 and C. The mean energy and nutrient intake of non-urban children was generally significantly lower than those of children living in urban areas ($p<0.01$). The overall conclusion of the NFCS was that a great majority of children consumed a diet deficient in energy and poor in nutrient density. The NFCS also identified the most commonly eaten food items by these children in the country. Maize was the food item most commonly consumed followed by white sugar, tea, whole milk and brown bread. More than 72% of children ate

maize and sugar. Bread consumption was relatively low during the first three years of life, with only about 33% of children consuming brown bread. The consumption of the latter increased to 44% in 7-9 year olds.

Based on the findings of the NFCS, a Fortification Task Group recommended that maize and wheat flour be fortified to provide, per 200g raw maize meal/wheaten flour, the following:

i) Vitamin A, thiamin, niacin, pyridoxine - 25% of the RDA of a person 10 years and older;

ii) Folate- 50% of the RDA of a person 10 years and older;

iii) Riboflavin- 17% for maize and 20% for wheat flour of the RDA of a person 10 years and older;

iv) Iron- 25% of the RDA of a person 10 years and older;

v) Zinc- 20% of the RDA of a person 10 years and older;

The relevant legislation has been drafted and was promulgated during the latter part of 2002. Compulsory fortification starts in October 2003.

4. MAIN OBJECTIVE (Purpose)

To develop a valid and reliable questionnaire, which is able to test knowledge and practices of dietitians in South Africa with regard to the use of dietary supplements and fortified foods.

5. SPECIFIC OBJECTIVES

Primary objectives:

i) To develop a questionnaire for evaluating dietitians' knowledge and practices with respect to the use of dietary supplements and fortified foods.

Secondary objectives:

i) To evaluate dietitians' knowledge with respect to the use of dietary supplements and fortified foods within the process of the development of the questionnaire.

ii) To evaluate dietitians' practices with regard to prescribing and/or recommending dietary supplements and fortified foods, (within the process of the questionnaire development) of their clients.

iii) To provide academic institutions who train dietitians with feedback regarding the outcomes of the survey.

iv) To use the data obtained in order to make a decision with respect to the development of educational material in this regard.

6. METHODS

6.1 Definition of Terms

Dietary supplements: As defined by the ODS (page 4 of the proposal).

Dietitian: A registered health professional who practices in accordance with Act 56 of 1974 governing the scope of practice of dietitians.

Fortified foods: The addition of one or more nutrients to a food to improve its nutritional quality; also known as "enrichment" (Latham, 1997).

Health enhancing ingredients: classified as "other dietary substances" by the ODS.

Micronutrients: Over 30 vitamins and minerals which are essential for human health and for the proper growth and development of children (Latham, 1997).

6.2 Study Design

A descriptive cross-sectional study was undertaken.

6.3 Study Population and Sampling

All registered dietitians in South Africa were included in the sample. The sampling frame comprised the most recent list of registered dietitians, which was obtained from the Health Professional's Council of South Africa. A questionnaire and business-reply envelope was mailed to all dietitians (N= 1450). Reminders were sent after the due return date and again a month later. A token of appreciation, namely a sample of multivitamins, was mailed to each participant on receipt of their completed questionnaire. Every attempt was made with follow-ups to attain a minimum response rate of 50%.

6.4 Questionnaire Development

A questionnaire was developed to test knowledge and practices of dietitians with regard to dietary supplements. The questionnaire comprises three sections (Appendix A). The first section includes demographic questions relating to the age, gender, educational background and field/area of practice of the dietitian. The second section comprises questions designed to assess the dietitians' practices with respect to the use of dietary supplements. (Practices in this study refer to prescribing/recommending supplements as well as own use of supplements). Demographic questions in

section 1 and practices in section 2 were identified by a panel of four nutrition experts. They included: a dietitian with research experience; a nutrition medical specialist with research and teaching experience; a dietitian working in industry regarding dietary supplements (micronutrients); and a chemist working with the industrial application of micronutrients. This group had sufficient expertise and experience to identify essential questions, and to provide construct, face and content validity to these sections.

The third section tests the dietitians' knowledge with regard to certain concepts related to dietary supplements. This knowledge test was compiled by means of a series of steps aimed at ensuring validity and reliability of the final product.

6.4.1 Development of the Knowledge Questions (Appendix A-Section C)

In order to develop a valid and reliable knowledge questionnaire (test) the following steps were undertaken:

Step 1. Identification of concepts and objectives

In order to ensure *construct* validity of the questionnaire it was necessary to ensure that a suitable and appropriate conceptual framework was

developed which identified those aspects (concepts) of the framework, and which would be considered relevant for the specific target group to know (Boekner et al, 1999; Alaimo et al, 1999). Furthermore the main knowledge concepts to be investigated were identified first (Byrd-Bredbenner, 1981; Dwyer et al, 1981; Lackey et al, 1981; Boekner et al, 1999; Alaimo et al, 1999), and were based on ones which were regarded as essential concepts to be known by the group of people to be tested (in this case dietitians). These concepts were identified by a panel of four nutrition experts, as described in the previous section (6.4). The concepts selected by the panel were: 1) structure and functions of micronutrients; 2) deficiency and potential toxicity of micronutrients; 3) recommended intakes of micronutrients; and 4) absorption, bioavailability and bioconversion of micronutrients. From these concepts the following objectives were identified as important elements of the knowledge test namely:-

1. The main functions of the essential micronutrients;
2. Micronutrient levels required to reduce the risk of certain diseases;
3. Effects of drug -micronutrient interactions;
4. Effects of disease and physiological conditions on micronutrient requirements;

5. Knowledge of the pharmacokinetics of micronutrients;

6.The role of micronutrients in maintaining optimal health; and

7. The rationale and efficacy of food fortification. The last objective was included because of the current initiatives on food fortification in the country by the National Department of Health.

Since there are so many essential micronutrients, only those relevant in terms of dietary inadequacies in South African populations (Labadarios et al., 2000), and those associated with chronic diseases (Steyn & Walker, 2000), were selected for inclusion in the questionnaire. These include vitamins: A; C; thiamin; riboflavin; niacin; B6; B12; folate; minerals: iron; calcium; zinc; magnesium and potassium; and other nutrients (lutein, lycopene, omega 3 and omega 6 fatty acids). The latter nutrients were added because of their topical nature and the voluminous research on their use.

Step 2. Development of the knowledge questions:

Using the concepts generated in Step 1, a total of 355 (true-false) knowledge questions (items) were originally generated by the nutrition panel. These items were generated from the literature as well as from expert advice provided by the panel of experts. The items generated were then sent to an external expert group. This group comprised 9 dietitians with

research experience and teaching in dietetics at 8 tertiary institutions in South Africa. The purpose of this step was to evaluate each question in terms of its relevance and the need for dietitians to know the aspect covered by the question. Using a scale of 1 to 5, (5 meaning very relevant and important for a dietitian to know and 1 meaning unimportant or irrelevant) each expert scored the questions in the item pool. A mean score was then generated for each question within each category. Questions which scored 3 or less were deleted from the questionnaire. This left a questionnaire with 120 items.

These remaining 120 items were then subjected to a second evaluation by 8 qualified practicing dietitians, selected from each of the following groups: private practice, therapy, community, industry and the academia. These dietitians convened at a meeting and discussed each of the questions for relevance and face value. Unsuitable items were eliminated or changed if it was felt that the item was not relevant/important for a dietitian to know, or if the wording of the questions was unsuitable. This resulted in a questionnaire comprising 70 items, which were judged to be appropriate and important for dietitians to know. These procedures in effect ensured *content* and *face* validity of the questionnaire (Sullivan & Schwartz, 1981;

Talmage & Rasher, 1981). To ensure *content* validity the panels were required to retain only those items, which they believed adequately addressed the concepts. To ensure *face* validity the panels were required to evaluate the appropriateness, relevance, accuracy and formulation of the items. Face validity relates to the appearance of reasonableness of the test from the perspective of the test-taker. Persons who have expertise with the intended audience itself are generally considered to be good judges of face validity (Talmage & Rasher, 1981).

Step 3. Ensuring criterion validity of the final questionnaire:

In order to demonstrate criterion validity the test of 70 items was administered to different groups who were expected to score high or low on the basis of their training, education and exposure to nutrition (Sullivan & Schwartz, 1981; Talmage & Rasher, 1981; Parmenter & Wardle, 1999). The groups selected were dietetic interns (n=105) and final year nursing students (n= 48). It was expected that dietetic interns would have the highest mean score, and nursing students the lowest mean score; also that their results would differ significantly in order to demonstrate criterion validity.

Step 4. Reliability of the questionnaire:

4.1 Item difficulty: Since items are not useful, if they are answered correctly by more the 80% (too easy) or fewer than 20 % (too difficult) of respondents (Kline, 1993), such questions were removed from the test taken by the dietetic interns.

4.2 Item discrimination: Each item should ideally correlate with the total test score. A minimum of 0.2 has been proposed as the cut-off value below which items should be discarded (Kline, 1986). A few such questions were retained in this study since it was felt that they were testing an essential aspect of micronutrients.

4.3 Internal consistency: Cronbach's alpha was used to determine internal consistency (reliability) of the test results of the dietetic interns (Byrd-Bredbenner, 1981; Dwyer et al, 1981; Lackey et al,1981; Boekner et al, 1999; Alaimo et al, 1999). Items, which had an alpha value greater than the standardized alpha value of each of the 4 concepts/factors described in Step 1 were deleted. This also included items, which had correlation values less than 0.2 with the totals in each category.

Step 5. Internal consistency of the final questionnaire

The final questionnaire (Appendix A) with a prepaid envelope was mailed to all dietitians whose names appeared on the Health Professionals Council's register in August 2002 (n= 1450). Reminders were mailed during September and again in November 2002.

6.5 Data Management and Analyses

Data was entered in Excel (spreadsheets), cleaned and then imported into the SAS programme. The Wilcoxon two-sample test was used to determine whether there were significant differences between concepts and groups. The Kruskal-Wallis test was used to compare 3 or more means. The mean scores and 95% confidence intervals on the overall knowledge test and on specific knowledge concepts were calculated. Spearman's correlations were calculated to determine the relationship between age and duration of practice on knowledge scores.

Ethical and Legal Considerations

The Ethics Committee of the University of Cape Town approved the protocol for the study. The interns and nurses who took part in the questionnaire development phase were fully informed regarding the purpose of the study

and participated anonymously. All dietitians who took part in the postal survey did so anonymously, by own choice. No participants were required to identify themselves by name on the questionnaire. Results of the study were mailed to all registered dietitians on completion of the study.

7. RESULTS

7.1 Criterion validity of the knowledge test

In Table 1 and Figure 1 it is shown that there were significant differences ($p < 0.001$) between the knowledge concepts and total scores of the two groups of participants, with the dietetic interns having the best scores, thus establishing criterion validity of the questionnaire. Based on the distribution of scores of the two groups, the following knowledge score category was adopted and is recommended for use: <35% = poor knowledge; 36-50% = average; 51-65% = good; > 65% = very good. Using these categories 25% of nurses and 54.3% of the interns scored as "good" and 0% nurses and 23.8% of interns scored as "very good".

Table 1: Mean knowledge scores of dietetic interns (n= 105) and nurses (n= 48) who participated in completing knowledge test comprising 70 questions

Concepts	Mean Score	% Correct	SD	Min	Max	Lower 95% CI	Upper 95% CI	p-value*
Dietetic Interns (n=105)								
A (max=20)	8.69	53.29	2.87	5.14	16.86	8.27	9.12	<0.0001
B (max=24)	14.87	61.94	3.13	6.00	22.00	14.26	15.48	<0.0001
C (max=16)	8.05	50.30	2.37	2.00	14.00	7.59	8.51	<0.0001
D (max=10)	6.67	66.67	1.37	2.00	10.00	6.38	6.96	<0.0001
Total = 70	40.24	57.48	7.27	17.99	58.99	38.79	41.69	<0.0001
Nurses (n=48)								
A (max=20)	6.62	34.58	2.89	1.00	13.00	5.80	7.45	
B (max=24)	11.79	49.13	3.51	2.00	17.00	10.73	12.85	
C (max=16)	4.54	28.39	2.21	1.00	9.00	3.88	5.21	
D (max=10)	3.65	36.46	1.90	0.00	9.00	3.07	4.22	
Total =70	36.90	38.42	8.91	9.00	44.0	24.21	39.58	

*Wilcoxon two-sample test

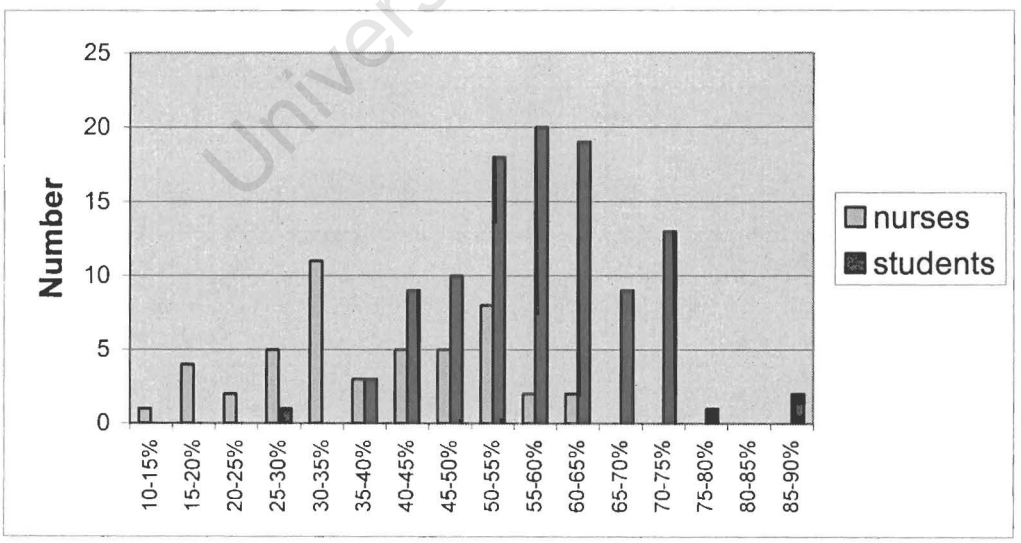
Concept A= Absorption, bio-availability and bioconversion

Concept B= Deficiency and toxicity of micronutrients

Concept C=Recommended intakes

Concept D=Structure and functions of micronutrients

Figure 1: Histogram of percentages scored by nurses and dietetic interns (students) in the knowledge test comprising 70 questions



7.2 Internal consistency of the knowledge test

Table 2 presents data on the internal consistency of the knowledge test at different stages, namely the 70 item and the 50 item tests. The original 70 question test alpha Cronbach values after the study on nurses and dietetic interns showed a value of 0.93 for nurses and 0.83 for dietetic interns. After deletion of 20 unsuitable items the alpha values were 0.91 for nurses and 0.85 for dietetic interns.

The second test for internal consistency was on the knowledge test results of the mail survey to dietitians. Thirty-seven questionnaires were returned with address unknown. Seven questionnaires were spoiled and hence discarded. A total of 367 questionnaires were returned which were suitable for analyses. The response was rather disappointing, even though every effort had been made to encourage responses; including two reminders and a token of appreciation on receipt of the returned questionnaire. The poor response rate can therefore be regarded as one of the limitations of the study.

The alpha Cronbach on the test (n=367) was found to be 0.87; a satisfactory value of internal consistency. The alpha values of the individual

subsections scored less favorably and ranged from 0.48 to 0.75. This implies that individual subsections should be used cautiously on their own and should rather remain as part of the overall test. Table 3 provides more detail on individual questions.

Table 2: Internal consistency of the knowledge test as demonstrated by alpha Cronbach values of dietetic interns, nurses and dietitians

Group	Alpha Cronbach values of the 70 question test	Alpha Cronbach values after deletion of 20 unsuitable questions
Nurses	N=48	N=48
Concept A	0.75	0.68
Concept B	0.83	0.79
Concept C	0.72	0.73
Concept D	0.73	0.52
Total test	0.93	0.91
Dietetic interns	N=105	N=105
Concept A	0.70	0.65
Concept B	0.70	0.71
Concept C	0.54	0.62
Concept D	0.28	0.48
Total test	0.83	0.85
Dietitians		N=367
Concept A		0.65
Concept B		0.75
Concept C		0.64
Concept D		0.48
Total test		0.87

Concept A= Absorption, bio-availability and bioconversion
Concept B= Deficiency and toxicity of micronutrients
Concept C=Recommended intakes
Concept D=Structure and functions of micronutrients

Table 3: Item analysis of 50 items remaining after the study of the interns (n= 105)

Question	Factor number	Loading	Concept Category	Correlation with total	Cronbach (if deleted)
25	1	0.422	A	0.311	0.622
63	1	0.646	A	0.261	0.629
15	2	0.557	A	0.351	0.615
33	2	0.359	A	0.486	0.593
60	4	0.605	A	0.303	0.623
10	6	0.551	A	0.323	0.620
14	6	0.670	A	0.283	0.626
2	7	0.452	A	0.189	0.640
40	7	0.815	A	0.306	0.622
55	11	-0.418	A	0.118	0.651
56	12	0.727	A	0.215	0.636
7	14	0.629	A	0.081	0.657
12	15	-0. 391	A	0.222	0.635
48	16	0.806	A	0.338	0.617
28	1	0.485	B	0.543	0.678
39	1	0.406	B	0.368	0.696
53	1	0.756	B	0.361	0.696
62	1	0.608	B	0.432	0.689
18	2	0.665	B	0.255	0.707
64	3	0.712	B	0.213	0.711
4	5	0.636	B	0.394	0.683
24	5	0.461	B	0.501	0.682
35	5	0.800	B	0.308	0.702
6	6	0.336	B	0.216	0.711
67	6	0.677	B	0.201	0.712
30	9	-0.721	B	0.224	0.710
42	10	0.548	B	0.251	0.707
11	13	0.540	B	0.410	0.692
70	14	0.629	B	0.223	0.710
23	17	0.749	B	0.020	0.728
29	18	0.876	B	0.067	0.724
38	18	0.328	B	0.333	0.699
9	2	0.385	C	0.361	0.579
5	3	0.603	C	0.541	0.541
57	4	0.770	C	0.332	0.584
59	7	0.339	C	0.352	0.581
34	8	0.803	C	0.239	0.603
51	10	0.777	C	0.131	0.623

8	11	0.702	C	0.138	0.622
49	12	0.523	C	0.123	0.624
68	13	0.789	C	0.180	0.614
69	13	0.577	C	0.440	0.562
26	14	-0.454	C	0.209	0.608
44	17	0.584	C	0.190	0.612
13	1	0.414	D	0.268	0.418
22	1	0.637	D	0.156	0.477
45	9	0.724	D	0.287	0.407
58	11	0.425	D	0.094	0.509
31	15	0.761	D	0.261	0.421
50	15	0.495	D	0.392	0.347

7.3 Demographic data of the dietitians surveyed

Of the 1450 questionnaires mailed to dietitians, 367 were returned which were suitable for analyses. Thirty-seven questionnaires were returned with address unknown. Seven questionnaires were spoiled and hence discarded. The response rate (26%) is rather disappointing, even though every effort had been made to encourage response; including two reminders and a token of appreciation on receipt of the returned questionnaire. The poor response rate can therefore be regarded as one of the limitations of the study.

The characteristics of the sample are presented in Table 4. The largest proportion of the sample comprised of females, with 43.3 % aged less than 30 and 36.5 % between 30 and 40 years. Only 15.2% of dietitians were working in rural areas with 84.8 % working in urban areas.

Table 4. Characteristics of the dietitians who participated in the study

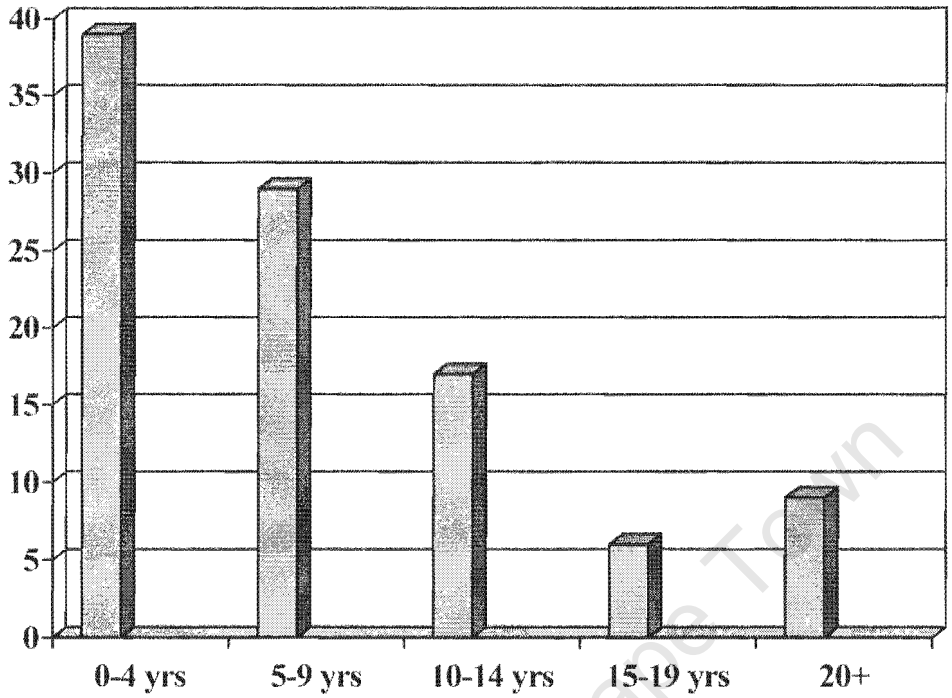
Characteristic	Number of respondents	Percent
Gender: Females	357	97.5
Males	9	2.5
Age in years: < 24.9	46	12.5
25-29.9	110	30.0
30- 39.9	134	36.5
40 & above	74	20.2
Area: Rural	53	15.2
Urban	296	84.8

Dietitians who participated in the study came from a variety of different areas of practice with the majority in private practice (37.1%) or hospital-based (27.8%), with a smaller number in food service management (10.9%), education (9.8%) and teaching (6.5%) (Table 5). Overall they had a similar distribution to the Association for Dietetics in South Africa (ADSA).

Table 5. Main area of practice of dietitians who participated in the study (N=367)

Field of working	No in sample	Percent	SA total number (ADSA)	Percent (ADSA)
Private practice	136	37.1	463	31.4
Teaching & research	24	6.5	123	8.3
Education/community	36	9.8	77	5.2
Clinical/hospital-based	102	27.8	254	17.2
Food service management	40	10.9	94	6.4
Industry and marketing	21	5.7	56	3.8
Not working/retired	8	2.2	-	-
Not specified	-	-	136	9.2
Other	-	-	272	18.4
Total	367	100%	1475	100%

Figure 2: Classification of the dietitians according to years of practice



7.4 Dietitians' practices with regard to prescribing dietary supplements and fortified foods

Table 6 presents a summary of the practices of dietitians in the present study with regard to supplements and fortified foods. More than 80% of dietitians indicated that they recommend one or more types of supplements to clients/patients, with 17.1% actually selling supplements.

Table 6. Dietitians' practices with regard to supplements and fortified foods

Practices	Number of respondents	Percent
Recommend supplements:		
No	63	17.4
Yes	294	81.2
N/A	5	1.4
Sell supplements:		
No	300	82.9
Yes	62	17.1
Recommend fortified foods:		
No	136	38.8
Yes	211	60.3
N/A	3	0.9

Sixty percent of dietitians in the present study recommended fortified foods to their clients. The most commonly recommended breakfast cereals were All Bran/ high fibre cereals, followed by Pronutro (Table 7). The most common brands recommended were Kellogs, and Bokomo.

Table 7. Fortified breakfast cereals commonly recommended by dietitians in the present study

Fortified Breakfast cereals*	Number of respondents	Percent
All Bran/ high fibre cereals	40	23.0
Pronutro	44	25.3
Wheatbix	6	3.4
Infant cereals	7	4.0
Corn Flakes	8	4.6
Oats	7	4.0
Muesli	4	2.3
Other breakfast cereals	10	5.7
Brands: Kellogs	85	48.9
Bokomo	21	12.1
Nestle	4	2.3
Total who answered:		
Recommend	174	92.6
Do not recommend any	14	7.4

*Voluntary fortification usually vitamin and mineral mixture of 15-25% RDA per serving

Floro proactive and Floro light margarine together were recommended by 84.2 % of dietitians (Table 8). This was followed by Canola (light) which was recommended by 12% of dietitians. The most common bread recommended was SASCO (43%) followed by Albany (16.7%) (Table 9). Forty percent specifically recommended brown or whole wheat bread.

Table 8. Fortified margarines commonly recommended by dietitians

Fortified margarine*	**Number of respondents**	**Percent**
Flora	112 (light &/or proactive)	84.2
Canola	16	12.0
Sunshine D	8	6.0
Stork	3	2.3
Blossom	1	0.7
Rama	2	1.5
Ole	2	1.5
Total who answered:		
Recommend	133	79.6
Do not recommend	34	20.4

*Voluntary fortification usually vitamin A and D

Table 9. Fortified breads commonly recommended by dietitians

Type of bread*	**Number of respondents**	**Percent**
SASCO (especially SAM)	26	43.3
Albany	10	16.7
Whole wheat/brown	24	40.0
Total who answered:		
Recommend	79	62.2
Do not recommend	48	37.8

*Voluntary fortification of vitamins A, B vitamins, Calcium and iron (15% of RDA per serving)

Table 10. Fortified maize meal commonly recommended by dietitians

Type of maize meal*	Number of respondents	Percent
Ace	23	25.8
Iwisa	17	19.1
White Star	6	6.7
Diva	6	6.7
Total who answered:		
Recommend	89	66.9
Do not recommend	44	33.1

*Voluntary fortification with vitamins A, B vitamins, calcium, iron and zinc (15% RDA)

The prescription pattern of dietitians varied widely, with multivitamins with minerals being prescribed at least 3 times a week by 38% of dietitians, while multivitamins alone are prescribed by 29% of dietitians (Table 11). About 34% of dietitians indicated that they prescribe calcium at least 3 times per week and omega-3 fatty acids are prescribed by 31%. The least common items prescribed are potassium, zinc, lycopene, and lutein. Overall 76.6% of dietitians prescribed a dietary supplement, whether occasionally or more frequently.

7.5 Dietitians' own practices with regard to dietary supplement usage

Fifty-one percent of dietitians indicated self-consumption of a dietary supplement at least three times a week and 35% indicated self-consumption of multivitamins plus minerals on a daily basis (Table 12). Also frequently

used on a daily basis were calcium (17.8%) and omega-3 fatty acids (17.3%). The rest of the supplements were used by less than 10% of dietitians on a regular basis.

Table 11. Frequency (%) with which dietitians in the present study(n=367) prescribed dietary supplements

Supplements	Never	Occasionally 1x/week	Frequently 3-5x/ week	Daily
Multivitamins	104 (31.9)	126 (38.6)	49 (15.0)	47 (14.4)
Multivitamins + minerals	86 (23.4)	142 (38.7)	73 (19.9)	66 (18.0)
B complex	110 (32.1)	144 (43.4)	45 (13.6)	33 (9.9)
Multivitamins + iron	177 (48.2)	128 (34.9)	35 (9.5)	27 (7.4)
Multivitamins + calcium	128 (40.7)	108 (34.3)	46 (14.6)	33 (10.5)
Vitamin C	119 (38.1)	117(37.5)	43 (13.8	33 (10.6)
Vitamin E	174 (57.4)	79 (26.1)	35 (11.6)	15 (5.0)
Vitamin A	190 (64.9)	59 (20.1)	27 (9.2)	17 (5.8)
Vitamin B6	178 (61.0)	82 (28.1)	18 (6.2)	14 (4.8)
Vitamin B12	170 (57.6)	93 (31.5)	18 (6.1)	14 (4.8)
Calcium	89 (27.1)	125 (38.1)	60 (18.3)	54 (16.5)
Iron	113 (36.1)	135 (43.1)	36 (11.5)	29 (9.3)
Potassium	216 (73.7)	59 (20.1)	13 (4.4)	5 (1.7)
Magnesium	170 (55.9)	95 (31.3)	25 (8.2)	14 (4.6)
Zinc	165 (53.7)	109 (35.5)	22 (3.6)	11 (3.6)
Omega 3	108 (32.9)	118 (36.0)	59 (18.0)	43 (13.1)
Lycopene	245 (86.3)	31 (10.9)	6 (2.1)	2 (0.7)
Lutein	262 (90.3)	23 (8.0)	2 (0.7)	0 (0)

Table 12. Frequency (%) with which dietitians in the present study (n=367) consumed dietary supplements themselves

Supplements	Never	Occasionally 1x/week	Frequently 3-5x/ week	Daily
Multivitamins	207 (71.6)	43 (14.9)	18 (6.2)	20 (6.9)
Multivitamins + minerals	84 (22.9)	70 (19.1)	59 (16.1)	127 (34.6)
B complex	187 (60.3)	66 (21.3)	30 (9.7)	27 (8.7)
Multivitamins + iron	226 (78.8)	34 (11.8)	8 (2.8)	19 (6.5)
Multivitamins + calcium	218 (75.4)	36 (12.5)	14 (4.8)	21 (7.3)
Vitamin C	155 (50.7)	95 (31.1)	25 (8.2)	30 (9.8)
Vitamin E	242 (84.9)	20 (7)	10 (3.5)	12 (4.2)
Vitamin A	253 (91.3)	16 (5.8)	4 (1.4)	4 (1.4)
Vitamin B6	247 (88.2)	19 (6.8)	6 (2.1)	8 (2.9)
Vitamin B12	246 (89.1)	18 (6.5)	5 (1.8)	7 (2.5)
Calcium	157 (51.5)	58 (19.1)	35 (11.5)	54 (17.8)
Iron	220 (76.1)	34 (11.8)	16 (5.6	18 (6.3)
Potassium	263 (94.6)	9 (3.2)	4 (1.4)	2 (0.7)
Magnesium	230 (78.8)	27 (9.3)	13 (4.5)	22 (7.5)
Zinc	231 (82.2)	22 (7.8)	16 (5.7)	12 (4.3)
Omega 3	179 (58.3)	44 (14.3)	31 (10.10)	53 (17.3)
Lycopene	263 (98.1)	3 (1.1)	1 (0.4)	1 (0.4)
Lutein	263 (99.1)	3 (1.1)	1 (0.4)	1 (0.4)
Other	265 (99.3)	2 (0.8)	-	-

7.6 Dietitians' knowledge of micronutrients and fortification

Dietitians had a mean and median score of 58.4% and 60% respectively for the overall knowledge test (Table 13). Mean and median scores were highest for concepts D and B and lowest for C and A. Mean and median scores were very similar on all concepts indicating a similar distribution around the 50th percentile.

Table 13. Knowledge scores of dietitians (n=367) who participated in the present study

Scores	Mean	SD	Median	Minimum	Maximum
Total / 50	29.2	7.8	30.0	0	46.0
Total %	58.4	15.7	60.0	0	92.0
A score/14	8.0	2.7	8.0	0	14.0
A %	57.1	19.3	57.1	0	100.0
B score/18	10.7	3.3	11.0	0	18.0
B %	59.4	18.2	61.1	0	100.0
C score/12	6.5	2.4	7.0	0	12.0
C %	54.2	20.2	58.3	0	100.0
D score/6	4.0	1.5	4.0	0	6.0
D %	66.6	24.3	66.7	0	100.0

A= Absorption, bio-availability and bioconversion; B= Deficiency and toxicity of micronutrients
C=Recommended intakes; D=Structure and functions of micronutrients

The oldest group of dietitians scored the highest on concept A (absorption and bio-availability of micronutrients), followed closely by the 25-29.9 year old group (Table 14). For concept B (deficiency and toxicity of micronutrients) the oldest and youngest groups had the highest scores. All groups had similar scores for concept C (recommended intakes) while the youngest group scored lowest on concept D (structure and functions of micronutrients). The 40+-year-old group scored the highest on the overall test with a mean of 31.3 (95% CI: 29.2-33.3%). The Kruskal-Wallis test indicates that there were significant differences in the overall score of

dietitians between age groups (p=0.018) and on Concepts A (p= 0.004) and B (p=0.003).

Table 14. Knowledge scores of the dietitians (n=367) who participated in the study categorized by age groups

Age group In years	Statistics	Concept A (Max=14)	Concept B (Max=18)	Concept C (Max=12)	Concept D (Max=6)	All (Max=50)
<25 (n=46)	Mean(SD)	7.2 (2.2)	11.6 (2.8)	6.3 (2.3)	3.7 (1.5)	28.7 (6.4)
	95% CI	6.5-7.8	10.8-12.4	5.6-6.9	3.2-4.1	26.8-30.6
	% Correct	51.1%	64.5%	52.2%	61.2%	57.4%
25-29.9 (n=110)	Mean(SD)	7.8 (2.8)	10.8 (3.0)	6.7 (2.2)	4.0 (1.4)	29.3 (7.1)
	95% CI	7.3-8.3	10.2-11.3	6.3-7.1	3.7-4.2	27.9-30.6
	% Correct	55.7%	59.8%	56.0%	66.4%	58.5%
30-39.9 (n=134)	Mean(SD)	8.0 (2.7)	10.0 (3.4)	6.2 (2.5)	4.1 (1.5)	28.2 (8.3)
	95% CI	7.5-8.5	9.4-10.5	5.8-6.7	3.8-4.3	26.8-29.6
	% Correct	57.1%	55.3%	51.9%	67.5%	56.5%
40+ (n=74)	Mean(SD)	8.8 (2.7)	11.4 (3.5)	6.9 (2.6)	4.1 (1.5)	31.3 (8.8)
	95% CI	8.2-9.4	10.6-12.2	6.3-7.5	3.8-4.5	29.2-33.3
	% Correct	62.8%	63.4%	57.8%	68.7%	62.5%
Difference between age groups Kruskal-Wallis test		0.0044**	0.0037**	0.0621	0.4083	0.0185*

Concept A= Absorption, bio-availability and bioconversion
Concept B= Deficiency and toxicity of micronutrients
Concept C=Recommended intakes
Concept D=Structure and functions of micronutrients
**Significant difference between age groups using non-parametric Kruskal-Wallis test for comparing scores for different age groups, $p<0.01$
*Significant difference between age groups using non-parametric Kruskal-Wallis test for comparing scores for different age groups, $p<0.05$

In Table 15 the results of the knowledge concepts are summarized. The 25-29.9 year old group scored the highest on concept A. For concept B, the oldest and youngest groups had the highest scores. For concept C, all groups had similar scores. The youngest group scored lowest on concept D although scores were similar.

The Wilcoxon two-sample test indicated that there were no significant differences between the scores of dietitians in urban versus rural areas (Table 16) or between dietitians who sell or do not sell dietary supplements (Table 17). Field of practice and knowledge was also tested, but there was no significant difference between fields of practice (Chi-square p= 0.22).

Table 15. Knowledge of dietitians with regard to different concepts

Age group	Concept A	Concept B	Concept C	Concept D
<25 (n=46)	7.2 (2.2)	11.6 (2.8)	6.3 (2.3	3.7 (1.5)
25-29.9 (n=110)	7.8 (2.8)	10.8 (3.0)	6.7 (2.2)	4.0 (3.0)
30-39.9 (n=134)	8.0 (2.7)	10.0 (3.4)	6.2 (2.5)	4.1 (1.5)
40+ (n=74)	8.8 (2.7)	11.4 (3.5)	6.9 (2.6)	4.1 (1.5)
Difference in age groups Kruskal-Wallis test	0.0044	0.0037	0.0621	0.4083

A= Absorption, bio-availability and bioconversion
B= Deficiency and toxicity of micronutrients
C=Recommended intakes
D=Structure and functions of micronutrients

Table 16. Knowledge scores of dietitians (n=367) according to location of work

Location	Variable	Mean	SD	Median	Minimum	Maximum	W p value
Rural (n=53)	Total score	29.4	7.1	30.0	9.0	40.0	0.7470
	Total %	58.7	14.3	60.0	9.0	40.0	
Urban (n=296)	Total score	29.4	7.6	30.0	2.0	46.0	
	Total %	58.8	15.3	60.0	4.0	92.0	

W = Wilcoxon two-sample test

Table 17. Knowledge scores of dietitians (n=367) who sell and do not sell dietary supplements

Sell supplements	Variable	Mean	SD	Median	Minimum	Maximum	W p value
No (n=300)	Total score	29.3	7.8	30.0	2.0	46.0	0.8190
	Total %	58.6	15.6	60.0	4.0	92.0	
Yes (n=62)	Total Score	29.3	7.5	29.5	13.0	44.0	
	Total %	58.6	15.0	59.0	26.0	88.0	

W = Wilcoxon two-sample test

There is a positive significant linear relationship between the length of practice of a dietitian and total score on the knowledge test (p= 0.0173), indicating that the longer the dietitian has been practicing the higher her score was (Table 18). However, this relationship should be interpreted cautiously, since it is based on one knowledge concept only. This relationship was also bordering on significant for age and knowledge score (p= 0.0640). Knowledge score on A was significant for both age and length of practice.

Table 18. Spearman's correlation coefficients of dietitians' age and length of practice time with their knowledge scores (N = 367)

	Age of dietitian	Length of practice	Total score	A score	B score	C score	D score
Age of dietitian	1.0000	0.7713 **<0.0001**	0.0968 0.0640	0.1422 **0.0063**	0.0501 0.3384	0.0527 0.3138	0.0577 0.2700
Length of practice	0.7713 **<0.0001**	1.0000	0.1242 **0.0173**	0.1839 **0.0004**	0.0600 0.2509	0.0578 0.2694	0.0975 0.0621
Total score	0.0968 0.0640	0.1242 **0.0173**	1.0000	0.8408 **<0.0001**	0.8694 **<0.0001**	0.7319 **<0.0001**	0.6597 **<0.0001**
A score	0.1422 **0.0063**	0.1839 **0.0004**	0.8408 **<0.0001**	1.0000	0.6316 **<0.0001**	0.4488 **<0.0001**	0.5125 **<0.0001**
B score	0.0501 0.3384	0.0601 0.2509	0.8693 **<0.0001**	0.6316 **<0.0001**	1.0000	0.4884 **<0.0001**	0.4550 **<0.0001**
C score	0.0527 0.3138	0.0578 0.2694	0.7319 **<0.0001**	0.4009 **<0.0001**	0.4488 **<0.0001**	1.0000	0.3510 **<0.0001**
D score	0.0577 0.2700	0.0974 0.0621	0.6597 **<0.0001**	0.5125 **<0.0001**	0.4550 **<0.0001**	0.3510 **<0.0001**	1.0000

Bold=p< 0.05

8. LIMITATIONS OF THE STUDY

One of the main limitations of the study was the poor rate of response (26%) of the participants. This means that the responders may not necessarily representative of dietitians in South Africa since it is possible that only those who feel confident about their knowledge of supplements completed the questionnaires. However the demography of the dietitians who completed the questionnaires is very similar to the group of dietitians as a whole that are registered members of ADSA (Table 5). Also it is possible that some dietitians used nutrition handbooks in order to answer questions correctly. This may have contributed to a higher knowledge scores than reflected here. However, this appears to be unlikely since the mean score of the dietitians was nearly identical to that of the dietetic interns (57 versus 58%) who had filled in the questionnaire under test conditions.

9. DISCUSSION

The aim of this study was to develop an instrument for testing knowledge and practices of dietitians. Knowledge of dietary supplements is fundamental to the practice of dietetics and has been approved in the scope of practice

of dietitians (ACT 56,1974) under this description: " The following acts are acts which shall for the purposes of the application of the Act be deemed to be acts pertaining to the profession of dietetics: (2d) contributing to therapeutic nutrition by- the compilation and application of scientifically-justifiable dietary measures as part of the treatment of a patient or client following referral by, or consultation with, a medical doctor."

Furthermore, there is basic and applied core knowledge, which is expected from a dietitian at entry level. The specific ones, which encompass knowledge of dietary supplements, include the following at core level: A comprehensive understanding of:

* Nutrient requirements of healthy individuals in different stages of the life cycle;

*Food and nutritional products and data sources;

* The bioavailability, interaction and functions of nutrients, including drug-nutrient interactions.

The questions contained in the dietary supplement knowledge test were chosen to reflect such core knowledge. The mean and median (58%; 60% respectively) knowledge scores obtained were lower than had been expected, particularly with regard to concept C which covered the

recommended dietary intakes (54%). This is most probably due to the recent introduction of the Dietary Reference Intakes (DRIs) of the Institute of Medicine of the Food and Nutrition Board USA. This is an area of concern since these DRIs provide dietitians with fundamental tools with which to plan and analyze dietary regimes. Poor knowledge in this regard, is not acceptable. A recommendation in this regard is that the Association for Dietetics in South Africa as well as the Professional Board for Dietetics needs to consider how this core knowledge can be improved. Various options could be used under the umbrella of continuing professional development to upgrade knowledge on supplements. It may even be useful to introduce a teaching module in this regard.

It was not possible to compare data on knowledge and practices found in the final stage of the present study with those of similar studies since there have only been two published studies on the knowledge and practices of dietitians in this regard. The first of these was undertaken in the State of Washington in 1981 (Worthington-Roberts & Breskin, 1984). Their study evaluated supplement use by dietitians, but not their prescribing practices. A more recent survey of dietitians was undertaken in Oregon by Lee et al. (2000). They evaluated practices of dietitians (n=162) with regard to their

recommendation of supplements, functional foods and herbs. More than 80% of the dietitians surveyed indicated that they had recommended dietary supplements during the previous year for preventative purposes. Similarly, more than 80% believed that nutrient supplements were effective for maintenance of good health and prevention and treatment of chronic illnesses. This finding is very similar to that found in the present study where 81% indicated that they recommend supplement use and 60% recommended fortified foods.

Another area of concern was the finding that the mean knowledge scores did not differ among dietitians working in different fields of practice. It was expected that dietitians in hospital and clinic settings would have a significantly higher knowledge than those working in food service administration or in industry or marketing. Perhaps the fact that the Internet and its vast resources are available to most dietitians may explain the findings.

An interesting finding in the present study was that 17.1% of dietitians surveyed sell supplements to their clients. Since we did not inquire about the type of products sold it is not possible to comment on this, however this is an interesting finding, which needs to be pursued.

In the survey of dietitians undertaken in Washington in the eighties, it was found that nearly 60% of the total group (n=665) used a nutritional supplement, some daily and some less frequently (Worthington-Roberts & Breskin, 1984). In the more recent study by Lee et al. (2000), 84% of dietitians (n=162) reported using supplement/s themselves. Perhaps this is indicative of a trend showing increasing use of dietary supplements by dietitians in the United States.

As found in the present study, the category of supplements most commonly used in the Washington survey was multivitamins plus minerals (20.9%), while vitamin C alone (19.1%) was the second most commonly used supplement. In South Africa the next most frequently used supplements were calcium and omega-3 fatty acids.

The present study found that the 40+ year-old-group had the highest mean knowledge score, with the remaining three age groups having very similar scores. In the study of dietitians in Oregon, participants were asked about their knowledge regarding supplements. About two thirds were confident about their knowledge regarding the functions of supplements for maintenance of good health and the prevention of chronic diseases. However about 75% showed a high interest in receiving training about the role of

nutritional supplements in prevention, maintenance and treatment of chronic illnesses. Dietitians, overwhelmingly (84%) indicated that they preferred training by the dietetics profession in receiving more knowledge about supplements.

It is recommended that the field of dietary supplements, in all its various categories, could be developed into a niche area for and by dietitians. Currently, this domain is largely dominated by pharmacists, who actually have little training in nutrition. However, if this is the case, training institutions for dietitians, and dietitians themselves, will need to become proactive in developing an adequate knowledge base on micronutrients and other supplements. The dietitian in the 21st century should be the first port of call when clients need information in this regard. Since this is a mega-buck industry, which is growing all the time, dietitians need to get on board or miss the train.

10. CONCLUSION

This study entailed the development of a questionnaire for use in determining knowledge and practices of dietitians regarding dietary supplements. The final questionnaire has face, content and criterion validity, and a satisfactory alpha Cronbach value. Part of the development phase of

the questionnaire was a mail survey to dietitians in South Africa whence it was found that a large proportion of dietitians who participated use dietary supplements themselves; and prescribe and/or sell them to clients.

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Appendix A

QUESTIONNAIRE ON KNOWLEDGE and PRACTICES OF DIETITIANS CONCERNING NUTRITIONAL SUPPLEMENTS AND FORTIFIED FOODS

This questionnaire is to be completed anonymously and you will not be identified as an individual participant.

Section A: QUESTIONS REGARDING YOUR BACKGROUND:

1. What is your gender? Male Female
2. What is your age in years?.....
3. What are your qualifications? .....
4. How long have you been practicing as a dietitian (in years)?.....
5. Do you work/practice in a rural or urban area? Mainly urban; Mainly rural
6. What is your main field of practice?(mark only one) Private practice; teaching; education/community; clinical (hospital based); institutional management; other.....
7. Do you prescribe/recommend nutritional supplements for your patients/clients? Yes No
8. Do you sell nutritional supplements? Yes No
9. Do you recommend the use of fortified foods for your clients? Yes No
10. If yes, which foods in particular?

FOODS	YES OR NO, IF YES PLEASE SPECIFY Type and BRAND
Breakfast Cereals	
Margarine	
Milk	
Bread	
Maizemeal	
Fruit Juices	
Other	

11. What advice do your clients most commonly request with regard to nutritional supplements?

.....

.....

.....

Section B1: QUESTIONS REGARDING YOUR ADVICE TO CLIENTS

How often do you recommend/prescribe the following? Fill in every line

	Never	Less than 1x week Occasionally	3-5x week Frequently	Daily	Specific brand if recommended
1.Multivitamins*					
2.Multivitamins + minerals					
3.B complex vitamins					
4.Multivitamins + iron					
5.Multivitamins + calcium					
Single vitamins/minerals					
1.Vitamin C					
2.Vitamin E					
3.Vitamin A					
4.Vitamin B6					
5.Vitamin B12					
6.Calcium					
7.Iron					
8.Potassium					
9.Magnesium					
10.Zinc					
Other ingredients					
Omega 3/6					
Lycopene					
Lutein					
Other Please specify eg.Lecithin, Garlic					

*Multivitamins is the term used to specify a combination of 2 or more vitamins

Section B2: QUESTIONS RELATED TO YOUR OWN PRACTICES

How often *do you* use any of the following? Please tick every line

	Never	Less than 1x week/ Occasionally	3-5x week Frequently	Daily	Specific brand
1.Multivitamins alone*					
2.Multivitamins + minerals					
3.B complex vitamins					
4.Multivitamins + iron					
5.Multivitamins + calcium					
Single vitamins/minerals					
1.Vitamin C					
2.Vitamin E					
3.Vitamin A					
4.Vitamin B6					
5.Vitamin B12					
6.Calcium					
7.Iron					
8.Potassium					
9.Magnesium					
10.Zinc					
Other ingredients:					
Omega 3/6 FAs					
Lycopene					
Lutein					
Other, specify eg.Lecithin,garlic					

*Multivitamins is the term used to specify a combination of 2 or more vitamins

Section C: QUESTIONS TO TEST KNOWLEDGE OF MICRONUTRIENTS

PLEASE MAKE A CIRCLE AGAINST THE OPTION OF YOUR CHOICE FOR EACH QUESTION: T= TRUE; F = FALSE; ? = DON'T KNOW

Question	Response		
The body cannot differentiate between vitamins found naturally in foods and vitamins which are industrially synthesized and added to foods	T	F	?
Daily intakes of vitamin A exceeding 30 000 retinol equivalents or 100 000IU by pregnant women can result in fetal abnormalities	T	F	?
The most recent recommended dietary allowance (RDA) for thiamin is 0.9-1.2 mg/day for adults	T	F	?
Both iron overload and iron deficiency result in alterations in the immune response of humans	T	F	?
A high dietary fibre intake (>30g/day) may decrease calcium absorption	T	F	?
The recommended dietary allowance (RDA) for vitamin C for adults is about 100 mg per day	T	F	?
An EAR (estimated average requirement) is the nutrient intake value that is estimated to meet the nutrient requirements of about 97% of individuals in a given life stage	T	F	?
Tryptophan is a precursor of niacin	T	F	?
Chronic vitamin A toxicity is induced by consuming 3 times the recommended dose for about 14 days	T	F	?
The bioavailability of folate in food is lower than that from vitamin supplements containing folic acid	T	F	?
Diets rich in lutein and zeanthin may play a role in reducing the risk of eye diseases such as age related macula degeneration and cataracts	T	F	?
The body's requirement for thiamin is related to the intake of carbohydrate	T	F	?
Exposing carotenoids to heat generally decreases their bio-availability	T	F	?
High doses of nicotinic acid result in histamine release which may be harmful to persons with asthma or peptic ulcers	T	F	?
Acute and chronic infections and disease can reduce levels of vitamin C in plasma and leucocytes	T	F	?
Riboflavin deficiency is most commonly seen alongside other nutrient deficiencies such as niacin deficiency	T	F	?
High doses of zinc sulphate (2g/day or more) can cause gastrointestinal irritation and vomiting	T	F	?
High intakes of calcium, protein, and vitamin D decrease the daily requirements for magnesium	T	F	?
An adequate intake (AI) is a nutrient recommendation which is made when there is insufficient evidence to set an estimated average requirement (EAR)	T	F	?
Side effects of nicotinic acid doses of 3g or more include elevated serum uric acid levels, hyperglycemia and impaired liver function	T	F	?
Folate deficiency often resemble the haematologic features of vitamin B12 deficiency	T	F	?
Riboflavin is toxic in doses exceeding 10 times the RDA	T	F	?

Question	Response		
Low folate levels in populations have been found to be associated with higher levels of homocysteine	T	F	?
Protein-induced hypercalciuria, has been reported to be associated with a high-protein diet, especially from animal proteins	T	F	?
Adult women require an RDA of iron of about 15mg of iron per day	T	F	?
In medical practice the most common cause of vitamin K deficiency is the use of anticoagulant drugs such as warfarin	T	F	?
Early symptoms of riboflavin deficiency include photophobia, soreness of lips, mouth and tongue	T	F	?
Women taking oral contraceptive agents have an increased risk of developing riboflavin deficiency	T	F	?
Ascorbic acid and meat are the most important promoters of non-heme iron absorption	T	F	?
To date vitamin B12 has shown no appreciable toxicity	T	F	?
The dietary reference intakes (DRIs) will replace the original RDA published in 1989	T	F	?
Vitamin E plays a role in reducing the risk of age related health problems such as cataracts, cardiovascular disease and decreased immune function	T	F	?
High intakes of calcium may interfere with the absorption of other minerals such as iron, zinc and manganese	T	F	?
The cheapest and most effective treatment of iron deficiency anemia is ferrous sulphate supplements given in a dose of 2 tablets of 100mg iron three times/day	T	F	?
Microbial synthesis supplies the body with a large proportion of the daily vitamin K requirements	T	F	?
Vitamin levels applied in food fortification are typically in the range of 15 to 33% of the RDA per serving	T	F	?
Pregnant women and the elderly are at increased risk of zinc deficiency	T	F	?
Drugs that induce diuresis decrease the absorption of thiamin	T	F	?
Increasing amounts of PUFA in the diet increase the vitamin E requirements because of the propensity of PUFA's to undergo lipid peroxidation	T	F	?
The 1989 RDA for zinc intake in adults is 150 mg per day	T	F	?
The n-3 and n-6 fatty acids compete with each other for enzymes to convert them to the metabolically active eicosanoids	T	F	?
The RDA for vitamin B12 for adults is about 2-2.4 mcg B12 per day	T	F	?
The major promoters of non-heme iron absorption are phytates and polyphenols	T	F	?
Essential fatty acid deficiency in humans has been reported with linoleic acid levels less than 2-5g per day or less than 1-2% of total daily energy	T	F	?
Up to 90% of vitamin B12 is destroyed when milk is pasteurized or evaporated	T	F	?
Doses of nicotinic acid in excess of 100 mg (6x RDA) have no adverse effects	T	F	?

Question	Response		
A very high intake of calcium, in the presence of vitamin D can lead to excessive calcification in soft tissues	T	F	?
The calcium requirement (Adequate Intake) for adults ranges from about 1000-1300 mg per day	T	F	?
The recommended intake of calcium for pregnancy & lactation is 2000mg per day	T	F	?
Magnesium deficiency is characterised by nausea, muscle weakness, personality changes and vomiting	T	F	?

Appendix B :QUESTIONS TO TEST DIETITIANS KNOWLEDGE ON DIETARY SUPPLEMENTS AND FORTIFIED FOODS

1= question is not important/appropriate for dietitians to know ; 5= question is very important for dietitians to know

PLEASE MAKE A CIRCLE AGAINST THE OPTION OF YOUR CHOICE FOR EACH QUESTION BETWEEN 1 AND 5. In addition you may also indicate if the question is too easy or too difficult

VITAMIN A

A retinal equivalent is a measure of vitamin A activity used in plants and animals (T)	1	2	3	4	5	>E or >D
Sub-clinical deficiency of vitamin A is uncommon in South Africa since dietary intakes are generally adequate (F)	1	2	3	4	5	>E or >D
The absorption of carotenoids varies greatly according to dietary factors such as level and type of fat, amount and digestibity of proteins consumed (T)	1	2	3	4	5	>E or >D
Free retinol is fairly unstable to heat and light but not destroyed by oxidation (F)	1	2	3	4	5	>E or >D
Loss of mucous membrane integrity due to vitamin A deficiency increases a person's susceptibility to bacterial infections (T)	1	2	3	4	5	>E or >D
Eating foods rich in carotenes may provide some protection against malaria, mainly due to their anti-oxidant properties (F)	1	2	3	4	5	>E or >D
Beta-carotene is the most active of all the provitamins A and is found mainly in liver (F)	1	2	3	4	5	>E or >D
Daily intakes exceeding 30 000 retinal equivalents or 100 000IU by pregnant women can result in foetal abnormalities (T)	1	2	3	4	5	>E or >D
Mineral oil dissolves carotenoids and retinol which are then excreted in the faeces instead of being absorbed (T)	1	2	3	4	5	>E or >D
Vitamin A aids in the synthesis of collagen, the ground substance of neurons (F)	1	2	3	4	5	>E or >D
The digestion and absorption of vitamin A is closely associated with lipid absorption (T)	1	2	3	4	5	>E or >D
Biannual doses of 200 000 IU vitamin A are recommended for preschool children in developing countries to prevent tuberculosis and HIV infections (F)	1	2	3	4	5	>E or >D
With marginal vitamin A deficiency subjects have difficulty in seeing in dim light because of the low level of vitamin A in the rods of the retina (T)	1	2	3	4	5	>E or >D
When given in repeated doses, cortisone significantly increases the vitamin A stores in the liver (F)	1	2	3	4	5	>E or >D
Precursors of vitamin A carotenoids are designated as provitamin A carotenoids and include alpha-, beta- , gamma-carotene and cryptoxanthin (T)	1	2	3	4	5	>E or >D
Lactating women require 2500-3500 micrograms retinol equivalents per day (F)	1	2	3	4	5	>E or >D
Prolonged vitamin A deficiency leads to changes in the conjunctiva and cornea, collectively known as sclerosis (F)	1	2	3	4	5	>E or >D
Children with mild vitamin A deficiency are more prone to respiratory disease and diarrhoea than those who are not (T)	1	2	3	4	5	>E or >D
Retinol is carried in plasma by retinol binding protein which can be measured as an indicator of vitamin A status (T)	1	2	3	4	5	>E or >D
Neomycin decreases vitamin A absorption by inactivating bile salts (T)	1	2	3	4	5	>E or >D
There is evidence that vitamin A reduces the transfer of HIV from mothers to children (T)	1	2	3	4	5	>E or >D
1 RE = 12 ug beta-carotene = 20 IU vitamin A activity from beta-carotene (F)	1	2	3	4	5	>E or >D
Vitamin A deficiency resuts in infertility in males whilst in females low rates of conceptions and increased rates of still births are seen (T)	1	2	3	4	5	>E or >D
Chronic vitamin A toxicity is induced by consuming 3 times the recommended dose for about 14 days or so (F)	1	2	3	4	5	>E or >D
Ingestion of large amounts of carotenoids can lead to hypercarotenaemia which can	1	2	3	4	5	>E or

lead to death (F)						>D
There appears to be no toxicity of carotenoids from foods, therefore high doses from pharmaceutical products are recommended (F)	1	2	3	4	5	>E or >D
Cholestyramine reduces vitamin A absorption by adsorbing bile salts (T)	1	2	3	4	5	>E or >D
VITAMIN B1 / THIAMIN	1	2	3	4	5	>E or >D
Polyneuritis due to thiamin deficiency is an inflammation of the peripheral nerves (T)	1	2	3	4	5	>E or >D
Thiamin deficiency is common in chronic heavy alcohol consumers since alcohol interferes with its absorption and storage (F)	1	2	3	4	5	>E or >D
Thiamin has a high turnover rate in the body and is not really stored anywhere specific (T)	1	2	3	4	5	>E or >D
An intravenous glucose load given to patients with Wernicke's encephalopathy will alleviate the condition (F)	1	2	3	4	5	>E or >D
Wernicke Korsakoff syndrome resulting from thiamin deficiency ranges from an inability to retain new information, disorientation to coma (T)	1	2	3	4	5	>E or >D
Thiamin is very stable to heat and food processing (F)	1	2	3	4	5	>E or >D
The requirement for thiamin is related to the intake of carbohydrate, alcohol and protein (T)	1	2	3	4	5	>E or >D
Diarrhea and ulcerative colitis are likely to decrease the absorption of thiamine and therfore megadoses are advised (F)	1	2	3	4	5	>E or >D
In developed countries, people who consume excessive quantities of alcohol are the main group at risk of thiamin deficiency(T)	1	2	3	4	5	>E or >D
Adequate intakes of thiamin for infants are based on thiamin levels typically found in milk (T)	1	2	3	4	5	>E or >D
Parenteral doses of thiamin at 10 times the recommended levels have produced headaches,muscular weakness and cardiac arrhythmia (F)	1	2	3	4	5	>E or >D
Thiamin, as the co-enzyme thiamin pyrophosphate (TPP), is involved principally in the breakdown of fats and glycerol (F)	1	2	3	4	5	>E or >D
Drugs that induce diuresis or increased intestinal motility, decrease the absorption of thiamin (T)	1	2	3	4	5	>E or >D
Thiamin aids in the formation of ribose, a sugar that is essential in DNA and RNA, the carriers of the genetic code (T)	1	2	3	4	5	>E or >D
Symptoms of thiamin deficiency occur because the tissues are unable to receive sufficient energy from fat breakdown (F)	1	2	3	4	5	>E or >D
Early symptoms of thiamin deficiency include: anaemia, nausea and tetany(F)	1	2	3	4	5	>E or >D
Thiamine triphosphate is a precursor of thiamin and is involved in metabolism of carbohydrates (F)	1	2	3	4	5	>E or >D
The functional form of thiamin is TPP, also called cocarboxylase(T)	1	2	3	4	5	>E or >D
About 10% of thiamine is carried as thiamine triphosphate by erythrocytes (F)	1	2	3	4	5	>E or >D
The most recent RDA for thiamine is 0.9-1.2 mg/day in adults (T)	1	2	3	4	5	>E or >D
VITAMIN B2 / RIBOFLAVIN	1	2	3	4	5	>E or >D
Cheilosis, which is a common symptom of vitamin B6 deficiency, presents with cracking of the skin(fissuring) at the corners of the lips (F)	1	2	3	4	5	>E or >D
Riboflavin deficiency is most commonly seen alongside other nutrient deficiencies such as pellagra (T)	1	2	3	4	5	>E or >D
Riboflavin is toxic in doses 10 times or more of the RDA (F)	1	2	3	4	5	>E or >D
Phenothiazine derivatives (eg chlorpromazine) and tricyclic antidepressants have little	1	2	3	4	5	>E or

effect on riboflavin metabolism (F)						>D
Riboflavin is unstable in ultra-violet light therefore foods like dairy products should not be left in the sun (T)	1	2	3	4	5	>E or >D
The physiological role of riboflavin resides largely in its being the precursor of flavin adenine dinucleotide (FAD), which is central to energy production (T)	1	2	3	4	5	>E or >D
Urinary excreted riboflavin is a good reflection of dietary riboflavin intake (T)	1	2	3	4	5	>E or >D
Anticholinergic drugs delay gastric emptying time and therefore decrease the absorption of riboflavin (F)	1	2	3	4	5	>E or >D
The riboflavin requirement for adults is 2.5-2.8 mg per day(F)	1	2	3	4	5	>E or >D
Women taking oral contraceptive agents may develop riboflavin deficiency, especially those on marginal diets (T)	1	2	3	4	5	>E or >D
Most of the riboflavin found in the body is in the muscle as flavinoids (F)	1	2	3	4	5	>E or >D
Riboflavin has been used as a drug marker to check adherence to a therapeutic drug regimen because of its distinctive colour in the urine(T)	1	2	3	4	5	>E or >D
Early symptoms of riboflavin deficiency include photophobia, burning of the eyes ,soreness of lips, mouth and tongue (T)	1	2	3	4	5	>E or >D
The statement that baking soda in cooking destroys much of the riboflavin is an old wives tale (F)	1	2	3	4	5	>E or >D
Riboflavin dietary deficiency is common in South African children since many do not consume dairy products regularly(T)	1	2	3	4	5	>E or >D
Parasites which cause diarrhea and effect absorption of nutrients may exascerbate a riboflavin deficiency (T)	1	2	3	4	5	>E or >D
Hard physical work and heat stress can result in increased urinary riboflavin excretion. (T)	1	2	3	4	5	>E or >D
Vitamin B12 deficiency presents with angular stomatitis,atrophy of the tongue papillae, nasolabial seborrheic dermatitis and anaemia(F)	1	2	3	4	5	>E or >D
NIACIN / NICOTINIC ACID	1	2	3	4	5	>E or >D
About half of the niacin in the body is absorbed as niacin, the other half is synthesized from tryptophan by the liver (T)	1	2	3	4	5	>E or >D
Niacin is water-soluble,well absorbed from the small intestine and transported in solution in the plasma (T)	1	2	3	4	5	>E or >D
Normally 1/60 th of the dietary tryptophan intake is converted in the liver to niacin ie. 60 mg tryptophan = 1 mg niacin (T)	1	2	3	4	5	>E or >D
Pellagra can be cured by giving either niacin or a generous amount of fish oil (F)	1	2	3	4	5	>E or >D
Doses of nicotinic acid in excess of 100 mg (6x RDA) have no adverse effects (F)	1	2	3	4	5	>E or >D
Side effects of nicotinic acid doses of 3mg or more may be elevated serum uric acid levels, hyperglycemia and liver damage (T)	1	2	3	4	5	>E or >D
At doses of 3 mg or more nicotinic acid inhibits lipolysis in adipose tissue and lowers plasma cholesterol and triglyceride (T)	1	2	3	4	5	>E or >D
Niacin equivalents (NE) equals = preformed niacin (mg) plus tryptophan divided by 40 (F)	1	2	3	4	5	>E or >D
Milk is not a good source of niacin yet a good source of tryptophan (T)	1	2	3	4	5	>E or >D
Niacin is part of the co-enzymes NAD and NADP in which the nicotinamide moiety acts as an electron acceptor during oxidative phosphorylation(T)	1	2	3	4	5	>E or >D
Vitamin B6 is required in the pathway of conversion from tryptophan to niacin (T)	1	2	3	4	5	>E or >D
Niacin deficiency is characterised by diarrhoea and tingling limbs (F)	1	2	3	4	5	>E or >D
Since maize is high in tryptophan it is a good source of niacin (F)	1	2	3	4	5	>E or

						>D
The weakest biochemical test for niacin is testing for N-methylnicotinamide in a 24 hour urine sample (F)	1	2	3	4	5	>E or >D
The term niacin is the generic description for nicotinic acid and nicotinamide that are found in green vegetables and some fruits (F)	1	2	3	4	5	>E or >D
Many foods derived from plants contain niacin in a form known as niacytin which is not biolgically available (T)	1	2	3	4	5	>E or >D
Soaking grains such as maize in lime water increases the bioavailability of niacin (T)	1	2	3	4	5	>E or >D
To date the 1989 RDA remain for niacin (F)	1	2	3	4	5	>E or >D
Upper limits of niacin intake for adults are 5 mg NE/day (F)	1	2	3	4	5	>E or >D
High doses of nicotinic acid result in histamine release which may be harmful to persons with asthma or peptic ulcers(T)	1	2	3	4	5	>E or >D
VITAMIN B6 (PYRIDOXINE)	1	2	3	4	5	>E or >D
VitamiN B6 occurs in nature in 3 forms, namely pyridoxine, pyridoxal and pyridoxamine which are interconvertable in the body (T)	1	2	3	4	5	>E or >D
Each form of vitamin B6 also occurs in the phosphorylated form, of which the main one is pyridoxal 5'phosphate (PLP) (T)	1	2	3	4	5	>E or >D
PLP is the major co-enzyme form in the body which functions in practically all reactions involving amino acid metabolism (T)	1	2	3	4	5	>E or >D
PLP is involved with transamination and synthesis of essential amino acids (F)	1	2	3	4	5	>E or >D
Zinc is involved in the conversion of tryptophan to niacin (F)	1	2	3	4	5	>E or >D
PLP is involved in the synthsis of sphingomyelin, lecithin and choline (T)	1	2	3	4	5	>E or >D
Vitamin B6 coenzymes are involved in the breakdown of glycogen to glucose	1	2	3	4	5	>E or >D
Vitamin B6 coenzymes are involved in the conversion of linoleic acid to oleic acid (F)	1	2	3	4	5	>E or >D
Pyridoxal is transported in the circulation in a free iodised form (F)	1	2	3	4	5	>E or >D
The major metabolite of vitamin B6 is pyridoxine which is excreted in the urine (F)	1	2	3	4	5	>E or >D
The various forms of vitamin B6 appear to be absorbed by passive diffusion mainly in the jejunum and ileum (T)	1	2	3	4	5	>E or >D
Vitamin B6 deficiency is common in alcoholics since acetaldehyde destroys pyrididoxal (F)	1	2	3	4	5	>E or >D
Homocysteinaemia responds to doses of folate, vitamin B12 and Vitamin B6 (T)	1	2	3	4	5	>E or >D
Muscle serves as the largest depot of vitamin B6 in the body with 80-90% of stores in the form of PLP bound to glycogen (F)	1	2	3	4	5	>E or >D
In 1998 dietary reference intakes were established for vitamin B6 which include AIs,RDAs and Uls(T)	1	2	3	4	5	>E or >D
Need for vitamin B6 increases with an increasing protein intake in a ratio of 16 mg/g protein (F)	1	2	3	4	5	>E or >D
Intakes of 10 times the RDA have been associated with toxicity of vitamin B6, namely peripheral neuropathy(F)	1	2	3	4	5	>E or >D
Clinical signs of vitamin B6 deficiency include convulsions in infants (T)	1	2	3	4	5	>E or >D
Isoniazid (for TB) increases urinary excretion of vitamin B6 (T)	1	2	3	4	5	>E or >D
Patients on penicillamine require a vitamin B6 supplement to prevent Wilsons	1	2	3	4	5	>E or

disease(F)						>D
Patients on renal dialysis have increase vitamin PLP losses in the urine(F)	1	2	3	4	5	>E or >D
Cycloserine, penicillamine, L-dopa and hydralazine are vitamin B6 antagonists(T)	1	2	3	4	5	>E or >D
FOLATE/FOLIC ACID	1	2	3	4	5	>E or >D
Folates include a large number of chemically related species including folic acid, folacin and folate (T)	1	2	3	4	5	>E or >D
Most folates are in the reduced form (tetrahydrofolic acid FH4) which serves as a carrier for single-carbon derivatives (T)	1	2	3	4	5	>E or >D
Dietary folates are only absorbed in the monoglutamate forms (F)	1	2	3	4	5	>E or >D
The muscles are the most important depot for folate, containing about half the total body stores(F)	1	2	3	4	5	>E or >D
Absorption of folates occurs actively and passively mainly in the jejunum(T)	1	2	3	4	5	>E or >D
The bioavailability of folate in food is about half of those in the purified vitamin(T)	1	2	3	4	5	>E or >D
Folate is essential for the formation of both white and red cells and for their maturation(T)	1	2	3	4	5	>E or >D
It is recommended that women who are capable of becoming pregnant consume 4g synthetic folic acid in supplemental form to reduce the risk of having an infant with a neural tube defect(F)	1	2	3	4	5	>E or >D
Folic acid supplementation should not be given with vitamin B12 supplementation since B12 can mask symptoms of anemia (F)	1	2	3	4	5	>E or >D
Very high doses of folate are encouraged because of positive effects on zinc absorption in (F)	1	2	3	4	5	>E or >D
Adequate folic acid status has been associated with a reduced risk of cervical cancer (T)	1	2	3	4	5	>E or >D
ULs of 10 g folate per day have been established for adults(F)	1	2	3	4	5	>E or >D
Deficiencies of folate result in impaired biosynthesis of DNA and RNA, thus reducing cell division (T)	1	2	3	4	5	>E or >D
Folate deficiency manifests as microcytic anaemia with large fragile red blood cells (F)	1	2	3	4	5	>E or >D
Folate deficiency leads to impaired cell division and protein synthesis (T)	1	2	3	4	5	>E or >D
Recommended intakes of folate for adults are approximately 14 mg per day(F)	1	2	3	4	5	>E or >D
Recommended levels of folate during pregnancy are 4g per day to maintain maternal folate stores and keep pace with the increased folate needs (F)	1	2	3	4	5	>E or >D
Folate is also required in the synthesis of methyl groups (CH3) which are needed for the synthesis of methionine and choline(T)	1	2	3	4	5	>E or >D
The red blood cells contain about 3 times more folate than the plasma (F)	1	2	3	4	5	>E or >D
Secondary folate deficiency is most likely in iron deficient adults (F)	1	2	3	4	5	>E or >D
Folate deficiency manifests as megaloblastic anaemia, general weakness, depression and polyneuropathy(T)	1	2	3	4	5	>E or >D
Clinical manifestations of folate deficiency often resemble the hematologic features of vitamin B12 deficiency (T)	1	2	3	4	5	>E or >D
It has been demonstrated that folate is a determinant ofvitamin C levels(F)	1	2	3	4	5	>E or >D
Homocysteine levels are responsive to vitamin intervention, the most effective being thiamin and niacin (F)	1	2	3	4	5	>E or >D

Intervention with folate reduces homocysteine levels which positively effects the morbidity and mortality from heart disease and stroke (T)	1	2	3	4	5	>E or >D
VITAMIN B12	1	2	3	4	5	>E or >D
Bitamin B12 is also known as cobalamin,and comprises a corrinoid ring containing an atom of cobalt(T)	1	2	3	4	5	>E or >D
Vitamin B12 is linked to nucleic acid metabolism by regenerating tetrahydrofolate from methyl folate(T)	1	2	3	4	5	>E or >D
Serum levels of vitamin B12 acurately reflect the vitamin B12 status of a person(F)	1	2	3	4	5	>E or >D
Vitamin B12 is absorbed by the mucosal cell of the ileum, after binding to cobalt (F)	1	2	3	4	5	>E or >D
The RDA for adults is about 2-2.4 mcg B12 per day (T)	1	2	3	4	5	>E or >D
Normal body stores of Vitanin B12 can last for up to 3 months (F)	1	2	3	4	5	>E or >D
Vitamin B12 has no appreciable toxicity (T)	1	2	3	4	5	>E or >D
Vitamin B12 is caused by malabsorption therefore it is rarely seen in developing countries (F)	1	2	3	4	5	>E or >D
The commonest type of B12 deficiency is pernicious anaemia, which results from gastric atrophy (T)	1	2	3	4	5	>E or >D
Vitamin B12 deficiency results in megaloblastic anaemia which is characterised by an excess of red blood cells (F)	1	2	3	4	5	>E or >D
Vitamin B12 deficiency interupts normal nuclear division by trapping RNA, leading to a reduction in DNA synthesis(F)	1	2	3	4	5	>E or >D
The neuropathy resulting from a B12 deficiency is characterised by loss of sensation and motor power in the lower limbs(T)	1	2	3	4	5	>E or >D
The Rorsch test measures absorption of Vitamin B12 (F)	1	2	3	4	5	>E or >D
Excess urinary excetion of methylmelonate is indicative of low B12 status(T)	1	2	3	4	5	>E or >D
Spirulina is a type of fish often promoted as a source of B12 (F)	1	2	3	4	5	>E or >D
Pernicious anaemia can result from atrophy of gastric parietal cell associated with ageing(T)	1	2	3	4	5	>E or >D
Atrophy of the parietal cells can also be the result of a vitamin B12 deficiency(F)	1	2	3	4	5	>E or >D
VITAMIN C	1	2	3	4	5	>E or >D
The best-defined function of Vitamin C is its role in the synthsis of collagen, which is a commective tissue protein(T)	1	2	3	4	5	>E or >D
Vitamin C is required for the conversion of dopamine to noradrenaline which is an essntial co-enzyme (F)	1	2	3	4	5	>E or >D
Vitamin C is required for the conversion of carnitineto lysine which plays an essential role in the transfer of long-chain fatty acids into cells (F)	1	2	3	4	5	>E or >D
Vitamin C is required for synthesis of bile acids in the liver (T)	1	2	3	4	5	>E or >D
Vitamin C has been found to act as an efficient anti-oxidant by for example regenrating Vitamin E from its radical state (T)	1	2	3	4	5	>E or >D
Cigarette smokers have lower concentrations of acsorbic acid in their red blood cells (F)	1	2	3	4	5	>E or >D
Metabolic turnover of VitaminC in smokers is twice that in nonsmokers(T)	1	2	3	4	5	>E or >D
Acute and chronic infections and disease can reduce levels of vitamin C in plasma and leucocytes(T)	1	2	3	4	5	>E or >D

Beyond a daily intake of about 2g, virtually all the excess vitamin C will be excreted in the urine within 24 hours(F)	1	2	3	4	5	>E or >D
The RDA for vitamin C for adults is about 60 mg per day(T)	1	2	3	4	5	>E or >D
The adverse effects of continued high doses of vitamin C are neurologic changes(F)	1	2	3	4	5	>E or >D
It is recommended that smokers take in at least 1000mg vitamin C per day (F)	1	2	3	4	5	>E or >D
Vitamin C is readily destroyed during cooking and processing (by oxidation and losses in water) (T)	1	2	3	4	5	>E or >D
Measurement of vitamin C status is usually by analysis of serum or leucocytes(T)	1	2	3	4	5	>E or >D
In the stomach vitamin C can increase the conversion of nitrosamines to nitrites(F)	1	2	3	4	5	>E or >D
Vitamin C enhances the absorption of haem iron when consumed at the same meal(F)	1	2	3	4	5	>E or >D
The efficiency of enteric absorption of vitamin C is high at low intakes and declines markedly as intakes increase above 1g per day(T)	1	2	3	4	5	>E or >D
Vitamin C is an antioxidant by virtue of its ability to reacat with free radicals (free radical scavenger)(T)	1	2	3	4	5	>E or >D
Vitamin C promotes resistance to infection through the immunological activity and production of interferron(F)	1	2	3	4	5	>E or >D
Vitamin C promotes resistance to infection through the process of inflammatory reaction and by maintaing integrity of mucous membranes(T)	1	2	3	4	5	>E or >D
There is come evidence to suggest that vitamin C may have a protective role against tuberculosis (F)	1	2	3	4	5	>E or >D
VITAMIN E	1	2	3	4	5	>E or >D
Alpha-tocopherol has the highest biological activity of all eight isomers of vitamin E (T)	1	2	3	4	5	>E or >D
The dietary requirement for vitamin E depends in part on the amounts of anino acids consumed(F)	1	2	3	4	5	>E or >D
Most vitamin E in the body is found in cell membranes where it functions to protect polyunsaturated fatty acids from free radical attack(T)	1	2	3	4	5	>E or >D
Vitamin E plays a role in reducing the risk of age related health problems such as cataracts, cardiovascular disease and decreased immune function(T)	1	2	3	4	5	>E or >D
Vitamin E is passively absorbed from the duodenum into the hepatic system (F)	1	2	3	4	5	>E or >D
Vitamin E is distributed throughout the body in association with cell membranes, plasma lipoproteins and adipose(T)	1	2	3	4	5	>E or >D
Vitanin E protects unsaturated membrane phospholipids from oxidative degradation due to free radicals(T)	1	2	3	4	5	>E or >D
Vitamin E is one of the most toxic of all vitamins(F)	1	2	3	4	5	>E or >D
Symptoms of vitamin E deficiency are common in humans and occur in cases of lipid malabsorption or lipid transport abnormalities(F)	1	2	3	4	5	>E or >D
Vitamin E is an important component of the cellular antioxidant defense system of humans (T)	1	2	3	4	5	>E or >D
Available data raise the possibility that vitamin E may decrease the risk of cardiovascular disease in populations having a concurrent high selenium intake(F)	1	2	3	4	5	>E or >D
High doses of vitamin E may improve immunity in relatively short time periods (T)	1	2	3	4	5	>E or >D
Epidemiological studies suggest that populations who have low dietary vitamin E intake may be at increased risk for certain types of cancer (T)	1	2	3	4	5	>E or >D
Increasing amounts of PUFA in the diet increase the vitamin E requirements because of the propensity of PUFA's to undergo lipid peroxidation(T)	1	2	3	4	5	>E or >D

In humans vitamin E is mobilised by long periods of bed rest (F)	1	2	3	4	5	>E or >D
VITAMIN K	1	2	3	4	5	>E or >D
Breast milk is a good source of vitamin K and provides sufficient vitamin K for infants younger than 6 months (F)	1	2	3	4	5	>E or >D
Microbial synthesis supplies the body with a large proportion of vitamin K (T)	1	2	3	4	5	>E or >D
Vitamin K deficiency has been associated with prolonged use of broad spectrum antibiotics since they destroy colonic bacteria(T)	1	2	3	4	5	>E or >D
Recently ULS and NOELS have been set for vitamin K due to evidence of toxicity in humans(F)	1	2	3	4	5	>E or >D
Vitanmin K status is critical in obstructive jaundice since bile is required for vitamin K absorption (T)	1	2	3	4	5	>E or >D
Vitamin K deficiency has not been reported in adults (F)	1	2	3	4	5	>E or >D
In medical practice the most common cause of vitamin K deficiency is the use of anticoagulant drugs such as warfarin and dicoumarol (T)	1	2	3	4	5	>E or >D
Low levels of vitamin K have been reported in the elderly with femoral neck fractures(T)	1	2	3	4	5	>E or >D
Prothrombin time is a very sensitive indictor of vitamin K status (F)	1	2	3	4	5	>E or >D
Infants are usually given a vitamin K injection immediately after birth to increase their vitamin K levels(T)	1	2	3	4	5	>E or >D
Vitamin K is efficiently transported across the human placenta from mother to child(F)	1	2	3	4	5	>E or >D
IRON	1	2	3	4	5	>E or >D
Both iron overload and iron deficiency result in changes in the immune response of humans(T)	1	2	3	4	5	>E or >D
Iron deficiency is the most frquently encountered nutritional deficiency in humans(T)	1	2	3	4	5	>E or >D
Nonheme iron is a form of iron which is derived from meat and fish (F)	1	2	3	4	5	>E or >D
Two-iron binding proteins (transferrin and lactoferrin) appear to protect against infection by releasing iron from microrganisms that need it for growth (F)	1	2	3	4	5	>E or >D
Of major importance is iron's reactivity viza viz the reversible one-electron oxidation-reduction reaction allowing iron to shuttle between the ferrous and ferric form (T)	1	2	3	4	5	>E or >D
About 25% of iron is in the haemoglobin of red blood cells and about 60% in the form of stores in the liver(F)	1	2	3	4	5	>E or >D
No iron absorption takes place in the duodenum and upper jejunum(F)	1	2	3	4	5	>E or >D
Ferrous iron is better absorbed by the gut mucosal cells than ferric iron(T)	1	2	3	4	5	>E or >D
Both iron uptake and release by the duodenum appear to beinversely related to the amount of iron stored by the body(F)	1	2	3	4	5	>E or >D
The majority of iron is in transit in the portal circulation bound to the plasma protein transferrin(F)	1	2	3	4	5	>E or >D
Ascorbic acid and meat are the most important promoters of nonheme iron absorption(T)	1	2	3	4	5	>E or >D
The major enhancers of of non-haem iron absorption are phytate and polyphenols, common constituents of unrefined cereals and some vegetables(F)	1	2	3	4	5	>E or >D
Acsorbic acid is believed to convert ferric to ferrous iron and to chelate iron in the lumen of the gut in order to keep it in a more soluble form(T)	1	2	3	4	5	>E or >D
Adult women require an RDA of about 15-20mg per day(T)	1	2	3	4	5	>E or >D

Tannin, a polyphenol found in tea, coffee and red wine, is one of the most potent enhancerof non-haem absorption(F)	1	2	3	4	5	>E or >D
Polyphenols also form strong coloured compounds with iron; a major problem in food fortification(T)	1	2	3	4	5	>E or >D
Decreasing the bran content of a meal produces a dose-related depression in iron bioavailability(F)	1	2	3	4	5	>E or >D
A large percentage of South African children have marginal or deficient dietary iron intakes.(T)	1	2	3	4	5	>E or >D
Calcium has also been shown to inhibit absorption of both haem iron and non-haem iron up to intakes of about 300mg per meal(T)	1	2	3	4	5	>E or >D
Iron deficiency in the developed world is usually due to the poor bioavailability of a cereal-based diet combined with the effects of parasitic infestations(F)	1	2	3	4	5	>E or >D
First stage of iron deficiency is characterised by decreased stores (ferritin) but there is sufficient iron for erythropoeisis(T)	1	2	3	4	5	>E or >D
The second stage of iron deficiency anaemia is characterised by low iron stores, decreased iron in circulation and deficient erythropoiesis(T)	1	2	3	4	5	>E or >D
A single biochemical index can assess all stages of anaemia(F)	1	2	3	4	5	>E or >D
The first stage of iron deficiency is manifested by a hypochromic, microcytic anaemia(F)	1	2	3	4	5	>E or >D
Anaemia may be corrected by providing high dose supplements in the form of ferrous sulphate or ferrous gluconate until blood parameters return to normal(T)	1	2	3	4	5	>E or >D
Long-term ingestion of large amounts of iron or frequent blood trans fusions cannot lead to abnormal accumulation of iron in the liver(F)	1	2	3	4	5	>E or >D
A high intake of iron above the RDA by men and postmenopausal women may contribute to an increased risk of cancer and heart disease(T)	1	2	3	4	5	>E or >D
Female athletes and women who practice endurance sports are not at risk of iron deficiency and do not require iron supplements(F)	1	2	3	4	5	>E or >D
Increased intestinal motility increases iron absorption by increasing contact time(F)	1	2	3	4	5	>E or >D
The cheapest and most effective treatment of iron deficiency anaemia is ferrous sulphate given in a dose of 2 tablets of 100mg iron three times/day(T)	1	2	3	4	5	>E or >D
For males and females 14 years and over anemia is defined as a hemoglobin level below 13 g/ dl and 12g / dl respectively(T)	1	2	3	4	5	>E or >D
Ferric EDTA is not commonly used as an iron fortificant since it produces noticable colour change in food vehicles(F)	1	2	3	4	5	>E or >D
The diagnosis of iron deficiency is best made in developing populations by a combination of low haemoglobin and an elevated serum transferrin receptor(T)	1	2	3	4	5	>E or >D
In the absence of inflammation the combination of haemoglobin and 2 other measurements of iron deficiency is best(T)	1	2	3	4	5	>E or >D
In practice, a serum ferritin concentration of < 12 mcg/l is diagnostic of iron deficiency (if other parameters are normal)(T)	1	2	3	4	5	>E or >D
Iron-deficient erythropoiesis is characterised by a high serum iron concentration and a transferrin saturation above 16%(F)	1	2	3	4	5	>E or >D
When the iron supply is increased, protoporphyrin, a precurser of haem accumulates in red blood cells and can be used as an indicator of transferrin saturation(F)	1	2	3	4	5	>E or >D
FEP(free erythrocyte protoporphyrin) can be measured by a single drop of blood by means of a haematofluorometer(T)	1	2	3	4	5	>E or >D
FEP is reduced in lead poisoning and in inflammation(F)	1	2	3	4	5	>E or >D
Severe poisoning in children has been described after 600mg of iron and death at 1g(T)	1	2	3	4	5	>E or >D
CALCIUM	1	2	3	4	5	>E or >D
The calcium requirement(AI) for adults vary from 1000-1300 mg per day(T)	1	2	3	4	5	>E or >D

Oxalic acid is found in some leafy green vegetables and binds with cations such as calcium, thereby increasing its absorption from these vegetables(F)	1	2	3	4	5	>E or >D
The UL for calcium is set at 250 mg per day since high calcium intakes are a potential cause of hypercalceamia(F)	1	2	3	4	5	>E or >D
The most rapid absorption of calcium after a meal takes place in the duodenum in an acid medium(T)	1	2	3	4	5	>E or >D
Calcium citrate is more difficult to absorb than calcium carbonate due to its higher solubility(F)	1	2	3	4	5	>E or >D
The active absorption of calcium in the duodenum and proximal jejunum is controlled by vitamin K.(F)	1	2	3	4	5	>E or >D
High intakes of calcium may interfere with the absorption of other divalent cations such as iron, zinc and manganese(T)	1	2	3	4	5	>E or >D
Passive absorption of calcium takes place along the entire lenth of the small intestine and is independent on vitamin K.(F)	1	2	3	4	5	>E or >D
A high dietary fibre intake (>30g/day) may decrease calcium absorption(T)	1	2	3	4	5	>E or >D
The active transport mechanism of calcium becomes more important when calcium intakes are low and body requirements are not being met(T)	1	2	3	4	5	>E or >D
A very high intake of calcium, in the presence of vitamin D can lead to hypercalceamia, which leads to excessive calcification in soft tissues(T)	1	2	3	4	5	>E or >D
Low vitamin D intake and/or decreased sunlight increases calcium absorption, especially in the elderly(F)	1	2	3	4	5	>E or >D
Taking calcium supplements with meals reduces absorption since calcium cannot be absorbed in an acid medium(F)	1	2	3	4	5	>E or >D
Lactose enhances calcium absorption in infants(T)	1	2	3	4	5	>E or >D
Consumption of large amounts of coffee may decrease urinary calcium losses due to the efects of caffeine(F)	1	2	3	4	5	>E or >D
Phytic acid found in the outer husks of cereal grains combines with calcium to form soluble calcium phytate, which is soluble and easily absorbed(F)	1	2	3	4	5	>E or >D
Aging results in decreased efficiency of calcium absorption due to achlorhydria and an adapted response of vitamin D to a decreased calcium intake(T)	1	2	3	4	5	>E or >D
PTH does not play a role in maintaining calcium equilibrium in the blood(F)	1	2	3	4	5	>E or >D
Ordered movement of ionic calcium plays a role in regulating muscle contractions, nerve conductivity, ion transport, enzyme activators, blood clotting and secretion of hormones(T)	1	2	3	4	5	>E or >D
Calbindins are calcium-binding proteins which store calcium ions temporarily after a meal and ferry them to the basolateral membrane for absorption(T)	1	2	3	4	5	>E or >D
Lactose intolerant individuals have a reduced risk for osteoporosis(F)	1	2	3	4	5	>E or >D
In individuals with fat malabsorption, calcium absorption is increased because of the formation of calcium-fatty acid soaps(F)	1	2	3	4	5	>E or >D
The post menopausal rate of decline in bone mineral is not effected by estrogen status(F)	1	2	3	4	5	>E or >D
At menopause, calcium excretion is gratly increased, but in postmenopausal women treated with oestrogen, less calcium is excreted(T)	1	2	3	4	5	>E or >D
Protein-induced hypercalcuria, has been reported to accompany a high-protein diet, especially from animal proteins(T)	1	2	3	4	5	>E or >D
A significant increase in serum calcium concentration will not cause cardiac or respiratory failure(F)	1	2	3	4	5	>E or >D
A significant decrease in serum calcium results in tetany of skeletal muscles(T)	1	2	3	4	5	>E or >D
The recommended intake of calciumfor pregnancy & lactation is 200mg per day(F)	1	2	3	4	5	>E or >D
The recommended intake of calcium for adults & adolescents is 1200mg per day(F)	1	2	3	4	5	>E or

						>D
Ionised calcium initiates the formation of thromboplastin from blood platelets(T)	1	2	3	4	5	>E or >D
A low calcium intake may be an important factor in several chronic diseases such as colon cancer and hypertension(T)	1	2	3	4	5	>E or >D
Chronic aspirin use can alter the gastrointestinal tract's ability to absorb calcium and iron(T)	1	2	3	4	5	>E or >D
Prolonged bed rest promotes significant calcium retention in response to lack of tension on bones(F)	1	2	3	4	5	>E or >D
Chronic laxative abuse can result in mal-absorption of sodium, potassium and calcium(T)	1	2	3	4	5	>E or >D
The strict regulation of iodinised calcium makes it a useful diagnostic tool in assessing estrogen function and monitoring osteoporosis risk (F)	1	2	3	4	5	>E or >D
Another potential adverse effect of inadequate calcium supplementation ,is constipation(F)	1	2	3	4	5	>E or >D
ZINC	1	2	3	4	5	>E or >D
The 1989 RDA for zinc intake in adults is 15mg per day.(T)	1	2	3	4	5	>E or >D
Zinc absorption is affected by the level of zinc in the diet and by the presence of interfering substances such as phytates(T)	1	2	3	4	5	>E or >D
Impaired absorption of zinc is associated with a variety of intestinal diseases such as Chrohn's or pancreatic insufficiency(T)	1	2	3	4	5	>E or >D
Phytates in cereals increases zinc absorption by forming soluble complexes with zinc(F)	1	2	3	4	5	>E or >D
High dietary calcium intakes increases both zinc absorption and balance(F)	1	2	3	4	5	>E or >D
High doses of zinc can impair absorption of iron from ferrous sulfate(T)	1	2	3	4	5	>E or >D
Zinc absorption may be reduced by glucose , lactose or soy protein(F)	1	2	3	4	5	>E or >D
Signs of zinc toxicity include loss of appetite, growth retardation, skin changes, delayed wound healing and immunological abnormalities(F)	1	2	3	4	5	>E or >D
Zinc is better absorbed from human than from cows milk(T)	1	2	3	4	5	>E or >D
Plasma zinc levels increase by 5% in the acute-phase response to injury (F)	1	2	3	4	5	>E or >D
Zinc participates in reactions involving either synthesis or degradation of major metabolites such as carbohydrates, lipids, proteins and nucleic acids(T)	1	2	3	4	5	>E or >D
Zinc is involved in the stabilisation and integrity of nucleic acid structure(T)	1	2	3	4	5	>E or >D
Metallothionein is the most abundant non-enzymatic zinc-containing protein which functions in zinc absorption(T)	1	2	3	4	5	>E or >D
Patients receiving TPN have developed clinical signs of zinc toxicity (F)	1	2	3	4	5	>E or >D
Pregnant women and the elderly are at increased risk of zinc deficiency(T)	1	2	3	4	5	>E or >D
Acrodermatitis enteropatica is an autosomal recessive disease characterised by zinc malabsorption(T)	1	2	3	4	5	>E or >D
Athletes may be at a decreased risk for zinc deficiency since physical activity contributes to decreased mobilisation of zinc from zinc store(F)	1	2	3	4	5	>E or >D
Excess oral ingestion of zinc to the point of toxicity is common(F)	1	2	3	4	5	>E or >D
Zinc sulphate in amounts of 2g/day or more can cause gastrointestinal irritation and vomiting(T)	1	2	3	4	5	>E or >D
The major type of zinc toxicity is seen in patients with renal failure treated with	1	2	3	4	5	>E or

hemodialysis and presents with anemia, fever and CNS disturbances(T)						>D
Zinc toxicity results in a variety of immunological defects including decreased lymphocyte prolific response to mitogens(F)	1	2	3	4	5	>E or >D
MAGNESIUM	1	2	3	4	5	>E or >D
Magnesium plays a role in neuromuscular transmission and activity working in concert with calcium(T)	1	2	3	4	5	>E or >D
The reactivity of vascular and other smooth muscle cells depends on the ratio of iron to magnesium in the blood(F)	1	2	3	4	5	>E or >D
A deficiency of magnesium can result in CNS depression, anaethesia and paralysis in patients with renal insufficiency(F)	1	2	3	4	5	>E or >D
Renal patients should be given magnesium supplements(F)	1	2	3	4	5	>E or >D
Magnesium deficiency is characterised by nausea, muscle weakness, personality changes and vomiting(T)	1	2	3	4	5	>E or >D
Severe magnesium deficiency is common(F)	1	2	3	4	5	>E or >D
There is an UL of 350mg magnesium per day for adults(T)	1	2	3	4	5	>E or >D
Patients using glucothiazide diuretics should take magnesium and potassium supplements(T)	1	2	3	4	5	>E or >D
High intakes of calcium, protein, vitamin D and alcohol decrease the requirements for magnesium(F)	1	2	3	4	5	>E or >D
Acute hypomangesemia is associated with the use of (chemotherapeutic) cistoplatin administration(T)	1	2	3	4	5	>E or >D
Leukocyte magnesium is the most sensitive marker of magnesium status(T)	1	2	3	4	5	>E or >D
Physical or psychological stressmay decrease magnesium needs(F)	1	2	3	4	5	>E or >D
Moderate depletion of magnesium has never been found in elderly populations in western countries(F)	1	2	3	4	5	>E or >D
CAROTENOIDS	1	2	3	4	5	>E or >D
There is increasing epidemologic evidence that high levels of carotenoids including beta-carotene are associated with diminished risk of cancer& CHD (T)	1	2	3	4	5	>E or >D
Beta-carotene is both nutritionally and biologically active.(T)	1	2	3	4	5	>E or >D
Lycopene is nutritionally active and biologically inactive (F)	1	2	3	4	5	>E or >D
Exposing carotenoids to heat generally decreases their bio-availability (F)	1	2	3	4	5	>E or >D
Lycopene constitutes up to 80% of the total carotenoids found in adrenal glands and testes (T)	1	2	3	4	5	>E or >D
Human epidemiological studies have found a strong association between dietary lycopene and a reduced risk of prostate cancer	1	2	3	4	5	>E or >D
Diets rich in lutein and zeaxanthin may play a role in reducing the risk of serious eye diseases such as age related macula degeneration and cataracts	1	2	3	4	5	>E or >D
Both beta-carotene and lycopene are used by the food industry as natural colourants	1	2	3	4	5	>E or >D
PUFA's	1	2	3	4	5	>E or >D
Essential fatty acids include members of the n-3 and n-6 families of fatty acids (T)	1	2	3	4	5	>E or >D
The relatively high consumption of vegetable oils such as sunflower and safflower, result in a competitive pressure of n-6 with n-3 fatty acids(T)	1	2	3	4	5	>E or >D
If the diet is deficient in linoleic acid, oleic acid is desaturated and elongated to	1	2	3	4	5	>E or

eicosatrienoic acid (T)						>D
Reduced levels of EPA and DHA in the elderly may be associated with impaired and poor vision (F)	1	2	3	4	5	>E or >D
Essential fatty acid deficiency is very common in underweight children inSouth Africa (F)	1	2	3	4	5	>E or >D
Llinoleic acid and &-linoleic acid are required for cell wall integrity and are converted into prostaglandins and leucotrines(T)	1	2	3	4	5	>E or >D
The optimal consumption ratio between n-6 and n-3 fatty acids is between 1:1and 3:1(F)	1	2	3	4	5	>E or >D
The actual consumption in western countries of n-6 and n-3 is estimated to be in the ratio of 2:1(F)	1	2	3	4	5	>E or >D
Essential fatty acid deficiency has been reported at linoleic acid levels less than 2-5g per day or less than 1-2% of total energy(T)	1	2	3	4	5	>E or >D
The longer chain n-3 fatty acids are found in mailnly in sunflowerand safflower oils (F)	1	2	3	4	5	>E or >D
Linoleic acid is converted to arichidonic acid while &-linoleic acid is converted to eicossapenntaenoic acid and docosahexaenoic acids (T)	1	2	3	4	5	>E or >D
Enzymatic metabolism of the n-3 and n-6 fatty acids produces a wide range of oxidised products, collectively known as eicosanoids (T)	1	2	3	4	5	>E or >D
A high ratio of linoleic to &-linoleic acid in the diet tends to reduce the amount of &-linoleic acid converted to EPA and DHA (T)	1	2	3	4	5	>E or >D
Decreased production of EPA from n-6 fatty acid metabolism has been implicated in heart disease prevention (F)	1	2	3	4	5	>E or >D
Eicosanoids are further classified into prostaglandins, thrombaxanes and leucotrines(T)	1	2	3	4	5	>E or >D
Thrombaxane A2 synthesized in platelets from arichidoic acid stimulates vasoconstriction and platelet aggregation (T)	1	2	3	4	5	>E or >D
There is evidence that n-3 fatty acid supplements improve learning behavior and learning ability in well-nourished children (F)	1	2	3	4	5	>E or >D
Prostacyclin I2 produced in the endothelial cells of the vessel wall stimulates vasoconstriction and enhances platelet aggregation(F)	1	2	3	4	5	>E or >D
There is increasing evidence to suggest a positive association between n-6 fatty acid intake and a reduction in auto immune diseases such as arthritis(F)	1	2	3	4	5	>E or >D
A high dietary intake ofoleic acid can influence the balance of thromboxanes and prostacyclines(F)	1	2	3	4	5	>E or >D
EPA consumption shifts production from the more inflammatory 4 series leucotrines synthsized from arachidonic acid to the less inflammatory 5 series(T)	1	2	3	4	5	>E or >D
Breast- fed infants have lower levels of EPA and DHA in their plasma and red cells (F)	1	2	3	4	5	>E or >D
Leucotrines are important in several diseases involving inflammatory or hypersensitivity reactions such as asthma and rheumatoid arthritis (T)	1	2	3	4	5	>E or >D
FORTIFICATION	1	2	3	4	5	>E or >D
Up tp 90% of vitamin B12 is lost when milk is pasteurized or evaporated (T)	1	2	3	4	5	>E or >D
Food fortification should be aimed at providing those micronutrients found to be deficient in the dietary intake of large groups of people (T)	1	2	3	4	5	>E or >D
The upper and lower levels of intake of the food selected as a vehicle for fortification are not important, only the average (mean) value (F)	1	2	3	4	5	>E or >D
Nutritional information on fortified foods must indicate levels of micro-nutrients at point of packaging, not at consumption (F)	1	2	3	4	5	>E or >D
Since micro-nutrients added to foods are susceptible to O2, heat and light, megadoses are required is added in order to compensate for these losses(F)	1	2	3	4	5	>E or >D
Vitamins used to fortify foods are identicalin structure to vitamins which are found in supplements(T)	1	2	3	4	5	>E or >D
The body cannot differentiate between vitamins found naturally in foods and vitamins	1	2	3	4	5	>E or

which are industrially synthesized and added to foods(T)						>D
Fortification is most effective when the vehicle selected for fortification is consumed by less than 20% of the population(F)	1	2	3	4	5	>E or >D
Vitamin levels applied in food fortification are typically in the range of 15 to 33% of the RDA per serving (T)	1	2	3	4	5	>E or >D
Fortification monitoring processes should include regular analysis of micro-nutrient levels at points of production (F)	1	2	3	4	5	>E or >D
Dietary reference intakes	1	2	3	4	5	>E or >D
The dietary reference intakes (DRIs) will replace the original RDA published in 1989 (T)	1	2	3	4	5	>E or >D
The adequate intake (AI) is based on derived nurient intake levels of approximations of observed mean nutrient intakes by a group of healthy people(T)	1	2	3	4	5	>E or >D
An adequate intake (AI) is a nutrient recommendation which is made when there is insufficient evidence to set an estimated average requirement (EAR) (T)	1	2	3	4	5	>E or >D
An EAR is the nutrient intake value that is estimated to meet the nutritient requirements in about 97% of the individuals in a given life stage (F)	1	2	3	4	5	>E or >D
The RDA is the daily dietary intake level that is sufficient to meet the requirements ofabout 50% individuals in a given lifestage(F)	1	2	3	4	5	>E or >D
A NOAEL refers to the highest intake at which adverse effects have been observed (F)	1	2	3	4	5	>E or >D
A LOAEL refers to the lowest intake at which adverse effects were observed (T)	1	2	3	4	5	>E or >D
A UL is the lowest level of intake of a nutrient that is considered unlikely to pose any risk of adverse health effects to almost all individuals (F)	1	2	3	4	5	>E or >D

Appendix C: QUESTIONS TO TEST KNOWLEDGE ON MICRONUTRIENTS AND FORTIFICATION

University: .....
Degree: ..... **Year of study**.....

PLEASE MAKE A CIRCLE AGAINST THE OPTION OF YOUR CHOICE FOR EACH QUESTION: T= TRUE; F = FALSE; ? = DON'T KNOW

No	Question	No	Response		
1	There appears to be no toxicity of carotenoids from foods, therefore high carotenoid doses from pharmaceutical products can be safely recommended	1	T	F	?
2	The body cannot differentiate between vitamins found naturally in foods and vitamins which are industrially synthesized and added to foods	2	T	F	?
3	Sub-clinical deficiency of vitamin A is uncommon in South Africa since dietary intakes are generally adequate	3	T	F	?
4	Daily intakes exceeding 30 000 retinol equivalents or 100 000IU by pregnant women can result in fetal abnormalities	4	T	F	?
5	The most recent RDA for thiamin is 0.9-1.2 mg/day in adults	5	T	F	?
6	Both iron overload and iron deficiency result in alterations in the immune response of humans	6	T	F	?
7	A high dietary fibre intake (>30g/day) may decrease calcium absorption	7	T	F	?
8	The RDA for vitamin C for adults is about 100 mg per day	8	T	F	?
9	An EAR (Estimated average Requirement) is the nutrient intake value that is estimated to meet the nutrient requirements of about 97% of the individuals in a given life stage	9	T	F	?
10	Cow's milk is not a good source of niacin yet a good source of tryptophan (a precursor of niacin)	10	T	F	?
11	Chronic vitamin A toxicity is induced by consuming 3 times the recommended dose for about 14 days	11	T	F	?
12	The bioavailability of folate in food is lower than that from vitamin supplements containing folic acid	12	T	F	?
13	Diets rich in lutein and zeanthin may play a role in reducing the risk of eye diseases such as age related macula degeneration and cataracts	13	T	F	?
14	The requirement for thiamin is related to the intake of carbohydrate	14	T	F	?
15	Exposing carotenoids to heat generally decreases their bio-availability	15	T	F	?
16	Nutritional information on fortified foods must indicate levels of micro-nutrients at the point of packaging, not at the point of consumption	16	T	F	?
17	Vitamin C has been found to act as an efficient anti-oxidant by for example regenerating Vitamin E from its oxidized state	17	T	F	?
18	High doses of nicotinic acid result in histamine release which may be harmful to persons with asthma or peptic ulcers	18	T	F	?
19	A UL(Tolerable Upper Intake Level) is the lowest level of intake of a nutrient which is considered unlikely to pose any risk of adverse health effects to almost all individuals	19	T	F	?
20	Essential fatty acids include members of the n-3 and n-6 families of fatty acids	20	T	F	?
21	For males and females aged 14 years and over anemia is defined as a hemoglobin level below 13 g/ dl and 12g / dl	21	T	F	?

No	Question	No	Response		
	respectively				
22	Acute and chronic infections and disease can reduce levels of vitamin C in plasma and leucocytes	22	T	F	?
23	Riboflavin deficiency is most commonly seen alongside other nutrient deficiencies such as niacin deficiency	23	T	F	?
24	High doses of zinc sulphate (2g/day or more) can cause gastrointestinal irritation and vomiting	24	T	F	?
25	High intakes of calcium, protein, and vitamin D decrease the daily requirements for magnesium	25	T	F	?
26	An adequate intake (AI) is a nutrient recommendation which is made when there is insufficient evidence to set an estimated average requirement (EAR)	26	T	F	?
27	Most of the vitamin E in the body is found in cell membranes where it functions to protect polyunsaturated fatty acids from free radical attack	27	T	F	?
28	Side effects of nicotinic acid doses of 3g or more include elevated serum uric acid levels, hyperglycemia and impaired liver function	28	T	F	?
29	Folate deficiency often resemble the haematologic features of vitamin B12 deficiency	29	T	F	?
30	Riboflavin is toxic in doses exceeding 10 times the RDA	30	T	F	?
31	Low folate levels in populations have been found to be associated with higher levels of homocysteine	31	T	F	?
32	Vitamin K deficiency has been associated with prolonged use of broad spectrum antibiotics	32	T	F	?
33	Protein-induced hypercalciuria, has been reported to be associated with a high-protein diet, especially from animal proteins	33	T	F	?
34	Adult women require an RDA of iron of about 15-20mg of iron per day	34	T	F	?
35	In medical practice the most common cause of vitamin K deficiency is the use of anticoagulant drugs such as warfarin	35	T	F	?
36	Thiamin is very stable to heat and food processing	36	T	F	?
37	The longer chain n-3 fatty acids are found in mainly in sunflower and safflower oils	37	T	F	?
38	Early symptoms of riboflavin deficiency include photophobia, soreness of lips, mouth and tongue	38	T	F	?
39	Women taking oral contraceptive agents have an increased risk of developing riboflavin deficiency	39	T	F	?
40	Ascorbic acid and meat are the most important promoters of non-heme iron absorption	40	T	F	?
41	It is recommended that women who are considering conception should take 4g supplemental folic acid to reduce the risk of having an infant with a neural tube defect	41	T	F	?
42	To date vitamin B12 has shown no appreciable toxicity	42	T	F	?
43	Acsorbic acid is believed to convert ferric to ferrous iron and to chelate iron in the lumen of the gut in order to keep it in a more soluble form	43	T	F	?
44	The dietary reference intakes (DRIs) will replace the original RDA published in 1989	44	T	F	?
45	Vitamin E plays a role in reducing the risk of age related health problems such as cataracts, cardiovascular disease and decreased immune function	45	T	F	?
46	Folate deficiency manifests as microcytic anaemia, general weakness and depression	46	T	F	?
47	Vitamin B12 deficiency results in microcytic anaemia which	47	T	F	?

No	Question	No	Response		
	is characterised by small red blood cells				
48	High intakes of calcium may interfere with the absorption of other minerals such as iron, zinc and manganese	48	T	F	?
49	The cheapest and most effective treatment of iron deficiency anemia is ferrous sulphate supplements given in a dose of 2 tablets of 100mg iron three times/day	49	T	F	?
50	Microbial synthesis supplies the body with a large proportion of the daily vitamin K requirements	50	T	F	?
51	Vitamin levels applied in food fortification are typically in the range of 15 to 33% of the RDA per serving	51	T	F	?
52	Children with mild vitamin A deficiency are more prone to respiratory disease and diarrhoea than those who are not	52	T	F	?
53	Pregnant women and the elderly are at increased risk of zinc deficiency	53	T	F	?
54	Thiamin deficiency is common in chronic heavy alcohol consumers because alcohol interferes with its absorption and storage	54	T	F	?
55	Drugs that induce diuresis decrease the absorption of thiamin	55	T	F	?
56	Increasing amounts of PUFA in the diet increase the vitamin E requirements because of the propensity of PUFA's to undergo lipid peroxidation	56	T	F	?
57	The 1989 RDA for zinc intake in adults is 150 mg per day	57	T	F	?
58	The n-3 and n-6 fatty acids compete with each other for enzymes to convert them to the metabolically active eicosanoids	58	T	F	?
59	The RDA for vitamin B12 for adults is about 2-2.4 mcg B12 per day	59	T	F	?
60	The major promoters of of non-heme iron absorption are phytates and polyphenols	60	T	F	?
61	There is increasing epidemiological evidence that high levels of carotenoids including beta-carotene are associated with diminished risk of cancer& coronary heart disease	61	T	F	?
62	Essential fatty acid deficiency in humans has been reported linoleic acid levels less than 2-5g per day or less than 1-2% of total daily energy	62	T	F	?
63	Up to 90% of vitamin B12 is destroyed when milk is pasteurized or evaporated	63	T	F	?
64	Doses of nicotinic acid in excess of 100 mg (6x RDA) have no adverse effects	64	T	F	?
65	It is recommended that smokers take in at least 1000mg vitamin C per day	65	T	F	?
66	The upper and lower levels of intake of the food selected as a vehicle for fortification are not important, only the average (mean) intake is	66	T	F	?
67	A very high intake of calcium, in the presence of vitamin D can lead to excessive calcification in soft tissues	67	T	F	?
68	The calcium requirement (Adequate Intake) for adults ranges from about 1000-1300 mg per day	68	T	F	?
69	The recommended intake of calcium for pregnancy & lactation is 2000mg per day	69	T	F	?
70	Magnesium deficiency is characterised by nausea, muscle weakness, personality changes and vomiting	70	T	F	?

Appendix D

CONCEPTS RELATED TO MICRONUTRIENT KNOWLEDGE

A. Absorption, bioavailability and bioconversion

2. The body cannot differentiate between vitamins found naturally in foods and vitamins, which are industrially synthesized and added to foods
7. A high dietary fibre intake (>30g/day) may decrease calcium absorption
10. Tryptophan is a precursor of niacin
12. The bioavailability of folate in food is lower than that from vitamin supplements containing folic acid
14. The body's requirement for thiamin is related to the intake of carbohydrate
15. Exposing carotenoids to heat generally decreases their bio-availability
16. Nutritional information on fortified foods must indicate levels of micro-nutrients at the point of packaging, not at the point of consumption
17. Vitamin C has been found to act as an efficient anti-oxidant by for example regenerating vitamin E from its oxidized (radical) state
25. High intakes of calcium, protein, and vitamin D decrease the daily requirements for magnesium
33. Protein-induced hypercalciuria, has been reported to be associated with a high-protein diet, especially from animal proteins
36. Thiamin is very stable to heat and food processing
40. Ascorbic acid and meat are the most important promoters of non-heme iron absorption
43. Ascorbic acid is believed to convert ferric to ferrous iron and to chelate iron in the lumen of the gut in order to keep it in a more soluble form
48. High intakes of calcium may interfere with the absorption of other minerals such as iron, zinc and manganese
54. Thiamin deficiency is common in chronic heavy alcohol consumers because alcohol interferes with its absorption and storage
55. Drugs that induce diuresis decrease the absorption of thiamin
56. Increasing amounts of PUFA in the diet increase the vitamin E requirements because of the propensity of PUFA's to undergo lipid peroxidation
60. The major promoters of non-heme iron absorption are phytates and polyphenols
63. Up to 90% of vitamin B12 is destroyed when milk is pasteurized or evaporated
66. The upper and lower levels of intake of the food selected as a vehicle for fortification are not important, only the average (mean) intake is

Total A = 20

B. Deficiency and toxicity of micronutrients(safety)

1.There appears to be no toxicity from carotenoids in foods, therefore high carotenoid doses from pharmaceutical products can be safely recommended.
3. Sub-clinical deficiency of vitamin A is uncommon in South Africa since dietary intakes are generally adequate

4. Daily intakes of vitamin A exceeding 30 000 retinol equivalents or 100 000IU by pregnant women can result in fetal abnormalities
6. Both iron overload and iron deficiency result in alterations in the immune response of humans
11. Chronic vitamin A toxicity is induced by consuming 3 times the recommended dose for about 14 days
18. High doses of nicotinic acid result in histamine release which may be harmful to persons with asthma or peptic ulcers
23. Riboflavin deficiency is most commonly seen alongside other nutrient deficiencies such as niacin deficiency
24. High doses of zinc sulphate (2g/day or more) can cause gastrointestinal irritation and vomiting
28. Side effects of nicotinic acid doses of 3g or more include elevated serum uric acid levels, hyperglycemia and impaired liver function
29. Folate deficiency often resemble the hematological features of vitamin B12 deficiency
30. Riboflavin is toxic in doses exceeding 10 times the RDA
32. Vitamin K deficiency has been associated with prolonged use of broad spectrum antibiotics
35. In medical practice the most common cause of vitamin K deficiency is the use of anticoagulant drugs such as warfarin
38. Early symptoms of riboflavin deficiency include photophobia, soreness of lips, mouth and tongue
39. Women taking oral contraceptive agents have an increased risk of developing riboflavin deficiency
42. To date vitamin B12 has shown no appreciable toxicity
46. Folate deficiency manifests as microcytic anaemia, general weakness and depression
47. Vitamin B12 deficiency results in microcytic anaemia which is characterised by small red blood cells
52. Children with mild vitamin A deficiency are more prone to respiratory disease and diarrhoea than those who are not
53. Pregnant women and the elderly are at increased risk of zinc deficiency
62. Essential fatty acid deficiency in humans has been reported with linoleic acid levels less than 2-5g per day or less than 1-2% of total daily energy
64. Doses of nicotinic acid in excess of 100 mg (6x RDA) have no adverse effects
67. A very high intake of calcium, in the presence of vitamin D can lead to excessive calcification in soft tissues
70. Magnesium deficiency is characterised by nausea, muscle weakness, personality changes and vomiting
Total B = 24

C. Recommended intakes of micronutrients
5. The most recent recommended dietary allowance (RDA) for thiamin is 0.9-1.2 mg/day for adults

8. The recommended dietary allowance (RDA) for vitamin C for adults is about 100 mg per day
9. An EAR (estimated average requirement) is the nutrient intake value that is estimated to meet the nutrient requirements of about 97% of individuals in a given life stage
19. A UL(Tolerable Upper Intake Level) is the lowest level of intake of a nutrient which is considered likely to pose a risk of adverse health effects to almost all individuals
21. For males and females aged 14 years and over anemia is defined as a hemoglobin level below 6 g/ dl and 5g / dl respectively now false
26. An adequate intake (AI) is a nutrient recommendation which is made when there is insufficient evidence to set an estimated average requirement (EAR)
34. Adult women require an RDA of iron of about 15mg of iron per day
41. It is recommended that women who are considering conception should take 4g supplemental folic acid daily to reduce the risk of having an infant with a neural tube defect
44. The dietary reference intakes (DRIs) will replace the original RDA published in 1989
49. The cheapest and most effective treatment of iron deficiency anemia is ferrous sulphate supplements given in a dose of 2 tablets of 100mg iron three times/day
51. Vitamin levels applied in food fortification are typically in the range of 15 to 33% of the RDA per serving
57. The 1989 RDA for zinc intake in adults is 150 mg per day
59. The RDA for vitamin B12 for adults is about 2-2.4 mcg B12 per day
65. It is recommended that smokers take in at least 1000mg vitamin C per day
68. The calcium requirement (Adequate Intake) for adults ranges from about 1000-1300 mg per day
69. The recommended intake of calcium for pregnancy & lactation is 2000mg per day
Total = 16

D. Structure and functions of micronutrients

13. Diets rich in lutein and zeanthin may play a role in reducing the risk of eye diseases such as age related macula degeneration and cataracts
20. Essential fatty acids include members of the n-3 and n-6 families of fatty acids
22. Acute and chronic infections and disease can reduce levels of vitamin C in plasma and leucocytes
27. Most of the vitamin E in the body is found in cell membranes where it functions to protect polyunsaturated fatty acids from free radical attack
31. Low folate levels in populations have been found to be associated with higher levels of homocysteine
37. The longer chain n-3 fatty acids are found in mainly in sunflower and safflower oils
45. Vitamin E plays a role in reducing the risk of age related health problems such as cataracts, cardiovascular disease and decreased immune function

50. Microbial synthesis supplies the body with a large proportion of the daily vitamin K requirements
58. The n-3 and n-6 fatty acids compete with each other for enzymes to convert them to the metabolically active eicosanoids
61. There is increasing epidemiological evidence that high levels of carotenoids including beta-carotene are associated with diminished risk of cancer& coronary heart disease
Total D = 10

APPENDIX E

Dear Dietitian,
We are conducting a national survey on nutritional supplements and fortified foods used/recommended by dietitians **in private practice** and in an educational context. There are two important reasons for this survey. Firstly we are interested in the extent to which dietitians are using and recommending supplements/ fortified foods as well as their knowledge in this regard. These general findings will be published in a peer-reviewed journal to which you all subscribe, so that you know the outcome of the study. Secondly we are trying to determine whether there is a need for a guide on supplement usage/ fortified foods for dietitians in the workplace. So, ultimately we plan to develop such a manual if the results of this survey indicate that it would be of benefit.

This questionnaire has been sent to all registered dietitians and nutritionists in South Africa, with the assistance of the Vitamin Information Centre. We rely on you to cooperate and to return the questionnaire as speedily as possible. The information will be regarded as strictly confidential and you are not required to identify yourself.

If you return the completed questionnaire before the 30th September 2002 we will send you a complimentary CD and book on the latest information on micronutrients. In order for us to do this please address the envelope enclosed with your return address. You do not need to add your name and can simply address it as "The Residents"

Please answer the questionnaire as honestly as you can and return it before 30 September 2002. If you have any specific queries please contact me -Dr Nelia Steyn, at 021-9380242.

Dr NP Steyn (Medical Research Council)
Prof DL Labadarios (University of Stellenbosch)