Vitamin C and zinc status of elderly women in residential care in Cape Town

Karen Charlton*
HSRC/UCT Centre for Gerontology, University of Cape Town

Fatima Hoosen and Shamila Jaffer
Department of Human Ecology and Dietetics, University of the Western Cape

Abstract

Institutionalized older persons are at risk of malnutrition, particularly regarding vitamin C and zinc deficiencies. These two micronutrients have been shown to play a role in wound healing and tissue repair, as well as immune function and appetite. A cross-sectional descriptive study was undertaken to assess the vitamin C and zinc status of 49 women aged 65 years and older, who reside in a long-term care facility in Cape Town. Fasting blood samples were drawn from all consenting subjects for the analysis of serum albumin, plasma vitamin C and zinc concentrations. Dietary intake was assessed using a plate-waste method, repeated on three days – two weekdays and one weekend day. Plates were weighed using an electronic scale, before and after subjects partook of their meals. Food wastage was recorded and actual food intake was calculated in grams. Anthropometrical assessment included weight, height, skinfold thickness measurements and girth circumference. Mean energy intake of the subjects was 76% of the RDA (6 085 kJ). Mean vitamin C intake was less than a third of the RDA (15.9 mg) and zinc intake was about two-thirds of the RDA (8.5 mg). No subject had an adequate intake of vitamin C, i.e. above 67% of the RDA. A low plasma concentration of vitamin C and zinc was found in 34% and 9.3% of the subjects, respectively. The majority tended towards underweight. It is recommended that low-dose micronutrient supplementation be administered to older women living in long-term care facilities and that ongoing nutritional assessment be an integral part of the care of older residents.

Introduction

Malnutrition is highly predictive of mortality and morbidity in institutionalized older adults (Chumlea & Baumgartner, 1989; Sullivan, Walls & Lipschitz, 1991; Delmi, Rapin, Bengoa *et al.*, 1990). In a prospective two-year study of institutionalized persons aged 65 to 98 years, almost a third of the population studied had net weight losses of 4.5 kg or more (Dwyer Coleman, Krall *et al.*, 1987). Subjects who exhibited such weight losses had lower four-year survival rates than did subjects with stable or increasing weights.

Older adults generally have an increased susceptibility to many illnesses, including infectious diseases. In a study of short-term hospital stays, hospitalization for infectious and parasitic disease was three times more common in adults aged 65 years and over, compared with those aged 45 – 64 years old (Graves & Owings, 1997). Older residents in long-term care facilities are at even higher risk of infections, particularly urinary tract infections, pneumonia, and skin or soft tissue infections (Yoshakawa & Norman, 1996).

There is current interest in the potential for micronutrient supplementation to enhance immune function in the elderly. In a one-year study of independently living older people, those given a multi-micronutrient supplement had fewer days of illness owing to infections and fewer days during which antibiotics were used, compared to those given a placebo (Chandra, 1992). In addition to influences on immune function, poor nutritional status has been shown to be a contributing factor in the development of decubital ulcers (pressure sores) (Breslow, Hallfrisch & Goldberg, 1991; Pinchcofsky-Devin, 1986). Nutrients involved in wound healing and tissue repair are protein, vitamin C (collagen synthesis) and zinc (increases epithelialization and collagen strength), among others (Ferrell & Osterweil, 1990).

Recent epidemiological evidence has shown an association between high blood concentrations, or dietary intakes of vitamin C and a lowered risk of senile cataract. One study showed people in the lower third of vitamin C intake to have a 14-fold increase in risk for sub-capsular cataract compared to those in the upper third of vitamin C intake (Jacques & Chylack, 1991).

Although frank vitamin C deficiency is rarely seen in younger adults, it has been demonstrated that up to 50% of older adults may have low levels of serum vitamin C (Russell & Suter, 1993). More than half of elderly subjects in a long-stay nursing home in France were found to have a dietary vitamin C intake of less than 50% of the RDA (Suboticanec, Stavljenic, Bilic-Pesic *et al.*, 1989). In a study of hospitalized elderly patients in South Africa, sub-optimal blood vitamin C concentrations were identified in 71% of subjects (Gouws, Roussouw & Labadarios, 1989).

Regarding zinc deficiency, symptoms include a reduced appetite, an impaired ability for wound healing, and a diminished sense of taste and smell (Sandstead, Hendriksen, Gregor *et al.*, 1982). The prevalence of zinc deficiency has been shown to vary from 18 to 30% in elderly subjects living at home (Bogden, Bendich, Kemp *et al.*, 1994; Bunker, Stansfield, Deacon-Smith *et al.*, 1994; Payettre & Gray-Donald,

* *Address correspondence to*
Ms Karen E. Charlton, HSRC/UCT Centre for Gerontology, Medical School, University of Cape Town, Observatory 7925, South Africa.
E-mail: kc@anat.uct.ac.za

1991; Hercberg, Preziosi, Galan *et al.*, 1994), compared with 12 to 80% of institutionalized elderly (Suboticanec *et al.*, 1989, Goode, Penn, Kellener *et al.*, 1991; Maller, Löwik, Ferry & Ferro-Luzzi *et al.*, 1991; Galan, Preziosi, Richard *et al.*, 1994).

No data are available on the nutritional status of older adults in residential care in South Africa. A cross-sectional study was therefore undertaken to assess the vitamin C and zinc status of institutionalized women aged 65 years and older.

Methods

A sample of 49 women aged 65 years and older who reside in a home for the aged in the Cape Peninsula was recruited using a random sampling technique. Exclusion criteria included unconscious subjects, those who were being tube-fed, and those who were unable or unwilling to give their informed consent. The study was approved by the Ethics and Research Committee of the University of the Western Cape.

Fasting blood samples were drawn from all consenting subjects using the vacutainer™ method. The samples were separated by standard centrifugation on the same day and serum was retained for analysis of serum albumin by an Hitachi 747 autoanalyser. Plasma was analysed for total plasma vitamin C using the 2.6-dichlorophenolindophenol titration method (Harris & Ray, 1935). Plasma zinc concentration was analysed using the atomic absorption spectrophotometry method (Smith, Butrimovitz & Purdy, 1979). Blood analyses were conducted by the Department of Chemical Pathology at Groote Schuur Hospital. Reference values for deficient plasma vitamin C and zinc concentrations were ≥0.4 mg/dl (Loria, Whetton, Caulfield *et al.*, 1998) and <10.7 µmol/l (Klasing & Pilch, 1987), respectively.

Body mass was measured to the nearest 0.5 kg with the subject standing barefoot, wearing light clothing, on a calibrated digital bathroom scale. Standing height was measured to the nearest 0.5cm, with the subject barefoot and the head in the Frankfurt horizontal plane, using a headboard placed at right angles against a wall. In subjects who were wheelchair or bed bound, height was estimated from knee height measurement using the formula of Chumlea and Guo (1992). Body mass index (BMI) was calculated as mass (kg)/height squared (m^2) and categorized as follows: Underweight: BMI < 20; Obesity: BMI ≥ 30. Waist circumference was measured, in duplicate, at the level of the umbilicus. Hip circumference was measured, in duplicate, at the largest diameter below the umbilicus or maximum circumference over the buttocks, taken perpendicularly on the axial line of the trunk. Waist-to-hip ratio (WHR) was calculated. Biceps, triceps, subscapular and suprailiac skinfold thicknesses were measured in triplicate to the nearest millimetre using Harpenden^R calipers. Mid-arm muscle area (MAMA) was calculated indirectly according to the equation: MAMA (cm^2) = (mid-upper arm circumference – (3.14 x TST))^2/ 4 x 3,14 (Frisancho, 1981). Percentage body fat was estimated using three age and sex specific prediction regression equations, incorporating (1) biceps and triceps skinfold thickness measurements (Visser, Van den Heuvel & Deurenberg, 1994), (2) waist circumference (Lean, Han & Deurenberg, 1996), and (3) biceps, triceps, subscapular and suprailiac skinfold thickness measurements (Durnin & Womersely, 1974).

Dietary intake was assessed using a plate-waste method, repeated for three days during a nine-day period: two weekdays and one weekend day. The quantity of food served to each of the subjects at a meal was weighed using an electronic scale. After the meal, food wastage was recorded and actual food intake was calculated in grams. Mean daily nutrient intake for each subject was calculated using the 1991 MRC Food Composition Tables (Langenhoven *et al.*, 1991). Only food eaten at mealtimes was observed and recorded; snacks and tuckshop purchases were not included in the analyses. The adequacy of nutrient intake was assessed by calculating the percentage of subjects with nutrient intakes below 67% of the Recommended Dietary Allowance (National Research Council, 1989).

The "expected" nutrient content of the meals provided, according to the planned menu cycles, was calculated for the nine-day period which corresponded with the dietary intake data collection period. Differences between expected and actual nutrient intake were calculated.

Information was collected on the socio-economic status of the subjects, length of stay in the facility, the prevalence of health conditions, and the subjects' ability to perform activities of daily living. Subjects were also asked about their appetite, and whether or not they took micronutrient supplements.

The data were analysed using descriptive statistics and the two-sample t-test. Means and standard deviations were used to describe normally distributed continuous variables.

Results

Sample characteristics

The mean age of the subjects was 78.8 years (SD = 7.2; range = 65 – 94 years). The majority of the subjects (91.5%) received a state old-age pension, which amounted to R480.00 per month at the time of the study. Over half (55.3%) of the subjects perceived their income to be adequate for meeting their needs; a third (34%) perceived it to be inadequate, while the remainder refused to say. Over half (55.3%) of the subjects had received only primary school education; 17% had received some secondary school education but had not completed matriculation; and 27% had completed secondary school education. A quarter of the subjects had been housewives, 42.6% had held clerical or factory jobs and the remainder had held other occupations. Over two-thirds of the subjects were widowed (69%). Regarding life satisfaction, the majority (70.2%) reported being satisfied, 17% were dissatisfied and 13% were neither satisfied nor dissatisfied. Forty-seven per cent of the subjects had never smoked; 35% had smoked in the past and 18% currently smoked. Appetite was reported to be good by 78% of the subjects and as poor by the remainder. Three-quarters of the subjects (74%) wore dentures, and only one subject reported that she did not wear dentures but needed to obtain dentures. Only two subjects rated their present health status as poor; the remainder rated it as good or average. Regarding mobility, 37% of the subjects were independently mobile, 8% reported difficulty with mobility, 37% used a cane or walking stick, and 18% were bedridden or confined to a wheelchair. Only one subject needed assistance with eating; the remainder could feed themselves independently. Arthritis and rheumatism were the most common chronic diseases (67%), followed by hypertension (37%), cardiovascular disease (31%), stroke (22%) and diabetes (10%) (diagnoses were obtained from clinical notes and history from nursing staff).

Biochemical parameters

Mean concentrations of serum albumin, plasma vitamin C and zinc are shown in Table 1. No subjects had low serum albumin levels (<35g/l); 9.3% had low zinc concentrations (<10.7 µmol/l) and 34% had low vitamin C concentrations (≤ 0.4 mg/dl).

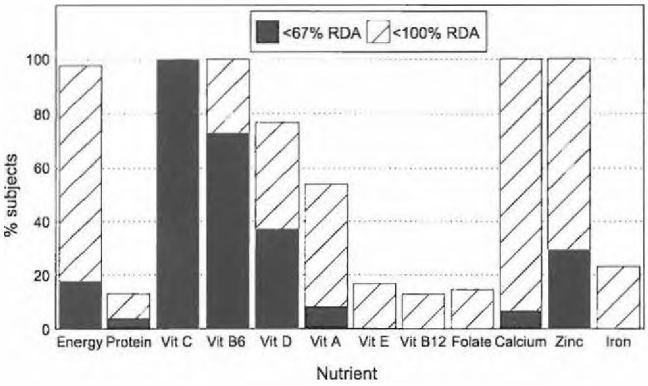
Table 1
Mean concentrations of serum albumin, plasma zinc and plasma vitamin C

	Mean (SD)	Range	N	Normal range	% of subjects deficient
Albumin	45 (3.5)	35-53	46	35-50 g/l	–
Zinc	15 (3.7)	4.6-22.2	43	10.7-22.9 μmol/l	9.3%
Vitamin C	0.63 (0.33)	0.2-2.0	48	0.4-2.0 mg/dl	34.0%

Dietary intake

The mean daily nutrient intake of the subjects is compared with the "expected" nutrient intakes, as calculated from the catering manager's menu cycle, and with the RDAs for age (National Research Council, 1989) in Table 2. The contribution of micronutrient supplementation to total dietary intake was not calculated since only two subjects reported its use. The percentage of subjects with nutrient intakes less than 100% and 67% of the RDA is shown in Figure 1. The daily energy content of the menu (8 826 kJ) exceeded the RDA; however mean actual energy intake of the subjects was 76% of the RDA (6 085 kJ). Only one subject had a mean energy intake which exceeded the RDA. Mean vitamin C intake was less than a third of the RDA at 15.9 mg (SD=4.3) and zinc intake was about two-thirds of the RDA (8.5 (SD=1.2) mg). No subject had an adequate intake of vitamin C, i.e. above 67% of the RDA. Calcium intake reached only 56% of the RDA (446 (SD=56) mg). In addition, intakes of calcium and vitamin B_6 were particularly low.

Figure 1
Percentage of subjects with nutrient intakes below 100% and below 67% of the RDA



Regarding the contribution of meals to vitamin C and zinc status, lunch provided the greatest contribution to these nutrients (72% and 51% of daily intake, respectively). The evening meal provided 20% of vitamin C and 33% of zinc intake, respectively, while breakfast supplied the least in terms of these nutrients (8% and 16%, respectively).

The contribution of macronutrients to total daily energy intake was 47% of energy from carbohydrate, 36% of energy from fat, and 17% energy from protein sources.

Anthropometrical measurements

Mean BMI fell within the desirable range for age of 24 – 29.7, as recommended by Bray and Gray (1988). (See Table 3.) Few subjects (11.9%) were obese (i.e. BMI ≥ 30); the majority (64.3%) had a BMI below 24. Arm measurements were close to the 50th percentile for age; however mean mid-arm muscle area fell between the 25th and 50th percentile (Frisancho, 1981).

Table 2
Mean daily nutrient intake of the subjects, compared with expected intakes (nutrient content according to menus) and RDAs[a]

	RDA[a]	Actual intake Mean (SD)	Expected intake (menu content) Mean	Difference (expected minus actual)
Macro nutrients				
Energy (kJ)	7980	6085 (827)	8826	2741
Protein (g)	50	60 (10)	105	45
Fat (g)		58 (9)	74	16
Carbohydrate (g)		170 (43)	227	57
Fibre (g)	20	22 (4)	53	31
Minerals				
Zinc (mg)	12	8.5 (1.2)	14.6	6.1
Calcium (mg)	800	446 (56)	626	180
Iron (mg)	10	10.5 (1.4)	19.1	8.6
Vitamins				
Vitamin C (mg)	60	15.9 (4.3)	20.2	4.3
Vitamin A	800	904 (359)	1237	333
Vitamin B6 (RE) (mg)	1.6	0.98 (0.18)	1.51	0.53
Folic acid (μg)	180	236 (40)	474	238
Vitamin B12 (μg)	2	2.80 (0.98)	3.78	0.98
Vitamin D (μg)	5	3.8 (1.6)	5.5	1.7
Vitamin E (mg)	8	10.5 (2.3)	10.4	0.1

a National Research Council, 1989.

Table 3
Anthropometric measurements of the subjects

Measurements	N	Reference	Mean (SD)
Weight (kg)	42	65.0[a]	58.6 (13.1)
Height (cm)	47	160.0[a]	150 (7.4)
BMI	42	24-29[b]	24.2 (5.5)
% obese (BMI ≥30)	5		11.9
% underweight (BMI <20)	6		14.3
Waist-to-hip ratio	47		0.90 (0.56)
Mid-arm circumference (cm)	47	22.5[c]	28.2 (5.1)
% Body fat			
Equation of Visser *et al.* (1994)	46		43.6 (2.4)
Equation of Lean *et al.* (1996)	46		45.5 (7.7)
Equation of Durnin & Womersely (1974)	46		36.6 (4.7)
Skinfold thickness			
Suprailiac skinfold thickness (mm)	48		17.3 (8.4)
Subscapular skinfold thickness (mm)	48		15.7 (6.5)
Biceps skinfold thickness (mm)	48		13.8 (6.7)
Triceps skinfold thickness (mm)	48	20.6[d]	21.0 (7.4)
Sum of 4 skinfolds (mm)	48		67.7 (22.9)
Mid-arm muscle area (cm^2)	48	40.2[c]	37.8 (12.4)

a Persons aged 51+ years (National Research Council, 1989).
b Bray and Gray (1988).
c Persons aged 65-74 years (Frisancho, 1981).
d Persons ≥ 70 years (Chumlea, Roche & Mukherjee, 1986).

Risk factors for low vitamin C status

The characteristics of subjects with low plasma vitamin C concentrations (≤ 0.4 mg/dl) are compared with those who had normal vitamin C concentrations in Table 4. No significant differences were found between the groups for age, anthropometric measurements, length of stay, serum albumin, or plasma zinc concentrations.

Table 4
Characteristics of subjects with low plasma vitamin C concentrations versus subjects with normal vitamin C concentrations: means (SD)

	Low (N=16)	Normal (N=31)
Vitamin C (mg/dl)	0.36 (0.66)	0.76 (0.32)*
Age	80.2 (7.0)	78.1 (7.1)
Mid-arm muscle area (cm^2)	34.8 (102)	39.5 (13.4)
Weight (kg)	57.7 (14.5)	59.3 (12.8)
Triceps skinfold (mm)	21.8 (8.1)	20.7 (7.3)
BMI	23.6 (6.4)	25.3 (4.0)
Zinc	14.7 (3.6)	21.8 (36.3)
Albumin (g/l)	44 (3.6)	45 (3.5)
Stay (months)	40.5 (52.3)	32 (28.6)
When excluding one subject whose stay >202 months	29.3 (26.9)	33.2 (30.8)

* Independent 2-sample t-test, $p < 0.001$.

Discussion

Findings from the present study showed that older women in a residential institution in Cape Town had an inadequate dietary intake of energy and most micronutrients. Dietary intake of vitamin C and zinc were particularly low. In the case of vitamin C, mean dietary vitamin C intake was a quarter of the RDA (National Research Council, 1989). No subject had an intake which exceeded two-thirds of the RDA, which is the reference value generally used to assess dietary adequacy. A wide variation in vitamin C intake has been reported for both free-living and institutionalized elderly. A survey conducted in 686 subjects aged 60 years and older in Boston reported median dietary vitamin C intakes to be high for free-living subjects: 132 and 128 mg for men and women, respectively. Only 5% of this sample had intakes less than two-thirds of the RDA (Sahyoun, 1992). Similarly, a study of 270 free-living subjects age 60 years and older in New Mexico demonstrated that the mean dietary vitamin C intake of women (N=166) was high at 137 mg/day and over half of the subjects reported taking vitamin C supplements (which supplied a median of an additional 355 mg) (Garry, Goodwin, Hunt & Gilbert, 1982). As would be expected from the high dietary intakes, very few individuals (2%) had deficient plasma ascorbic acid concentrations of less than 0.2 mg/dl.

In the present study, 34% of subjects had low plasma vitamin C levels (≤ 0.4 mg/dl). In a study of new geriatric admissions to a psychiatric hospital in Leeds, UK, 25 to 54% of patients were at high risk of vitamin C deficiency, based on their blood levels (Hancock, Hollin, Aylard *et al.*, 1985). Similarly, 40% of new admissions to a geriatric ward in North Shields, UK were found to have low plasma vitamin C levels (Mandal & Ray, 1987).

Correlation between dietary intake and serum level of the vitamin has previously been shown to be good (Marazzi, Mancinelli & Palombi, 1990; Jacob, Otradovec & Russel, 1988). The reference period for a single serum ascorbate measure may vary from one month, for chronically low levels of dietary intake, to one week for higher intake levels (Blanchard, 1991; Kallner, Hartmann & Horniig, 1979). It may be argued that the use of a single measure to determine vitamin C status may be subject to misclassification error. However, it has been demonstrated that although higher dietary vitamin C intakes are associated with more intra-individual variation in serum levels than low intake levels, a single measure is a good indicator of chronically low levels of vitamin C intake (Jacob, Skala & Omaye, 1987; Bates, Rutishauser, Black *et al.*, 1979).

In a study in New Mexico, older women were found to have higher levels of plasma ascorbic acid than men (1.30 and 1.13 mg/dl, respectively) on similar dietary intakes (Garry *et al.*, 1982). It has been shown, using radioactive labelled ascorbic acid, that the total body pool of ascorbic acid reaches a maximum of 20 mg/kg, and that this amount can be achieved at a steady-state plasma concentration of 1.0 mg/dl (Kallner *et al.*, 1979). The New Mexico study demonstrated that older women could achieve this plasma concentration at a dietary intake of 75 mg of vitamin C per day, while for men of the same age the mean dietary intake required is twice that at 150 mg (Garry *et al.*, 1982). This finding was repeated by Vander-Jagt, Garry and Bhagavan (1987). However, it remains uncertain whether there are health benefits associated with achieving a maximum body pool of ascorbic acid in older adults (Marazzi *et al.*, 1990).

Mean serum zinc concentrations in subjects in the present study (15 (SD=3.7) µmol/l) were consistent with other studies of older adults in which zinc levels were reported to be between 12.2 and 15.4 µmol/l (Bogden, Oleske, Lavenhov *et al.*, 1990; Bogden, Oleske, Munves *et al.*, 1987; Bunker *et al.*, 1994; Payettre & Gray-Donald, 1991; Suboticanec *et al.*, 1989), and was substantially higher than a study of institutionalized subjects in France, in which 61% of subjects had levels <10.7 µmol/l (Giordon, Lombard, Galan *et al.*, 1997). By contrast, only 9% of subjects in the present study had low serum zinc concentrations.

Regarding the validity of the dietary assessment method used, it was assumed that an assessment of three days (two weekdays and one weekend day) would be sufficiently representative of habitual nutrient intake. The home for the aged in which the study subjects reside operates a three-week menu cycle; however, the inclusion of vitamin-C rich foods (fruit and vegetables) did not differ markedly from week to week. The plate-waste dietary assessment method is not beset with difficulties of recall on the part of subjects. At mealtimes, nursing assistants apportion and plate the food for residents. It is possible that the presence of the researchers at mealtimes may have biased the allocation of the portion size of the food which was being served by staff. Reasons for disparities between the calculated nutrient content of the menu and that of actual nutrient intake may be attributed to a lack of standardization of portion sizes being served to the residents. It is unclear whether personal preferences of the residents regarding appetite are taken into account by the staff when meals are being served. However, most subjects (78%) reported that their appetite was "good" and that they were able to feed themselves without assistance. The acceptability of the meals provided was not assessed in the present study.

Another potential bias is that the contribution of nutrient intake from foods which were purchased from the tuckshop and from other snacks was not calculated. However, the consumption of these foods is unlikely to influence the intake of either vitamin C or zinc since snack items usually comprised confectionary and crisps.

Vitamin C is a water-soluble vitamin which is sensitive to thermal processing of food. In the present study, a cook-chill

catering method is employed by the institution from which the sample subjects were drawn, whereby food is prepared three days in advance and may be stored for up to five days. Nutrient losses during food preparation, storage and regeneration may therefore be substantial. Such losses were not accounted for in the nutrient analyses, which were performed using the database of the South African Food Composition Tables (Langenhoven *et al.,* 1991) and may have resulted in even lower dietary intakes than those reported here.

Based on the findings of the present study, a question arises whether widespread micronutrient supplementation of women in long-term care is indicated and if so, at what dosage? In the case of vitamin C, absorption occurs through an active, saturable process (Mayersohn, 1972) and thus depends on the amount ingested. Bio-availability is further influenced by the form, whether it be from food sources, or a standard or sustained-release capsule. It has been demonstrated that a sharp rise in plasma concentrations of ascorbic acid levels is associated with a dietary intake of up to 150 mg/day, followed by a slower trend to higher levels with increasing intakes (Garry *et al.*, 1982). Girodon *et al.* (1997) examined the influence of low dose multi-micronutrient supplementation during a two-year period on the incidence of infections in geriatric patients at a long-term care facility in France. Compared with the placebo group, the subjects who were given trace elements (zinc and selenium) had two to four times fewer infections during the study period; however the trend for a reduction in the vitamin-supplemented group (vitamins C and E, ß-carotene) was not significant. Serum concentrations of the nutrients increased in both the trace element and vitamin-supplemented groups, but not in the placebo group. For example, the prevalence of low serum zinc (< 10.7 µmol/l) and vitamin C (< 4.0 µg/ml) levels decreased from 61% and 75%, respectively, at baseline, to 40% and 10% after six months of supplementation in subjects receiving both trace elements and vitamins; thereafter a plateau was reached. The study demonstrated that low dose supplementation of twice the RDA for vitamin C (120 mg/day) and 60 – 75% of the RDA for men and women, respectively, for zinc (20 mg/day) was sufficient to correct deficiencies of these nutrients. Previous studies have demonstrated that the use of large doses of micronutrient supplementation may have adverse effects on health outcomes in older adults, as demonstrated for zinc by Chandra (1984) and Bogden *et al.* (1990). Randomized controlled trials are required to compare the cost effectiveness and efficacy of supplementation versus efforts to increase dietary vitamin C intake in older adults in long-stay residential institutions.

Regarding anthropometrical assessment, most of the subjects tended towards underweight. Sixty-four percent of the subjects had a BMI below 24, the value which is considered by Bray and Gray (1988) to be the lower value of the desirable range for age; however the most recent guidelines suggest the normal range for BMI to be 18.5-24.9, regardless of age (World Health Organization, 1997). Although the mean triceps skinfold thickness (TSF) measurement was close to the 50th percentile for age (Chumlea, Roche & Mukherjee, 1986), 44% of subjects had a TSF below the 50th percentile and almost a fifth of subjects had a TSF below the 5th percentile. Similarly, mid-arm muscle area fell between the 25th and 50th percentile for age (Frisancho, 1981), which suggests a degree of muscle atrophy. Nevertheless, in terms of biochemical assessment of protein status, no subject was found to have a serum albumin concentration which fell below the reference value of 35g/l. Other studies have estimated protein-energy malnutrition to be present in 30 – 50% of elderly people in residential care (Abbasi & Rudman, 1994) and in 5 – 10% of community-dwelling older persons (Manson & Shea, 1991).

Few subjects were classified as obese; however, mean percentage body fat was relatively high, ranging from 37 to 45%, depending on which prediction equation was used. It has recently been argued that an equation which includes waist circumference, adjusted for age, provides a prediction of percentage body fat with low error and freedom from measurement bias, compared with the conventional equations which include the log sum of four skinfold thickness measurements (Lean, Han & Deurenberg, 1996). A waist circumference measurement is easier to perform than skinfold measurements which require highly trained personnel and the use of expensive calipers.

Low body weight and rapid unintentional weight loss have been shown to be highly predictive of mortality and morbidity in elderly populations (Dwyer *et al.,* 1987; Tayback, Kumanyika & Chee, 1990; Ho, Harris, Madans & Feldman, 1993). It is therefore recommended that an assessment of nutritional status, including anthropometic measures, is performed for each individual on admission to a long-stay institution and that at least body weight is assessed on a regular basis. This will enable early identification of the presence of disease or of potential nutritional deficiencies and provide opportunity for early dietary intervention.

Conclusion

The dietary intake of a sample of 49 older women residing in a long-stay institution in Cape Town was found to be inadequate, in terms of energy and micronutrient intake. A high prevalence of borderline plasma vitamin C concentrations was identified and a sub-optimal zinc status was found in 9% of the sample. It is recommended that more vitamin C-rich fruit and vegetables be included in the menus of homes for the aged, particularly homes in which a cook-chill catering system is operated. Vitamin C is found in many fruits and vegetables, particularly citrus fruits, guavas, mango, tomatoes, capsicums (peppers), cabbage and other green vegetables, as well as potatoes. Vegetables may be more palatable to residents if they are incorporated into composite dishes, such as casseroles and soups, and fruit may be included more regularly as desserts. In addition, the administration of a low-dose multivitamin and mineral supplement appears to be warranted.

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Dr Morag Insley, UK Representative, AGES International, 16 Ravelston Garden, Edinburgh EH4 3LD, Scotland. Fax: 0181 537-9145. E-mail: ages@finsley.dircon.co.uk