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Apparent low frequency of undernutrition in Dublin hospital in-patients: should we review the anthropometric thresholds for clinical practice?

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Protein–energy undernutrition, or the possibility of its development, has been documented to occur frequently in patients on admission to hospital. Deterioration in nutritional status is known to occur in hospital. In a prospective study of 594 sequential hospital admissions, we aimed to assess the prevalence of undernutrition among patients on admission to two acute teaching hospitals in Dublin, Republic of Ireland using the widely-accepted anthropometric criteria applied in a large study from Dundee, Scotland, UK (McWhirter & Pennington, 1994) and to determine changes in nutritional status in hospital. The mean prevalence of undernutrition (11 %) was considerably lower than was reported from Dundee (40 %). Unintentional weight loss before admission and functional impairment on admission occurred to a similar extent in both centres. Weight loss in hospital occurred in the same proportion of patients, but less frequently among those undernourished on admission to hospital, in Dublin compared with Dundee. The patients found to be undernourished on admission in this study had a mortality rate in hospital (6·5 %) over three times that of the adequately nourished group (2 %). The magnitude of the difference in prevalence of undernutrition between the two centres cannot be explained by ethnicity, case-mix or age distribution. With the secular increase in BMI in the population, the thresholds for classifying patients as undernourished or at risk of nutritional deterioration may need to be reviewed. For clinical use, recent weight loss and functional status may be more appropriate variables to use in the evaluation of nutritional status on admission to hospital.

Undernutrition: Anthropometry: Reference data

The deleterious effects of impaired nutritional status on clinical outcome (Gallagher-Allred *et al*. 1996; Giner *et al*. 1996; Lumbers *et al*. 1996) and hospital costs (Tucker & Miguel, 1996) are widely acknowledged. If undernutrition is adequately documented on hospital admission and appropriate nutrition therapy is initiated, an improvement in clinical outcome should be expected. Protein–energy undernutrition, or the possibility of its development, has been documented to occur frequently in patients on admission to hospital (Butterworth, 1974; Bistrian *et al*. 1976; Hill *et al*. 1977; McWhirter & Pennington, 1994; Naber *et al*. 1997; Gariballa *et al*. 1998). However, these studies examined specific patient groups and employed a number of different definitions of undernutrition. As a result, direct comparison between the published studies and current assessment of the overall prevalence of undernutrition on admission to hospital is difficult.

Many studies assessing the prevalence of undernutrition have been criticised as they based their results on formulas which included biochemical measurement of serum proteins (Bistrian *et al*. 1976; Hill *et al*. 1977; Coats *et al*. 1993; Veterans Affairs Total Parenteral Nutrition Co-operative Study Group, 1991; Naber *et al*. 1997), for example, albumin, which may reflect either disease severity or nutritional status. The use of serum proteins may lead to inaccuracy in the estimation of prevalence of undernutrition in sick patients as many patients have reduced levels as a result of their disease, although they would not be classified as undernourished if an alternative method of classification were used. Although many believe that anthropometric criteria can define nutritional status more accurately, the reference data available to define nutritional status do not always reflect the normal distribution of the local healthy population (McWhirter & Pennington, 1994). The lack of such local reference material may make interpretation of the estimates of undernutrition more difficult. The reference data in current use in the UK and Republic of Ireland were derived from measurements made in the early 1970s of healthy Caucasian Americans (Bishop *et al*. 1981; Frisancho, 1981) while reference data derived from subjects in South Wales in the UK, published in 1984, are frequently used for defining the nutritional status of those aged 65 years

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or more (Burr & Phillips, 1984). Considerable geographical variation in anthropometric variables has been observed (Bishop *et al*. 1981; Frisancho, 1981; Burr & Phillips, 1984; Delarue *et al*. 1994; Launer & Harris, 1996; Bannerman *et al*. 1997; Rea *et al*. 1997). Whereas for survey purposes, the use of standard data allow the rates of obesity and underweight to be estimated in different areas of the world and for secular changes to be monitored, for clinical purposes, reference to local, healthy population data may be more appropriate. Although the standard cut-off values for categorising underweight are based on physiological and medical correlates, these do not consider recent weight loss. In ill patients recent weight loss is also correlated with undernutrition-related-complications, which are, in turn, linked to poor outcome. Therefore, the criterion of BMI $< 20\,kg/m^2$, widely used in clinical practice, may not always detect those patients at risk of undernutrition-related-complications, for example, patients of high initial body weights who have lost weight (Stack *et al*. 1996) or different ethnic (Norgan, 1994; Launer & Harris, 1996) or age groups (World Health Organization, 1995; Zemel *et al*. 1997). With the secular increase in adult BMI, the cut-off values at which patients are considered to be at nutritional risk may have to be reviewed (e.g. BMI $< 22\,kg/m^2$ was observed to be a significant predictor of mortality in older Italian people living in the community (Landi *et al*. 1999) while in the USA, the BMI at which the elderly are now considered at nutritional risk is now defined as $24\,kg/m^2$).

The aims of this study were, first, to measure the prevalence of undernutrition among medical and surgical patients admitted to two teaching hospitals in Dublin, Republic of Ireland, using the same anthropometric criteria as were used in a large study from Dundee, Scotland, UK (McWhirter & Pennington, 1994) and, second, to determine changes in nutritional status during the hospital stay. The results of the survey were intended to provide a background for planning the resources needed for effective nutritional care in the study hospitals.

Patients and methods

During an 8-month period, including a summer (1996) and a winter (1996–7) season, data were collected from every 10th and 3rd patient respectively admitted to a larger (812 beds) and a smaller (275 beds) Dublin teaching hospital, both with busy Accident and Emergency units and on active call every second day. The list of patient names was obtained from computerised admission records on a daily basis. All patients were assessed within 48 h of admission. Acute admissions to the special care units in either hospital were excluded, such as Intensive Care, Coronary Care, Burns and Bone Marrow Transplant Units. This was because such patients are generally well nourished on admission to hospital and assessment of their anthropometric status is difficult or impossible. Patients admitted to day wards and children under the age of 16 years were also omitted. Patients were excluded from the analysis of both admission (*n* 25) and discharge (*n* 16) data if gross fluid retention had been documented or if BMI was not calculable. In order to use the criteria for undernutrition devised by McWhirter & Pennington (1994), both BMI and upper-arm anthropometry must be measured. Of the twenty-five patients omitted from the analysis, six may have been undernourished, as five had a mid-arm muscle circumference or triceps skinfold thickness between the 5th and 15th percentile, and one had a mid-arm muscle circumference or triceps skinfold thickness below the 5th percentile. However, the inclusion of these six patients in the undernourished group would not have altered the overall prevalence of undernutrition in our study. Of 594 patients assessed, 569 were analysed to estimate the prevalence of undernutrition on admission. This represented 7·6 % of total admissions during the recruitment periods in the larger hospital, and 15·3 % in the smaller hospital. Of the 760 patients picked for inclusion, 10 (1·3 %) patients refused, 117 (15·3 %) were discharged before they could be assessed, 29 (3·8 %) could not be assessed within the first 48 hours of their admission, 7 (0·9 %) were picked for a second time and 3 (0·4 %) died before they could be assessed. The distribution between specialities of patients recruited in this study was comparable to that of patients admitted throughout the previous year, suggesting that the sample was representative of the usual admission profile. Table 1 shows the admission details of the patients studied. Follow-up data were available on discharge from 218 (71 %) of those staying in hospital for a minimum of 7 d. These patients were not pre-selected. Every attempt was made to reassess as many patients as possible by liaison with medical, nursing, dietetic and secretarial staff. Despite this, 21 % of patients were discharged before a second assessment could be carried out. The remaining 8 % of patients died in hospital and were therefore not reassessed. The data were analysed from 202 of these patients to determine the extent of change in nutritional status during the hospital stay. In the sixteen cases omitted from the discharge analysis, BMI could not be calculated or gross fluid retention was documented.

Written informed consent was obtained before measurements were made, and ethical approval was obtained from the joint research ethics committee of St. James's and the Federated Dublin Voluntary Hospitals.

The current nutritional status of the subjects was classified as normal, mildly, moderately or severely undernourished, overweight or obese. Patients were considered to be mildly undernourished if their BMI was less than $20\,kg/m^2$ and if their triceps skinfold thickness or mid-arm muscle circumference was below the 15th percentile. A BMI of less than $18\,kg/m^2$ and a triceps skinfold thickness or mid-arm muscle circumference below the 5th percentile were evidence of moderate undernutrition, and a BMI of less than $16\,kg/m^2$ and a triceps skinfold thickness or mid-arm muscle circumference below the 5th percentile were evidence of severe undernutrition (McWhirter & Pennington, 1994).

Height was measured with a Leicester portable stadiometer (Chasmors Weighing Equipment Ltd, London, UK). If height could not be measured (*n* 95), stature was calculated from knee height using the equations devised by Chumlea (Chumlea *et al*. 1985). Weight was measured with high-specification portable scales (Chasmors Weighing Equipment Ltd) which was regularly checked against two others of similar make. No re-calibration of the scales was required during the study period. Patients who could not stand were weighed on mechanical chair scales (calibrated

Table 1. Details of patients admitted to hospital in Dundee, Scotland, UK and Dublin, Republic of Ireland

	Elective procedures			Non-elective procedures			Total		
	Dundee	Dublin		Dundee	Dublin		Dundee	Dublin	
	n	*n*	%	*n*	*n*	%	*n*	*n*	%
General medicine:	47	38	19	53	160	81	100	198	100
Ischaemic heart disease	8	4		21	26		29	30	15
Malignant disease	11	18		2	21		13	39	20
Neurological disorders	3	3		9	16		12	19	10
Inflammatory bowel disease	9	1		4	1		13	2	1
Other gastrointestinal disorders	7	2		4	20		11	22	11
Diabetes mellitus	0	2		3	3		3	5	2
Vascular disease	5	1		5	23		10	24	12
Protein–energy malnutrition	1	0		2	1		3	1	0·5
Investigation of weight loss	2	1		0	1		2	2	1
Renal failure	1	1		3	3		4	4	2
Congestive cardiac failure	0	0		0	8		0	8	4
Haematological disorders	0	0		0	1		0	1	0·5
Fevers of unknown origin	0	0		0	4		0	4	2
Drug overdose	0	0		0	4		0	4	2
Psychiatric disorders	0	1		0	9		0	10	5
Acquired immune deficiency syndrome	0	0		0	5		0	5	2
Others	0	4		0	14		0	18	9
Respiratory medicine:	38	5	8	62	55	92	100	60	100
Chronic obstructive pulmonary disease	6	0		32	23		38	23	38
Asthma	7	0		11	4		18	4	7
Malignant disease	12	3		0	7		12	10	17
Tuberculosis	3	0		0	0		3	0	
Trauma	0	0		3	1		3	1	2
Other respiratory disease	10	2		16	20		26	22	37
Medicine for the elderly:	18	10	38	82	16	62	100	26	100
Respite care	18	2		0	0		18	2	8
Neurological disorders	0	4		15	4		15	8	31
Respiratory symptoms	0	0		14	6		14	6	23
Malignant disease	0	2		4	0		4	2	8
Gastrointestinal disorders	0	0		5	1		5	1	4
Renal disease	0	0		2	0		2	0	
Investigation of weight loss	0	0		1	1		1	1	4
Ischaemic heart disease	0	0		15	0		15	0	
Other acute illness	0	0		26	2		26	2	8
Vascular disease	0	2		0	2		0	4	15
General surgery:	53	132	57	47	100	43	100	232	100
Major abdominal surgery	14	12		11	17		25	29	12
Oesophageal surgery	4	9		2	0		6	9	4
Minor surgical procedures	10	59		7	36		17	95	41
Other major surgery:	16	18		2	15		18	33	14
Vascular surgery	8	9		6	8		14	17	7
Surgical emphysema	0	0		1	0		1	0	
Urological procedures/surgery/renal colic	0	24		2	14		2	38	16
Pancreatic disease	0	1		4	0		4	1	0·4
Abdominal pain	1	0		12	4		13	4	2
Investigations for gastrointestinal bleeding	0	0		0	6		0	6	3
Orthopaedic surgery	43	6	11	57	47	89	100	53	100
Metastatic bone disease	6	2		0	0		6	2	4
Trauma fractures	0	0		47	33		47	33	62
Joint replacements	19	0		0	0		19	0	
Minor surgical procedures	18	3		10	4		28	7	13
Neurological observations	0	0		0	7		0	7	13
Investigations joint pain	0	1		0	3		0	4	8

* McWhirter & Pennington (1994).

against the high-specification portable scales) or if not possible (*n* 50) weight was calculated using calf circumference, knee height, mid-arm circumference and subscapular skinfold thickness using the equations of Steinbaugh (Chumlea *et al*. 1987). BMI (weight (kg)/height (m)^2) was calculated and was used to grade patients into normal weight, overweight and obese. Mid-arm and calf circumferences were measured with a plastic insertion tape measure, and skinfold thickness measurements were made with Holtain skinfold callipers (Crymmych, Wales, UK), according to standard techniques (World Health Organization, 1995). Mid-arm circumference and triceps skinfold thickness were used to calculate mid-arm muscle circumference (mid-arm muscle circumference (cm) = mid-arm circumference − triceps skinfold thickness × 0·314) (World Health Organization, 1995). As in the Scottish study

(McWhirter & Pennington, 1994), the values obtained for patients aged 16–64 years were compared with American published reference tables (Bishop *et al*. 1981) while the values obtained for the elderly population were compared to Welsh reference data (Burr & Phillips, 1984). Our data were also compared to other published anthropometric reference material for the UK (BMI and mid-arm circumference) (Gregory *et al*. 1990) and Irish (BMI) (Lee & Cunningham, 1990) populations where these exist. Weight loss before admission to hospital was calculated from either recalled weight or from measurements recorded on a previous hospital visit. Functional status was measured with a hand-grip dynamometer (Takai Scientific Instruments Ltd, Tokyo, Japan). The highest of three readings made with the non-dominant arm was used.

Statistics

Statistical analysis was carried out using the Statistical Package for the Social Sciences for Windows, version 6.0.1 (SPSS UK Ltd, Woking, Surrey, UK). χ^2 analysis was used to test for differences between groups and to identify associations between unintentional weight loss before admission and undernutrition on admission. Independent sample *t* tests were used to test for differences in mean BMI, muscle and fat stores between the Dublin patients and published data from Edinburgh, Scotland, UK (Bannerman *et al*. 1997) and South Wales, UK (Burr & Phillips, 1984). Spearman's correlation was calculated to test the association between arm and calf muscle circumferences, between triceps and subscapular skinfold thickness measurements and between hand-grip strength on admission to hospital and weight loss before admission. *P* values of less than 0·05 were considered to indicate statistical significance.

Results

Body mass index

Of the 569 patients analysed on admission, sixty-two (11 %) were undernourished, a considerably lower proportion than the 40 % reported from Dundee. There was no difference in the prevalence of undernutrition between seasons (summer, *n* 269; winter, *n* 300) ($P = 0.39$), males (*n* 318) and females (*n* 251) ($P = 0.97$), higher (*n* 132) and lower (*n* 437) socio-economic groups ($P = 0.55$) and those aged equal to and above (*n* 218) or below (*n* 351) 65 years ($P = 0.53$).

A BMI of 20–24·9 kg/m^2 was recorded in 225 (40 %), 25–29·9 kg/m^2 in 179 (31 %) and 30 kg/m^2 or more in eighty-eight (15 %) subjects. A BMI below 20 kg/m^2 was recorded in seventy-seven (13·5 %) patients, 18–20 kg/m^2 in forty-nine (9 %), 16–18 kg/m^2 in twenty-one (4 %) and below 16 kg/m^2 in seven (1 %). The use of BMI as the sole determinant of undernutrition (i.e. disregarding triceps skinfold thickness or mid-arm muscle circumference measurements) gave a higher prevalence of undernutrition (13·5 %) than when the additional anthropometric measurements were also considered.

Direct comparison by speciality between Dublin and Dundee shows a lower prevalence of undernutrition in each patient group (Table 2) and a higher prevalence of overweight and obesity in Dublin ($P < 0.001$) (Table 3). In addition, the severity of undernutrition was less in Dublin with more normally nourished ($P < 0.001$) or mildly undernourished ($P < 0.001$). Despite these overall differences, the prevalence of overweight and obesity among respiratory and general surgical patients was similar in both centres.

Mean BMI in the patient group was similar to that of the healthy subjects measured in the Irish National Nutrition Survey (Lee & Cunningham, 1990). In Dublin patients aged over 75 years, females had significantly lower ($P < 0.05$) and males had a trend towards lower ($P = 0.05$) mean BMI than their community-based Edinburgh counterparts. BMI for both male and female Dublin patients aged 65 years or more was similar to healthy males and females from South Wales (Table 4).

Anthropometric measures of body composition

A triceps skinfold thickness below the 5th percentile was found in twenty (3 %) Dublin patients while eighty-three (15 %) were between the 5th and 15th percentiles. A mid-arm muscle circumference value below the 5th percentile was found in sixty-four (11 %) Dublin patients with 131 (23 %) between the 5th and 15th percentile. Fewer Dublin than Dundee patients aged 16–64 years had a mid-arm circumference less than 25 cm ($P < 0.001$) (Table 5). In all patients aged over 75 years in Dublin, mid-arm muscle

Table 2. Comparison of prevalence of undernutrition at admission between Dublin, Republic of Ireland and Dundee, Scotland, UK*

	Dublin			Dundee		
	No. undernourished		No. assessed	No. undernourished	No. assessed	Statistical significance†
	n	%				
General medicine	25	13	198	46	100	$P < 0.001$
General surgery	17	7	232	27	100	$P < 0.001$
Respiratory medicine	11	18	60	45	100	$P < 0.01$
Medicine for the elderly	4	15	26	43	100	$P < 0.05$
Orthopaedic surgery	5	9	53	39	100	$P < 0.001$

* McWhirter & Pennington (1994).
† χ^2 analysis.

Table 3. Distribution of nutritional status at time of admission to hospital in Dundee, Scotland, UK* and Dublin, Republic of Ireland

Hospital speciality	Total (*n*)	Undernutrition: Mild *n*	%	Moderate *n*	%	Severe *n*	%	Normal weight *n*	%	Overweight/obese *n*	%
General medicine:											
Dublin	198	17	9	7	4	1	0·5	90	45	83	42
Dundee	100	11		27		8		30		24	
General surgery:											
Dublin	232	10	4	7	3	0		96	41	119	51
Dundee	100	10		16		1		25		48	
Respiratory medicine:											
Dublin	60	8	13	0		3	5	26	43	23	38
Dundee	100	13		19		13		17		38	
Medicine for the elderly:											
Dublin	26	4	15	0		0		11	42	11	42
Dundee	100	4		20		19		27		30	
Orthopaedic surgery:											
Dublin	53	4	7	0		1	2	23	43	25	47
Dundee	100	28		5		6		30		31	

* McWhirter & Pennington (1994).

Table 4. BMI of Dublin, Republic of Ireland, hospitalised patients compared with Irish National Nutrition Survey, Edinburgh, Scotland, UK and South Wales, UK, data*

(Mean values and standard deviations)

Age group (years)	Dublin patients Mean	SD	*n*	Irish National Nutrition Survey Mean	SD	*n*	Edinburgh Mean	SD	*n*	South Wales Mean	*n*
Men											
16–18	21·1	1·4	5	21·2	2·5	73					
18–25	23·9	4·2	35	23·1	3·1	51					
25–40	25·5	5·3	68	26·0	3·2	85					
40–60	26·0	4·9	81	27·3	3·1	87					
⩾60	25·0	4·4	129	25·6	3·8	82					
75–79	24·4	4·6	24				26·4	3·5	31	23·9	188
80–84	23·8	4·9	13				25·9	2·6	18	23·7	87
⩾85	23·5	4·2	5				24·5	4·1	10	23·1	41
Women											
16–18	22·8	5·5	4	21·7	2·7	110					
18–25	23·8	4·6	18	23·2	3·0	54					
25–40	24·6	4·0	40	24·2	4·7	122					
40–60	26·1	5·7	59	26·6	4·3	111					
⩾60	24·8	5·5	130	26·4	4·9	84					
75–79	24·1	4·0	32				26·2	4·7	66	26·1	329
80–84	23·8	5·5	20				26·8	4·6	32	25·5	200
⩾85	22·5	3·5	11				24·9	3·8	30	23·6	88

* Lee & Cunningham (1990), Bannerman *et al*. (1997) and Burr & Phillips (1984) respectively.

Table 5. Distribution of mid-arm circumference in people aged 16–64 in Dublin, Republic of Ireland, hospitalised patients compared with data from Dundee, Scotland, UK and the general UK population*

	Men						Women					
	Dublin patients (*n* 214)		Dundee patients (*n* 134)		UK population (*n* 1191)		Dublin patients (*n* 137)		Dundee patients (*n* 90)		UK population (*n* 1187)	
Mid-arm circumference (cm)	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
<25	20	9	29	22	36	3	26	19	28	31	167	14
25·1–27·5	43	20	35	26	167	14	33	24	17	19	320	27
27·6–30	46	21·5	19	14	333	28	33	24	17	19	320	27
30·1–32·5	59	28	27	20	369	31	19	14	8	9	202	17
>32·5	46	21·5	24	18	286	24	26	19	20	22	178	15

* McWhirter & Pennington (1994) and Gregory *et al*. (1990) respectively.

circumferences were higher than in healthy people from South Wales ($P < 0·05$), but lower than recently reported from Edinburgh ($P < 0·05$). Triceps skinfold thickness measurements in both male ($P < 0·01$) and female ($P < 0·05$) patients in Dublin were higher than expected from the Welsh data, although they were similar to those found in Edinburgh (Table 6).

Calf circumference and subscapular skinfold thickness measurements were recorded in this study as additional measures of body composition. A significant correlation was observed between calf circumference and mid-arm muscle circumference (r 0·59, $P < 0·001$) and between subscapular and triceps skinfold thickness measurements (r 0·6, $P < 0·001$).

Weight loss on admission

Unintentional weight loss of over 10 % in the 6 months before admission occurred in sixty-four (12 % of the 538 patients for whom data on previous weight were obtained) patients by comparison with 13 % in the Dundee study (McWhirter & Pennington, 1994). A further twenty-nine (5 %) patients had unintentional weight loss of more than 5 % in the month before admission. Of the sixty-two undernourished patients, twenty-one (37 %) lost more than 10 % body weight over the previous 6 months while a further nine (16 %) lost more than 5 % over the previous month. Undernutrition on admission was significantly associated with unintentional weight loss over the 6 months before admission ($P < 0·001$).

Functional status on admission

The grip strength of 523 patients was measured. A similar percentage of patients in both the Dublin and Dundee studies recorded a hand-grip strength below 85 % of standard (Webb *et al.* 1989) (69 % *v.* 67 %). Highly significant negative correlations between hand-grip strength on admission to hospital and weight loss over both the 6 months (r 0·19, $P < 0·001$) and the 1 month (r 0·18, $P < 0·001$) before admission were observed. Of 218 patients reassessed before discharge, it was possible to measure hand-grip strength in 191. In the undernourished and high-nutritional-risk groups, a significantly higher proportion of patients who lost weight in hospital lost hand-grip strength in comparison to those in the same groups who gained weight ($P < 0·05$).

Changes in nutritional status during hospital stay

Table 7 shows details of the weight changes for the 202 patients in whom BMI could be calculated both on admission and on discharge. The median length of stay for these patients was 12 d. Weight loss occurred in 65 % of overweight and obese (median length of stay 11 d), 66 % of normal weight (median length of stay 13 d) and 43 % of underweight patients (median length of stay 15 d). Weight gain occurred in 31 % of overweight and obese, 30 % of normal weight and 43 % of underweight patients. None of the undernourished patients moved into a worse category of the three categories of undernutrition (mild, moderate, severe). Two normal weight (BMI 20–24·9 kg/m^2) patients became

Table 6. Mid-upper arm circumference, triceps skinfold thickness, and arm muscle circumference for Dublin, Republic of Ireland patients aged 75 years or more compared with those in Edinburgh, Scotland, UK and South Wales, UK*

(Mean values and standard deviations)

	75–79 years old					80–84 years old					≥85 years old				
	Dublin patients		Edinburgh		South Wales	Dublin patients		Edinburgh		South Wales	Dublin patients		Edinburgh		South Wales
	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean
Men	*n* 27		*n* 31		*n* 119	*n* 16		*n* 18		*n* 56	*n* 6		*n* 10		*n* 31
MAC (cm)	27·1	3·1	29·7	3·2	24·9	26·8	3·8	29·2	2·4	23·5	28·1	4·2	27·3	3·9	22·1
TSF (mm)	10·4	3·9	11·4	5·9	7·0	9·2	3·3	10·1	3·2	6·6	9·5	3·5	9·5	3·0	6·5
MAMC (cm)	23·8	2·4	26·1	2·7	22·1	23·8	3·1	26·0	2·0	21·5	25·1	3·2	25·4	4·2	20·8
Women	*n* 32		*n* 66		*n* 219	*n* 22		*n* 32		*n* 131	*n* 12		*n* 30		*n* 75
MAC (cm)	28·2	3·6	29·9	4·1	24·9	26·3	4·6	30·1	3·9	23·5	26·2	3·8	27·9	2·9	22·1
TSF (mm)	18·1	6·2	17·1	5·5	14·6	17·0	7·2	17·9	5·3	12·7	15·2	6·9	14·0	3·4	11·5
MAMC (cm)	22·5	2·5	24·5	2·9	20·0	20·5	2·6	24·5	2·7	19·2	21·4	2·1	23·5	2·1	18·2

MAC, mid-upper arm circumference; TSF, triceps skinfold thickness; MAMC, mid-upper arm muscle circumference.
* Bannerman *et al.* (1997) and Burr & Phillips (1984) respectively.

Table 7. Changes in weight during the hospital stay in 202 Dublin, Republic of Ireland patients who were reassessed on discharge

	Patient's status on admission										
					Undernourished						
	Overweight (*n* 91)		Normal (*n* 88)		Mild (*n* 16)		Moderate (*n* 5)		Severe (*n* 2)		Number referred (*n* 12)
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*
No change	4	4	4	5	2	12	1	20	0		0
Weight loss	59	65	58	66	7	44	2	40	1	50	6
Weight gain	28	31	26	29	7	44	2	40	1	50	6

mildly underweight (BMI $< 20\,kg/m^2$ and mid-arm muscle circumference or triceps skinfold thickness below the 15th percentile), six obese patients (BMI 30–39·9 kg/m^2) became overweight (BMI 25–29·9 kg/m^2) and seven overweight patients became normal weight. Of the twenty-three undernourished patients (BMI below $20\,kg/m^2$ and mid-arm muscle circumference or triceps skinfold thickness below the 15th percentile) reassessed on discharge, twelve (52 %) were referred for nutritional support. Six of these patients gained weight while six lost weight from time of admission to discharge.

Discussion

Using identical criteria to define undernutrition, our present study found that 11 % of patients admitted to hospital in Dublin were undernourished by comparison with 40 % in a similar study in Dundee (McWhirter & Pennington, 1994). The reasons for the difference are not clear but a number of possibilities must be considered. First, the case-mix of patients may be different. The diagnoses and nature of admissions for both Dublin and Dundee can be seen in Table 1. While the case-mix of two such studies can never be identical, with the exception of the general surgical group where admission for minor surgical procedures was more common in Dublin, and admission for abdominal pain higher in Dundee, the mix within each patient group is similar. While the Dublin study included more surgical patients who were certainly better nourished than their counterparts in Dundee, if only medical patients had been considered, the prevalence of undernutrition among such patients (*n* 284) was only 15 %, significantly lower than the 45 % among medical patients (*n* 100) in Dundee. The Dublin study included sixty patients in respiratory medicine by comparison with 100 in the Dundee study. Prevalence of undernutrition was 18 % in Dublin *v.* 45 % in Dundee. It is unlikely that if a further forty respiratory patients were assessed, thirty-four would be undernourished. The same principle applies to orthopaedic surgical patients where only 9 % of patients in Dublin *v.* 39 % in Dundee were undernourished. The differences in case-mix are unlikely to account for the discrepancy in results, particularly when the prevalence of undernutrition is compared within diagnostic categories. Indeed, malignant disease occurred more frequently in all diagnostic categories (with the exception of general surgery) in Dublin than in Dundee. Although only twenty-six patients admitted under Medicine for the Elderly were assessed in Dublin, 40 % (*n* 218) of the total patient group were aged 65 years or more. There was no difference in the prevalence of undernutrition occurring in patients aged under 65-years or in those aged 65 years or more in this study ($P = 0{\cdot}53$), or in the Dundee study (43 % in patients admitted under Medicine for the Elderly *v.* an overall prevalence of 40 %). The proportion of elective and non-elective patients admitted to each speciality can also be seen in Table 1. Although it could be postulated that differences between numbers of elective and non-elective admissions could account for the difference in prevalence of undernutrition, it is unlikely to account for a 29 % disparity between the two studies. Indeed, medical, respiratory, orthopaedic and elderly patients admitted acutely are in general sicker, and therefore one would expect, more undernourished than their counterparts admitted for elective procedures.

Second, there is a possibility that Scottish and/or UK patients are different in some way from Irish patients. Undoubtedly, while there is a significantly greater proportion of patients admitted to hospital in Dundee with a BMI below $20\,kg/m^2$, this has not been observed in other, more recent, studies carried out in Scotland and the UK. The Scottish study (Tessier *et al.* 2000) reported that 13 % of 219 patients admitted to hospital in Glasgow were undernourished on admission (defined as a BMI below $18{\cdot}5\,kg/m^2$ or 18·5–20 kg/m^2 with reported weight loss greater than 3 kg in 3 months). Two studies from London reported that 16·5 % of 410 general medical, general surgical and orthopaedic patients (Vlaming *et al.* 1999) and 22 % of 192 general medical admissions (Weekes, 1999) had a BMI below $20\,kg/m^2$ on admission while a study from Manchester (Strain *et al.* 1999) reported that 24 % of 400 medical, surgical and orthopaedic patients who were expected to be in hospital for at least 1 week (therefore choosing those who were sickest on admission) were undernourished according to the criteria of McWhirter & Pennington (1994; BMI below $20\,kg/m^2$ and mid-arm muscle circumference or triceps skinfold thickness below the 15th percentile). It is widely accepted that rates of undernutrition in nursing homes and institutions are broadly comparable to those found in hospital. The recent UK National Diet and Nutrition Survey (Finch *et al.* 1998) reported that 16 % of men and 15 % of women living in institutions were underweight, an identical figure to that found in Dublin among those admitted under Medicine for the Elderly (Table 2) and to all elderly patients (*n* 218) admitted in Dublin (16 %). It could be postulated that a unique situation exists in Dundee and that the figure of 40 % undernutrition found there is not representative of rates in other parts of the UK and Republic of Ireland. One possible explanation for this could be that the normal anthropometric profile in the Dundee population is different to that found more usually in the UK and Republic of Ireland. The recent data from the UK (Finch *et al*. 1998) and from our group (Corish *et al*. 2000) show that for those aged 65 years and over, the anthropometric profile for the healthy elderly is identical in both countries. Although not all patients are in this age group, 40 % of the Dublin patients and 55 % of those in Dundee were elderly, and as stated previously, differences in the prevalence of undernutrition between the younger and older age groups were not observed in either study. That the normal anthropometric profile is different in Dundee is supported by the fact that in both studies, a similar percentage of patients reported weight loss of more than 10 % in the 6 months before admission to hospital (12 % in Dublin *v*. 13 % in Dundee) and suffered functional impairment as indicated by a hand-grip strength less than 85 % of the reference data (Webb *et al*. 1989) (69 % in Dublin *v*. 67 % in Dundee). If patients in Dundee have to wait longer for hospital admission and are, therefore, presumably sicker on admission it is highly probable that recent weight loss and functional impairment would be observed to a far higher degree there compared with Dublin. The possibility that the population of Dundee has a lower distribution of BMI is supported by another Scottish study. This study from Edinburgh (Bannerman *et al*. 1997), using the same criteria as McWhirter & Pennington (1994), could find no undernutrition among 200 elderly patients (⩾ 75 years) registered with two general practices. Given that 43 % of patients admitted under Medicine for the Elderly are undernourished on admission to hospital in Dundee and therefore, must become undernourished while still living at home, it is surprising that none of the 200 elderly people in Edinburgh were found to be undernourished when assessed in their own homes which allowed for the inclusion of those too ill to attend the clinic or the general practitioner.

Although we cannot dispute the differences in the proportion of patients with a BMI below 20 kg/m^2 in Dublin and Dundee, we have to query the current applicability of such a cut-off for clinical purposes in most centres in the UK and Republic of Ireland. Selective catabolic loss of protein due to infection or injury causes extreme illness in overweight patients who lose muscle whilst still retaining substantial amounts of total body and subcutaneous fat (Ferro-Luzzi & James, 1996). Such selective loss of lean tissue was observed in this study. Although only 18 % of patients had a triceps skinfold thickness below the 15th percentile, 34 % had a mid-arm muscle circumference below this value. It is therefore probable that these patients are more undernourished than indicated by the measurement of BMI and fat stores. The prevalence of obesity is increasing in Republic of Ireland (Lee & Cunningham, 1990; Kilkenny Health Project, 1992), the UK (Prentice & Jebb, 1995; Jebb, 1999) and the USA (Galuska *et al*. 1996; Van Itallie, 1996; Flegal *et al*. 1998). We know that the mean BMI for the healthy elderly population in both the UK and Republic of Ireland is 26·7 kg/m^2 (Finch *et al*. 1998; Corish *et al*. 2000). The shift in the distribution of anthropometric data could lead to significant biases when used for assessing the nutritional status of patients on admission to hospital if the normal healthy local population from which these patients come is getting fatter, and the average and percentile lines for anthropometric measures are changing. Although we know that the pragmatic cut-off values for BMI are based on physiological and medical correlates, weight loss is also associated with undernutrition-related complications, particularly if it occurs with functional impairment, regardless of pre-illness weight (Haydock & Hill, 1986). Furthermore, there is little information in older age groups as to the appropriateness of a cut off value of 20 kg/m^2 to define undernutrition in this age group. With the secular increase in adult BMI, the cut-off values at which patients are considered to be at nutritional risk may have to be altered and in the elderly in the USA, nutritional risk is now defined as a BMI below 24 kg/m^2 while a BMI less than 22 kg/m^2 was observed to be a significant predictor of mortality in older Italian people living in the community (Landi *et al*. 1999). Significantly more elderly patients with an average BMI of 20·9 kg/m^2 who were undergoing lung-volume reduction surgery required ventilatory support and had significantly longer hospital length of stay than those patients with an average BMI of 26·1 kg/m^2 (Mazolewski *et al*. 1999). The definition of undernutrition in both the Dundee and Dublin studies included triceps skinfold thickness or mid-arm muscle circumference measurements in addition to the BMI cut-off of 20 kg/m^2. These had to fall below the 15th percentile compared to reference data in routine use in the UK and Republic of Ireland (Bishop *et al*. 1981; Burr & Phillips, 1984). The secular changes observed in the anthropometric distribution of the population obviously will change where the 15th percentile lies and define a different proportion of patients as undernourished compared to the use of the older reference data. A population shift in anthropometric variables has also recently been reported in infants in the UK (Paul *et al*. 1998; Savage *et al*. 1999) who conclude that there is a need for new reference data sets for head circumference and skinfold thickness for infants in the UK.

Anthropometric screening has been recommended for the detection of undernutrition in hospital and in the community as it is simple, cheap and non-invasive (McWhirter & Pennington, 1994; World Health Organization, 1995; Edington *et al*. 1996, 1997). Its use however, requires reference data. These data are used both by nutritional epidemiologists, for monitoring secular changes in populations, and for making cross-country comparisons between population, and by clinicians for assessing nutritional status among ill individuals, either in hospital, or at hospital or community clinic visits. The reference data routinely used in the UK and Republic of Ireland are over 20 years old and derived from the USA population for younger adults and from South Wales for the elderly. We know that these data are significantly different from current anthropometric data on the elderly (Bannerman *et al*. 1997; Finch *et al*. 1998; Corish *et al*. 2000). The current reference data are therefore useful for monitoring trends in the population but their use as a tool in clinical practice must be addressed. The small number of undernourished individuals in Dublin and the high mortality rate in this group (6·5 % *v*. 2 % in the adequately nourished group, ($P = 0{\cdot}05$)) suggest that the criteria used identified patients whose underlying disease had progressed to the point where nutritional intervention could no longer be of therapeutic benefit. If we state that there is a genuinely lower level of undernutrition in Dublin, we must then assume that few patients will benefit from nutritional intervention, as in general, studies have demonstrated benefits only in undernourished patients (Bastow *et al*. 1983; Delmi *et al*. 1990; Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991; Beattie *et al*. 1999) with benefits not being observed in well-nourished patients (Heslin *et al*. 1997; Watters *et al*. 1997). However, we also know that pre-operative weight loss is associated with increased post-operative complications (Studley, 1936; Klidjian *et al*. 1980; Meguid *et al*. 1988; Reilly *et al*. 1988; Windsor & Hill, 1988; Von Meyenfeldt *et al*. 1992) which can result in longer post-operative convalescence times (Bastow *et al*. 1983; Lumbers *et al*. 1996), increased duration of hospital stay (Bastow *et al*. 1983; Shaw-Stiffel *et al*. 1993) and increased post-operative mortality (Busby *et al*. 1980; Giner *et al*. 1996). It is obviously not necessary and uneconomical for all patients to receive nutritional intervention. It is equally unsatisfactory if patients who would benefit from nutritional intervention do not receive it. It is therefore necessary that outcome data should be considered among those falling at the lower end of the population distribution curve for a particular population to assess the potential benefits for this group from nutritional intervention.

Weight loss in hospital occurred as frequently in Dublin as in Dundee (63 % *v*. 64 % of patients lost weight). However, the mean weight loss was less in Dublin than in Dundee (4 % *v*. 6 %). Weight loss also occurred less frequently in the undernourished group in Dublin (43 % *v*. 75 %) ($P < 0{\cdot}05$). Referral for nutritional intervention occurred in 20 % of patients in Dublin including 40 % of the undernourished patients. In Dundee, only 18 % of the undernourished group were referred. The higher referral rate in Dublin may either reflect better nutritional practice in Dublin, or the fact that, in response to earlier studies such as that of McWhirter & Pennington (1994), there is generally a greater awareness with more referrals as a consequence. It is difficult to draw conclusions without historical data on referral rates in Dublin.

Nutritional status on admission to hospital is thought to be an important factor in determining clinical outcome. It has been argued that nutrition screening on admission to hospital is worthwhile to identify those who would benefit most from nutrition intervention (Lennard-Jones, 1992; Reilly *et al*. 1995). However, there is no clear definition of undernutrition or nutritional risk. Anthropometry provides a simple method of assessing nutritional status for this purpose, but in order to assess patients in the clinical setting knowledge of the normal anthropometric status of the local healthy population may be necessary. Although, we can certainly say that fewer patients in Dublin than in Dundee are undernourished using the current reference data and threshold levels, the changing anthropometric profile of the normal population in both the UK and Republic of Ireland means that this may not tell the full story. A review of the anthropometric criteria to assess nutritional status on admission to hospital is, therefore, mandatory. We need to have agreement on the most appropriate anthropometric thresholds to decide which patients in the clinical setting are at risk. Other variables (e.g. weight loss, loss of lean tissue and/or functional impairment) should also be fully evaluated and recommendations made as to how they should be incorporated into the definition of undernutrition. Complacency on the basis of these results from Dublin could result in many patients not receiving nutritional intervention who could benefit from it.

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