

## Original Article

# Anthropometric and biochemical markers for nutritional risk among residents within an Australian residential care facility

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The risk of malnutrition is high among elderly population, yet few studies have measured indicators of nutritional status among Australian aged-care residents. To determine the relationship between nutritional status and bone density, hand grip strength, and the timed-up and go test, in a group of Australian aged-care residents. Anthropometric and biochemical analysis measured in subjects recruited to be part of a six month multivitamin supplementation study. One hundred and fifteen subjects participated (68% female). The mean (SD) age and body weight was 80.2(10.6) years, and 66.5(15.0) kg, respectively. Eleven percent were underweight (body mass index, BMI,  $\leq 20.0 \text{ kg/m}^2$ ), and 20% were obese BMI  $\geq 30 \text{ kg/m}^2$ . Low serum 25-hydroxy-vitamin D (25(OH)D,  $\leq 50 \text{ nmol/L}$ ) concentrations were found among 79% of subjects. After adjustment for body weight, there was an association between serum 25(OH)D and bone density (heel ultrasound) ( $r = .204$ ,  $p = .027$ ). Low serum zinc ( $\leq 10.7 \text{ } \mu\text{mol/L}$ ) concentrations were found among 46% of subjects; this group had a slower timed up and go time compared with those with higher zinc concentrations ( $n = 19$ ,  $44.6 \pm 5.6$  seconds vs.  $n = 27$ ,  $30.0 \pm 3.3$  seconds,  $p = .020$ ). There were no associations between nutritional markers and hand grip strength. In this group, more than  $\frac{3}{4}$  of subjects had low serum 25(OH)D, and 46% had low zinc concentrations. Serum 25(OH)D was associated a lower bone density and zinc with a slower walking time. This indicates that the elderly in long term residential care facilities are at high risk for poor nutritional status, potentially increasing morbidity and mortality.

**Key Words:** long-term care, aged, Australia, nutritional status, bone density

## Introduction

The elderly population is extremely diverse with respect to body composition, physical activity levels, food intake, disabilities and disease status. In particular, the elderly in long-term care facilities appear to be at greater risk of nutritional deficiencies compared with community dwelling elderly.<sup>1-4</sup> Malnutrition results from an imbalance between energy and micronutrient input and output. This may be due to the impaired absorption of nutrients by the body, and/or a decrease in appetite and food intake. An inadequate food intake, contributing to negative energy balance, results in body weight loss and micronutrient deficiencies. Conversely, positive energy balance, as a result of increased energy intake and reduced physical activity levels, results in obesity. However, despite adequate energy intakes, obese people may still be at risk for micronutrient deficiencies.

Within long-term care institutions, there is limited information concerning the impact of nutritional status on functional status. Being underweight (low body mass index, BMI) or obese (high BMI) has been associated with disability, poor physical function and a decline in muscle strength.<sup>5-8</sup> It is well established that being underweight is also associated with increased mortality<sup>9-11</sup>, but it is unclear

whether being obese is also associated with increased mortality in this age group.<sup>12,13</sup>

Serum albumin is a marker of long-term protein intake and concentrations  $< 35 \text{ g/L}$  are a risk factor for protein-energy malnutrition.<sup>14</sup> Low levels of serum albumin have been found to occur in up to 48% of long-term care residents, overseas;<sup>15-17</sup> and have been associated with increased morbidity.<sup>18</sup> Low micronutrient status (i.e. zinc) also appears to be common within elderly institutionalised populations;<sup>19,20</sup> and low serum levels have been associated with a slower walking time among community dwelling women.<sup>21</sup> In addition, the cutaneous production of vitamin D declines with advancing age, mainly due to reduced sunlight exposure, leading to a decrease in circulating 25-hydroxy-vitamin D (25(OH)D) concentrations. In Australia, the number of aged care residents with low vitamin D levels is high, with estimates ranging between 22%-

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Manuscript received 14 March 2006. Accepted 1 May 2006.

74%.<sup>22-24</sup> Vitamin D deficiency has been associated with impaired functional performance, muscle strength<sup>25</sup> and increased risk of falls.<sup>22</sup>

As there is little information on nutritional status, bone density and functional status, in Australian long-term care facilities, our aim was to determine the relationship between nutritional status and bone density, hand grip strength, and the timed-up and go test, in a group of Australian long-term care residents.

## Materials and methods

### Subjects

Barwon Health is Victoria's largest, regional health care provider. It provides 758 inpatient beds with the Aged Care facility providing 260 high-level care (HLC) nursing home beds and 106 low-level care (LLC) hostel beds.

Three hundred and thirty four residents from the Aged Care facility (LLC: n=106; HLC: n=228) were eligible for inclusion (excluding rehabilitation, palliative care and gender specific dementia wards) in a study that investigated the effects of a multivitamin supplement on nutritional status. Residents gave informed consent, or if unable, their next of kin gave proxy consent. This project was approved by the Barwon Health Research and Ethics Advisory Committee and Deakin University Research Ethics Committee.

### Medical records

Information on dietary requirements, mobility levels, current body weight, medications, and medical conditions were collected from the medical records.

### Dietary intakes

Energy and nutrient intakes were assessed from 259 residents within the aged care facility, using a 24-hour, validated visual plate waste<sup>26</sup> survey. Nutrient intakes were calculated using the dietary analysis computer package Food Works, version 3. Values for vitamin D content were added to the database using data from British Food Composition Tables and American food standards data.<sup>27-29</sup>

### Anthropometry

Total stature height was calculated by measuring knee height (cm) using sliding callipers (Shapers, Coff's Harbour, NSW, Australia) on their left/right leg while seated. Knee height was measured as the distance from the sole of the foot to the anterior surface of the thigh with the ankle and knee each flexed to a 90° angle.<sup>30</sup> For an accurate 90° angle, a JAMAR Dynamometer was used to angle the knee correctly. One of the calliper blades was placed under the heel, while the other was placed over the anterior surface of the thigh above the condyles of the femur and just proximal to the patella.<sup>30</sup> Total stature height was used with body weight to calculate body mass index (BMI, kg/m<sup>2</sup>). In Australia, the National Health and Medical Research Council BMI reference ranges are: <20 kg/m<sup>2</sup> underweight; ≤20.0-25.0 kg/m<sup>2</sup> acceptable<sup>2</sup>, 25.0 - <30.0 kg/m<sup>2</sup> overweight, and ≥ 30.0 kg/m<sup>2</sup> obese.<sup>31</sup>

### Biochemistry

After a minimum eight hours fast, a single blood sample was taken for measurement of serum albumin, 25(OH)D, vitamin B12, folate and zinc concentrations. After clotting, blood specimens were centrifuged in a Spintron GT-15FR refrigerated centrifuge for 15 minutes at 3500 RPM. Aliquots were stored at -80°C prior to analysis. Serum albumin was assayed using a Randox Daytona automated clinical chemistry analyser (Antrim, UK, 2002). Radioimmunoassays were used to measure serum 25(OH)D (DiaSorin Inc, Minnesota, USA) and serum vitamin B12/folate (BioRad Laboratories, NSW, Australia) concentrations. Serum zinc was measured using flame atomic absorption spectrophotometry by direct aspiration (Varian SpectraAA-800). Low levels were defined as: serum albumin: ≤35 g/L<sup>17,32</sup>, 25(OH)D: ≤12.5 nmol/L,<sup>33</sup> vitamin B12: ≤150 pmol/L,<sup>34</sup> folate: ≤5 nmol/L,<sup>34</sup> and zinc: ≤10.7 μmol/L.<sup>35</sup>

### Ultrasound bone densitometry

Quantitative ultrasound (QUS) was used to measure broadband ultrasonic attenuation (BUA, dB/MHz) and velocity of sound (VOS, m/s) at the calcaneus using a Contact Ultrasound Bone Analyzer (McCue Ultrasonics, CUBA Clinical, Winchester, U.K), which utilizes two 19 mm unfocused transducers mounted coaxially. Velocity of sound was calculated from the distance between the transducers divided by the transit time of the ultrasound pulse through the bone and soft tissue. Broadband ultrasonic attenuation was calculated over 0.2 to 0.6MHz.

Measurements of BUA and VOS were made with each subject seated and their left/right leg at an angle of approximately 110 degrees, and their foot accurately positioned in the foot well. Special positioning inserts were used to ensure that the transducers were correctly aligned with the midportion of the heel. The midportion of the calcaneus was chosen as the site for the measurement as it is readily accessible and consists of >90% trabecular bone. Ultrasound gel was applied to both sides of the heel to provide acoustic coupling. To minimize movement, the lower leg was placed against a resting plate that extended from the foot to the knee. A single measurement was made at the left or right heel. The manufacture's phantom was measured prior to each testing session to ensure quality control.

### Timed-up-and go

The timed up and go (TUG) test is a performance measure which measures speed during several manoeuvres which potentially threaten balance.<sup>36</sup> TUG time has been shown to predict falls among community dwelling elderly,<sup>37</sup> and has been associated with falls risk scores in the elderly from a falls clinic.<sup>38</sup> The procedure began with the subject seated, their back against the chair, and arms resting on the chair arms. On the command "go", the subject stood up from the chair and walked at a comfortable speed for three metres, turned around and walked back to sit down in their chair.<sup>36</sup> The test was timed using a stopwatch (Digitor, 6 digit LCD stopwatch, Quartz Accuracy, China) from the commencement of the word "go", and stopped when the subject was seated again. Staff assistance and walking aids were utilised when necessary.

### Hand grip strength

Hand grip strength was measured using a JAMAR Hydraulic Hand Dynamometer (Sammons Preston, Rolyan; Homecraft Ltd, UK). Subjects were seated with their back straight and each arm at a 90° angle. All subjects were instructed to squeeze the tool as hard as they could. No verbal encouragement took place whilst the subject was squeezing. Grip strength was measured (in Kg Force) three times in each hand, and the average value for the right hand was used in the current analyses.

### Statistical analysis

Descriptive data is represented as mean (SD), or between groups as mean  $\pm$  SEM. Log 10 transformations were used to normalise skewed data (i.e. serum vitamin D, serum folate, hand grip strength). Student's *t* tests, Chi square tests, and univariate analyses were used where appropriate.

## Results

### Baseline characteristics

Of the 122 subjects who consented, two withdrew and five died prior to data collection. Data was collected from 115 residents within the high-level care wards (HLC, *n*=85) and low-level care hostels (LLC, *n*=30). Reasons for excluding subjects from some measurements are reported in Table 1. Sixty eight percent were female and 32% were male. Mean (SD) body weight was 66.5 (15.0) kg, and the mean age was 80.2 (10.6) years. Males were heavier than females (mean  $\pm$  SEM, 75.2  $\pm$  2.3 kg vs. 62.4  $\pm$  1.5 kg, *p*<.001), but females were older (82  $\pm$  1.1 years vs. 75  $\pm$  1.8 years, *p* =.001). There was no difference in age or body weight between HLC and LLC subjects.

Twenty eight percent of subjects (*n*=32) took a multi-vitamin preparation (Table 2). Twenty nine percent (*n*=33) of subjects took tablets containing calcium and/or vitamin D, and consumed between 162-1200mg calcium/day; and 5-25 $\mu$ g vitamin D/day. Six subjects took folate supplements (range: 30-90 $\mu$ g/day), two subjects took vitamin B12 supplements (range: 0.25-0.75 $\mu$ g/day); and seven subjects took vitamin B12 and folate supplements. Eleven percent of subjects (*n*=13) consumed nutritional drinks (Proform or Resource), providing per 100ml, between 127-25mg calcium; 0.7-1.0 $\mu$ g vitamin D; 0.25 $\mu$ g vitamin B12 and 30 $\mu$ g folate.

### Nutritional status

Dietary intakes were assessed in a group of 259 residents

(123 LLC, 136 HLC) at the long-term care facility. The mean (SD) daily energy intake was 6.4 (2.1) MJ. The mean intakes were: calcium: 830 (388) mg; zinc: 8 (3) mg; folate 249 (112)  $\mu$ g; and the median [inter-quartile range] for vitamin D intake was 1.89 [2.01]  $\mu$ g. There was no difference in intakes between HLC and LLC subjects.

The mean (SD) BMI for 113 subjects was 26.3 (5.0) kg/m<sup>2</sup>. Body mass index was divided into tertiles with the lower, middle and upper tertile cut points as:  $\leq$ 24.2 kg/m<sup>2</sup>; >24.2 -  $\leq$  28.5 kg/m<sup>2</sup>; >28.5 kg/m<sup>2</sup>. Mean ( $\pm$  SEM) BMI in the lower (*n*=37), middle (*n*=38) and upper (*n*=38) tertile were: 20.8  $\pm$  0.5 kg/m<sup>2</sup>; 26.3  $\pm$  0.2 kg/m<sup>2</sup>; and 31.5  $\pm$  0.5 kg/m<sup>2</sup>, respectively. Eleven percent were underweight (BMI  $\leq$ 20kg/m<sup>2</sup>) and 20% were obese (BMI  $\geq$ 30kg/m<sup>2</sup>). Mean (SD) serum micronutrient concentrations are presented in Table 3. Low serum zinc and 25(OH)D concentrations were common (Table 4). Those in LLC had higher serum albumin than those in HLC (39.8  $\pm$  3.0 g/L vs. 38.3  $\pm$  3.2 g/L, *p*=.022); but those in HLC had higher vitamin B12 than those in LLC (313.9  $\pm$  15.8pmol/L vs. 250.1  $\pm$  23.1pmol/L, *p*=.036), with both mean values being in the adequate range for vitamin B12.

Mean  $\pm$  SEM 25(OH)D concentrations were in the adequate range for those who took any form of calcium or vitamin D supplement (*n*=31, 50.7  $\pm$  3.7 nmol/L), compared with those who did not take any form of this supplement (*n*=82, 31.5  $\pm$  1.6 nmol/L, *p*<.001). Those taking folate combined with vitamin B12 (*n*=7, 24.5  $\pm$  4.5 nmol/L) or those taking folate without vitamin B12 (*n*=6, 30.7  $\pm$  7.5 nmol/L) had higher serum folate concentrations compared with those not taking folate supplements (*n*=102, 16.2  $\pm$  1.1 nmol/L, *p*=.010); however all mean levels were in the adequate range. There was no difference between HLC and LLC in the percentage of subjects who were taking vitamin B12/folate supplements (Table 2); or in serum folate and vitamin B12 concentrations (data not shown).

Sixty eight percent of subjects (*n*=77) either had low levels of serum albumin, 25(OH)D, vitamin B12, folate or zinc; and 11% (*n*=12) had a BMI  $\leq$ 20.0 kg/m<sup>2</sup>. Overall, 56% (*n*=64) could be classified as deficient or insufficient/borderline (i.e. 25(OH)D, vitamin B12, folate) in two or more biochemical markers. Seven percent (*n*=8) of subjects presented with no deficiencies or insufficiencies, of which three of these subjects consumed no supplements.

### Bone density

The mean (SD) BUA was 47.4 (23.2) dB/MHz, and was

**Table 1** Numbers and reasons for subject exclusion

Reason	Knee height	Blood sample	BUA	HGS	TUG
	n	n	n	n	n
Non compliant	1	2	5	2	29
Disease affecting measurement	1	-	-	2	1
Frail/bed bound/poor cognition	-	-	20	30	39
Total excluded:	2	2	25	34	69

BUA: broadband ultrasonic attenuation; HGS: hand grip strength; TUG: timed up and go.

**Table 2** General characteristics in High level care and Low level care residents

	HLC (n=85)		LLC (n=30)	
	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)
Mobility				
Immobile	52	61	3	10
With assistance	24	28	4	13
Independent	9	11	23	77
Eating Assistance				
Self fed	24	28	22	73
Self fed (with difficulty)	39	46	8	27
With assistance	22	26	-	-
Thickened Fluids				
Normal	69	81	30	100
Thickened	16	19	-	-
Supplement Use				
Calcium/Vitamin D	22	26	10	35
Folate/Vitamin B12	11	13	4	13
Other multivitamin type	15	18	5	17
Liquid supplement drink	11	13	2	7

HLC: High level care; LLC: Low level care

**Table 3** Mean (SD) values for serum micronutrients

Serum micronutrient	Albumin (g/L)	25(OH)D (nmol/L)	Zinc ( $\mu$ mol/L)	Folate (nmol/L)	Vitamin B12 (pmol/L)
Mean (SD)	38.7 (3.2)	36.8 (18.6)	11.2 (2.8)	17.5 (11.7)	297.5 (142.0)
Percentiles					
5 (n=5)	33.4	12.5	7.4	5.4	104.0
95 (n=5)	44.5	72.8	15.8	44.5	595.1

n=113

higher in males (n=29,  $58.1 \pm 4.0$  dB/MHz) than females (n=61,  $42.3 \pm 2.9$  dB/MHz,  $p=.002$ ). There was no difference in BUA between HLC and LLC subjects.

There was an association between BUA and body weight ( $r=.355$ ,  $p<.001$ ) and BMI ( $r=.312$ ,  $p=.001$ ). Once adjusted for body weight, there was no difference in BUA between BMI tertiles (data not shown).

After adjustment for body weight, a weak association was found between BUA and log serum 25(OH)D ( $r=.204$ ,  $p=.027$ ); and those with serum 25(OH)D  $\leq 25$ nmol/L had a 25% lower BUA than those with 25(OH)D  $>25$ nmol/L (n=22,  $38.0 \pm 4.3$  dB/MHz vs. n=68,  $50.4 \pm 2.8$  dB/MHz,  $p=.006$ ).

#### Functional status

The mean HGS was 25.0 (15.4) kg. Males had a stronger HGS (n=26,  $39.3 \pm 3.8$  kg) compared with females (n=55,  $22.4 \pm 1.4$  kg,  $p<.001$ ). There was no difference in HGS between HLC and LLC subjects. The mean TUG time was 36 (21) seconds (range: 10-112 seconds). Eighteen subjects (39%) used no aid, six subjects (13%) used a walking stick, and 22 subjects (48%) used a walking

frame. Those who used no aid had a faster walking time ( $22.9 \pm 4.5$  seconds) compared with those who used a walking stick ( $44.3 \pm 7.7$  seconds,  $p=.021$ ) and those who used a walking frame ( $44.5 \pm 4.0$  seconds,  $P=.001$ ). There was no difference in time between males and females or between HLC and LLC subjects. There was a negative association between TUG score and serum zinc ( $r=-.449$ ,  $p=.001$ ), and those who had serum zinc concentrations  $\leq 10.7$  $\mu$ mol/L had a slower TUG time compared with those with higher zinc concentrations (n=19,  $44.6 \pm 5.6$  seconds vs. n=27,  $30.0 \pm 3.3$  seconds,  $p=.020$ ). There was no difference between the zinc deficiency groups and TUG walking aids (data not shown).

#### Discussion

Among our group of institutionalised elderly, Australians, 68% of subjects had low levels of at least one serum marker, indicating nearly  $\frac{3}{4}$  may be at risk of nutrition-related diseases.

The mean BMI for the lowest and highest tertiles was 20.7kg/m<sup>2</sup> and 31.5kg/m<sup>2</sup>, respectively. These values are two-three units heavier than the lowest (19kg/m<sup>2</sup>) and

**Table 4** Serum micronutrient categories

Micronutrient	Frequency (n)	Percent (%)	Mean $\pm$ SEM
<b>Vitamin D</b>			
Frank deficient (<12.5nmol/L)	5	4%	9.69 $\pm$ 1.30
Marginally deficient (<12.5-25nmol/L)	26	23%	18.5 $\pm$ 0.78
Insufficient (25-50nmol/L)	58	51%	35.5 $\pm$ 0.95
Adequate (>50nmol/L)	24	21%	65.5 $\pm$ 2.36
<b>Albumin</b>			
Low (<35g/L)	16	14%	33.7 $\pm$ 0.19
Adequate (35-50g/L)	97	86%	39.5 $\pm$ 0.27
<b>Zinc</b>			
Low (<10.7 $\mu$ mol/L)	52	46%	9.12 $\pm$ 0.16
Adequate (>10.7 $\mu$ mol/L)	61	54%	12.9 $\pm$ 0.34
<b>Folate</b>			
Low (<5nmol/L)	4	4%	4.23 $\pm$ 0.23
Borderline (5-7nmol/L)	6	5%	5.74 $\pm$ 0.13
Adequate (>7nmol/L)	103	91%	18.7 $\pm$ 1.14
<b>Vitamin B12</b>			
Low (<150pmol/L)	15	13%	105.8 $\pm$ 8.38
Borderline (150-200pmol/L)	17	15%	176.2 $\pm$ 3.72
Adequate (>200pmol/L)	81	72%	357.9 $\pm$ 13.4

n=113

highest (29kg/m<sup>2</sup>) BMI tertile among long-term care residents in Italy.<sup>39</sup> Controversy exists regarding which BMI cut-off value should be used among elderly populations to predict mortality. Among male (mean age 87 years), but not female (mean age 89 years) long-term care residents in the US, one-year mortality risk was doubled for those with a BMI  $\leq$ 22kg/m<sup>2</sup> compared to those with a BMI >22 kg/m<sup>2</sup>.<sup>11</sup> Among 82 year old Italian long-term care residents, males and females with a BMI of  $\leq$ 21.6 kg/m<sup>2</sup> and  $\leq$ 22 kg/m<sup>2</sup> respectively, were at most risk of increased mortality; whereas those in the higher tertile of >25.4 kg/m<sup>2</sup> had a 40% lower risk of mortality over four years.<sup>39</sup>

Although BMI is a widely used index of obesity, it cannot distinguish between fat and muscle. Within elderly populations, being underweight or obese has been associated with disability, poor physical function and a decline in muscle strength;<sup>5-8</sup> yet the mechanisms causing these disabilities in underweight versus obese persons are likely to be different. In the elderly, there is increased fat mass, reduced muscle mass, and lower physical activity levels which exacerbate the imbalance between energy intake and energy expenditure, leading to positive energy balance. This results in weight gain and ultimately obesity, which has been associated with impaired activities of daily living<sup>40</sup> and disability.<sup>8</sup> In contrast, associations have been found between being underweight and lower levels of physical activity,<sup>40</sup> and increasing risk of falls<sup>41</sup> and fractures,<sup>42,43</sup> which leads to increased dependency in activities of daily living. These functional limitations and impairments all contribute to poor quality of life and increased mortality, yet prospective data linking these asso-

ciations to obese individuals in the elderly population is inconsistent. The 11% who were considered underweight are likely to be at greatest risk of increased mortality, but risk for the 20% who were obese is not clear.

Serum 25(OH)D insufficiency (<50nmol/L) was found among  $\frac{3}{4}$  of our institutionalised group, of which 27% had less than <25nmol/L. Low serum 25(OH)D levels within other Australian aged care facilities appears to be high, ranging between 22%-45% (<25nmol/L) of residents in Western Australia,<sup>22</sup> 52% of residents (<28nmol/L) in Victoria,<sup>23</sup> and 74% of residents in Sydney.<sup>24</sup> We found that low serum 25(OH)D was associated with lower bone density, which has previously been reported among Swiss institutionalised elderly, also using heel ultrasound.<sup>44</sup> Vitamin D plays a role in muscle metabolism, and it has been suggested that chronic deficiency may contribute to the progressive muscular weakness and impaired physical functioning observed with ageing.<sup>45</sup> In two cross-sectional studies, 25(OH)D deficiency has been associated with time to first fall among Australian institutionalised elderly;<sup>22</sup> and impaired functional performance and muscle strength in elderly subjects from a falls clinic.<sup>25</sup> Conversely, among disabled, elderly, community dwelling women, no association was found between 25(OH)D concentrations and bone density, hand grip strength, walking speed, or activities of daily living.<sup>45</sup> Nevertheless, in randomised, controlled trials, supplementation with vitamin D and calcium has been found to improve bone density and risk of fracture among the community dwelling<sup>46,47</sup> and institutionalised<sup>48,49</sup> elderly.

It has been consistently shown that serum homocysteine is inversely associated with serum folate<sup>50,51</sup>; and high serum homocysteine has been associated with vascular disease,<sup>52</sup> hypertension and hypercholesterolemia.<sup>53</sup> Short-term studies have revealed that increased folic acid intake through dietary means or tablet supplementation (0.5 to 5.0mg) produces a reduction of homocysteine by approximately 25%.<sup>54</sup> However, no clinical trials have confirmed that a reduction in homocysteine will reduce clinical vascular events or mortality. More recently, serum homocysteine has emerged as a new risk factor for increased risk of fracture among elderly people<sup>55,56</sup> and lower bone density.<sup>57</sup> Among our group, 91% of subjects had serum folate in the adequate range of >7nmol/L, however it is not known what the optimal level of serum folate is, to reduce fracture risk.

The mean serum zinc concentration was 11.2µmol/L, similar to healthy, Spanish (mean 10.49µmol/L)<sup>19</sup> and German (median 13.6µmol/L)<sup>20</sup> long-term care residents. Forty six percent of our residents had serum zinc concentrations <10.7µmol/L, which indicates a greater prevalence of low levels when compared to other studies conducted in community dwelling elderly, from Belgium, New Zealand and Canada, which ranged between 12%-28%.<sup>21,35,58</sup> We found low serum zinc concentrations were associated with a slower timed up and go time, which was also found among the New Zealand community dwelling elderly.<sup>21</sup> The association between zinc status and balance function has not been established. However, a low dietary zinc intake has been associated with an increased risk of fracture in middle aged and elderly men,<sup>59</sup> and has been associated with greater bone loss in middle aged women.<sup>60</sup> We found low zinc intakes among nearly half of the residents in the long-term care facility, indicating that many of our group may also be at risk for increased falls and fractures.

Our sample size was slightly larger than other descriptive studies,<sup>16,17,61,62</sup> however only ¼ of the total aged care population from the facility consented to be part of a multivitamin study. Therefore, our group was biased to a less frail population as we excluded those from the dementia and palliative care wards, who are likely to have a greater risk of nutritional deficiencies.

Provision of energy drinks may assist in the short-term to improve body weight among our underweight subjects, as this has been demonstrated among malnourished aged care residents.<sup>63</sup> Supplements of vitamin D in conjunction with calcium supplements have been found to reduce falls and fractures among aged care residents; and therefore should be recommended for elderly people in residential care settings. Further studies are required to investigate the effects of zinc and folate supplementation on risk of falls and fractures in this population.

#### Acknowledgements

The researchers greatly appreciate the assistance of Anthony Worsely (Professor of Public Health Nutrition) from Deakin University. We also greatly appreciate the assistance of a number of people from Barwon Health, including the nursing director, GPs, Unit Nurse Managers; and staff from Environmental Services, Allied Health, Supply, and Food Services. Finally, we wish to thank all of the residents who cooperated during the data

collection period.

#### Funding Sources

1. Australian Research Council (Linkage-Projects)
2. Murray Goulbourn Co-operative Co. Limited
3. Sigma Pharmaceuticals

#### Sponsors Role

Murray Goulbourn, Sigma Australian Pharmaceutical Company, Pty and the Australian Research Council provided financial support for this study, but had no input into the results presented in this report.

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## Original Article

## Anthropometric and biochemical markers for nutritional risk among residents within an Australian residential care facility

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### 澳洲住宅式照護設施住民之體位及生化標記營養風險

老人族群中營養不良的風險是高的，但是只有少數幾個研究曾測量澳洲接受老人照護的住民之營養狀況指標。本研究以手部握拳強度及計時起走測驗評估一組澳洲老人照護設施住民的營養狀況與骨質密度。體位測量及生化分析測量的研究對象來自一個六個月綜合維他命補充研究的參與者。共有 115 名研究對象參與(68%女性)。平均年齡(標準差)及體重分別為 80.2(10.6)歲及 66.5(15.0)公斤。11%體重過輕(身體質量指數, BMI<20.0 kg/m<sup>2</sup>)；20%肥胖(BMI≥30 kg/m<sup>2</sup>)。79%的研究對象為低血清 25(OH)D 濃度(25(OH)D≤50 nmol/L)。在校正體重之後，發現血清 25(OH)D 及骨質密度(腳後跟超音波)具有相關性( $r=.204$ ,  $p=.027$ )。46%的研究對象為低血清鋅(≤10.7 μmol/L)濃度；這組研究對象比起鋅濃度較高者其計時起走較慢( $n=19$ ,  $44.6 \pm 5.6$  秒 vs.  $n=27$ ,  $30.0 \pm 3.3$  秒,  $p=.020$ )。營養標記與收握拳強度沒有相關。在此組別，超過 3/4 的研究對象為低血清 25(OH)D 及 46%為低鋅濃度。血清 25(OH)D 與骨質密度及鋅較低以及較慢的走路時間具有相關性。這表示居住在長期照護設施的老年人有較高的營養狀況差的風險，可能增加死亡率及罹病率。

關鍵字：長期照護、年老的、澳洲、營養狀況、骨質密度。