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ENERGY AND PROTEIN INTAKE, ANTHROPOMETRICS, AND DISEASE BURDEN IN ELDERLY HOME-CARE RECEIVERS - A CROSS-SECTIONAL STUDY IN GERMANY (ERNSIPP STUDY)

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Abstract: *Objective:* To date, no study has examined the nutritional status and disease burden of elderly home-care receivers living in Germany. Aim of this cross-sectional study was, first, to assess disease burden and nutritional status, denoted in anthropometrics, and, second, to investigate associations between anthropometrics and disease burden. *Design:* Cross-sectional multi-centre study. *Setting:* Home-care receivers living in three urban areas of Germany in 2010. *Participants:* 353 elderly (>64 years) in home care (128 males aged 79.1 ±7.8 years, 225 females aged 82.0 ±7.5 years). *Measurements:* Nutritional status was assessed by body mass index (BMI), mid upper arm circumference (MUAC) and calf circumference (CC). Medical conditions were assessed in personal interviews. A 3-day prospective nutrition diary was kept. Metric data are reported as mean±SD or median (interquartile range), $p<0.05$ was considered significant. *Results:* Most participants were substantially (59%), and 11% severest in need of care. The seniors suffered from 5 (4-7) chronic diseases; dementia, depression, stroke, and respiratory illness were most prevalent (each 20-40%). More than one-third of participants had only moderate or poor appetite, nearly half were unable to eat independently. Chewing problems were reported for 52% of study participants, and more than one quarter of elderly had swallowing problems. Daily mean energy intake was 2017±528 kcal in men (n=123) and 1731±451 kcal in women (n=216; $p<0.001$). Mean protein intake amounted to 1.0 g/kg body weight. Mean BMI was 28.2±6.2 kg/m² (n=341), 14% of seniors had a BMI <22 kg/m² (including 4% with BMI <20 kg/m²). Critical MUAC (<22 cm) was indicated in 6% of subjects; and CC <31 cm in 11% of men, 21% of women ($p<0.05$). After adjusting for sex and age, BMI, MUAC and CC were negatively associated with high care level, hospitalization in the previous year, nausea/vomiting, prevalence of dementia, poor appetite, and eating difficulties like dependency, chewing and swallowing problems. *Conclusion:* We recommend to pay special attention to the nutritional status of elderly persons in home-care exhibiting named disease burden.

Key words: Elderly home-care receivers, nutritional status, disease status, anthropometrics.

Introduction

Over the past years the number of old and very old people rises steadily all over Europe (1). Comparisons of the different European countries showed the highest percentage of older people in Germany and with them an increasing number of those with care needs (1). In 2009 there were approximately 2.34 million people in need of care in the sense of the German Social Insurance Code (SGB XI) (2). Presently, 1.62 million seniors are cared for at home; about two-thirds are maintained by relatives, and one-third, partially or completely, through ambulatory care services (2).

Data from studies with nursing home residents and geriatric patients revealed a high risk for undernutrition for older adults in those settings (3-9). The studies examining the nutritional status in relation to disease burden showed significant negative associations. A degrade in nutritional status may in turn cause measurable adverse effects on physical function, clinical outcome, number of hospital admissions, risk of morbidity and mortality (4, 5, 10-12) and, thus, quality of life.

A recently published cross-setting comparison of nutritional status in older people living in the community versus older people living in shared housing-arrangements in Germany showed, that the more care-dependent seniors are in higher risk of malnutrition (13). Only few studies on care-dependent seniors were performed in home-care settings (14-18) and no study has examined the nutritional status in relation to disease burden of home-care receivers living in Germany yet.

Aim of the present study was, thus, to assess disease burden and anthropometrics of elderly home-care receivers in Germany. Second goal was to investigate associations between these parameters.

Materials and methods

The study was conducted by the universities of Bonn, Paderborn and Erlangen-Nuremberg and took place in these cities in 2010. The ethics committees of the participating universities approved the study.

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Study design

The nutritional status and disease burden of elderly home-care receivers in three urban areas of Germany were examined in a cross-sectional multi-centre design ('Ernährungssituation von Seniorinnen und Senioren mit Pflegebedarf in Privathaushalten', ErnSIPP). Participants were recruited in cooperation with local medical services of the statutory health insurance (MDK), ambulatory care services, press and public relations, which enabled contacts to eligible persons. Inclusion criteria were: minimum age of 65 years, living in a private household, care level I – III, and not being in the final weeks of life. Three field teams were collectively trained in interviewing technique and anthropometric measurement handling. They contacted potential participants in their city by telephone, gave detailed study information and made an appointment for the first visit. After the subjects gave signed consent, the teams assessed their data in the presence of the participant's primary caregiver on two personal visit occasions at the participants' homes approximately two weeks apart. If participants were cognitively impaired (Mini Mental State Examination <17 points), questions were addressed to the primary caregiver.

Participants' care levels reflected the degree of dependency according to the German Social Security Code (SGB XI). The level of care depends on the daily time needed for care and housekeeping activities. Care level I 'substantially in need of care' equates 90-<180 minutes of care per day, care level II 'severely in need of care' 180-<300 min/day, and care level III 'severest in need of care' ≥300 min/day (19).

Data collection

Subjects' characteristics such as date of birth, gender, living arrangements, and duration of care were collected in standardised personal interviews on the first visit.

Anthropometrics

Nutritional status was assessed by anthropometric measurements on first visit. Body weight (BW) was measured with a digital scale (Firma Beurer GmbH, Ulm) in lightweight clothing and without shoes to the nearest 0.1 kg (n=244). Body height (BH) was measured to the nearest 1 cm (n=216) with an ultrasound stadiometer (Fa. Soehnle Professional, Backnang). For participants unable to stand upright, knee height was measured with a sliding caliper on the left leg to the nearest 0.1 cm (n=105). From knee height, stature height was calculated according to Chumlea et al. (20). In individual cases (n=3) half arm-span measurement was used to estimate BH (21). When measurements of BH or BW were impossible, self-reported values were used (n=125). Body mass index (BMI) was calculated (weight [kg] /height $[m]^2$).

Mid upper arm circumference (MUAC) was measured on the non-dominant relaxed arm, at a point midway between acromion and olecranon. The mean of two measurements was recorded. Calf circumference (CC) was measured on the left undressed leg, bent at 90° angle at the knee, at the widest part of the calf. Measurements were repeated two times and the largest one was evaluated. All circumference measurements were taken with flexible measure tape to the nearest 0.1 cm.

For assessing deterioration of nutritional status with anthropometric markers, internationally used cut-off values were applied (BMI <18.5 kg/m^2, BMI <20 kg/m^2, BMI <22 kg/m^2, MUAC <22 cm, CC <31 cm; 22-25). Additionally, frequently used cut-offs for higher BMI values are presented graphically (BMI <24 kg/m^2, BMI 24-<29 kg/m^2, BMI ≥29 kg/m^2; 26).

Energy and protein intake

On first visit, study participants or their health care personnel were instructed how to keep a prospective nutrition diary on 3 consecutive days, including one weekend day. The record form consisted of 105 food items and 22 drink items commonly consumed by seniors, divided into 19 food groups, with open lines for addition of unlisted items. Validity of this nutrition diary has been shown by Volkert et al. (27). Food intake was analyzed for energy and nutrient content using EBISpro 8.0 for Windows (J. Erhard, Hohenheim University, Stuttgart) based on the German nutrient database BLS II.3. Oral nutritional supplements (ONS) and enteral nutrition (n=4) were also recorded and considered in the analyses. Evaluation of energy and protein intake was based on 'Reference Values for Nutrient Intake' (28). Thereby, adequacy of energy intake was assessed on the basis of percentage deviation of 3-day mean intake from the individuals' reference value. The individuals' reference value was calculated using individual basal metabolic rate (BMR; under consideration of sex, age and BW; m >60 years: BMR (kcal/d) = 13.5 * BW (kg) + 487; and w >60 years: BMR (kcal/d) = 10.5 * BW (kg) + 596; (27) and physical activity level (PAL). According to their personal particulars, study participants' PAL was judged (inactive = 1.2, little active = 1.3, moderately active = 1.4, very active = 1.6).

Disease burden and eating problems

On the second home visit, disease burden and eating problems were assessed in a questionnaire-structured interview. Prevalence of chronic diseases, swallowing problems, xerostomia, nausea/vomiting, hospitalisations in the last year and acute infections in the last three months were inquired with an answer 'yes – no'. Constipation was inquired with answers 'never/infrequent – occasionally – always', and the number of all regularly ingested drugs was recorded. The study participant was asked if she/he suffers from chewing problems ('no problems – with hard food only/occasionally – always'), and to rank her/his appetite as 'very good – good – moderate – poor'. Additionally, subjective global health status was asked in the interview ('fair – moderate – poor'). Eating dependency was assessed in categories 'independent – needs help – dependent'.

Statistics

Categorical data are presented as relative frequency. Metric data are given with mean ± standard deviation (SD), or median, 25th and 75th percentiles (P25-P75). Normal distribution of continuous variables was tested with Kolmogorov-Smirnov test. Comparison between sexes was performed using chi-squared test, unpaired Students' t-test, or Mann-Whitney U-test according to the data level. Correlations between BMI, MUAC and CC were tested by Pearsons correlation coefficient *r*. Univariate analysis of variance (ANOVA) with age as covariate and sex as fixed factor was used to identify selected medical conditions associated with low BMI, MUAC or CC. Differences were considered significant at $p<0.05$. Data were evaluated with Statistical Package for the Social Sciences (SPSS, version 19.0, Munich) for Microsoft Windows.

Results

A total of 353 elderly home-care receivers, 128 men aged 79.1 ±7.8 years, and 225 women aged 82.0 ±7.5 years, were included in the study. Female participants were significantly older than male ($p<0.001$). Characteristics of study participants including care level, diagnosis of chronic disease and medication are presented in Table 1. Most of the participants were substantially in need of care (level I, 59%). Only a few were severest in need of care (level III, 11%). Participants suffered from 5 (4-7) chronic diseases. Prevalence of diseases potentially compromising nutritional status like dementia, depression, stroke, respiratory illness, gastritis, and cancer were observed in a range of 10-40%. Men had significantly higher prevalence rates of respiratory disease, stroke, and hypertension than women ($p<0.001$, $p<0.01$, $p<0.05$). Osteoporosis was more frequent in women ($p<0.001$). Two-thirds of the study population were prescribed 5 or more medications. Men took more prescribed drugs than women ($p<0.05$). Nearly half of study participants suffered from obstipation. Pressure sores were only reported in 3% of the participants.

Table 2 summarizes the presence of eating problems. More than one-third of the older people showed only moderate or poor appetite. Nearly half of the participants were unable to eat independently, with more men requiring help than women (52% vs. 41%; $p<0.01$). Most help was needed for cutting food (44%). Chewing problems, occasionally or always, were reported for 52% of the study participants, and more than one quarter of the older adults suffered from swallowing problems. Xerostomia was also a frequent complaint. Most study participants assessed their health status as moderate, and nearly one-third classified themselves to be in poor health (data not shown).

Mean BMI was 28.2 ±6.2 kg/m² (n=341) without gender difference (Table 3). Nearly one quarter of seniors had BMI values below 24 kg/m² (24%); 14% were assessed as being underweight according to cut-off BMI <22 kg/m², including 4% with a BMI <20 kg/m² and 2% with a BMI <18.5 kg/m² (Figure 1). Critical MUAC (<22 cm) was only indicated in few participants (6%) and also similar in both sexes (Table 3). Calf circumference values of less than 31 cm were present in about 11% of men and 21% of women ($p<0.05$). MUAC and CC decreased with reduced BMI rendering high correlations (BMI vs. MUAC *r*: 0.80; and BMI vs. CC *r*: 0.63; both $p<0.001$). Furthermore, anthropometric values decreased with increasing age (BMI *r*: -0.22, MUAC *r*: -0.26, and CC *r*: -0.35; all $p<0.001$).

Table 1
Characteristics and disease burden of study participants

		Male (n=128)	Female (n=225)	p[1]
Age (years; mean ±SD[2])		79.1 ±7.8	82.0 ±7.5	<0.001
Care level (%)	I	56	60	n.s.
	II	35	27	
	III	9	13	
No. of chronic diseases (median (P25-P75))		6.0 (4.0-7.8)	5.0 (4.0-6.5)	n.s.
No. of medications (mean ±SD)		7.8 ±3.6	6.9 ±3.6	<0.05
Hospitalization in the previous year (%)		63	58	n.s.
Acute infection in the previous 3 months (%)		30	21	n.s.
Chronic diseases				
Hypertension (%)		81	69	<0.05
Heart failure (%)		61	58	n.s.
Dementia (%)		36	34	n.s.
Diabetes mellitus (%)		33	26	n.s.
Depression (%)		31	30	n.s.
Stroke (%)		38	25	<0.01
Respiratory disease (%)		38	21	<0.001
Osteoporosis (%)		12	33	<0.001
Gastritis (%)		12	11	n.s.
Cancer (%)		14	11	n.s.
Chronic kidney diseases (%)		13	11	n.s.
Chronic liver diseases (%)		3	6	n.s.
Constipation (%)		47	45	n.s.
Diarrhoea (%)		15	14	n.s.
Nausea/vomiting (%)		12	20	n.s.

1. Gender differences using chi-squared test, unpaired Students' t-test, or Mann-Whitney U-test according to the measurement level; 2. Abbreviations: SD-standard deviation; P-percentile; n.s.-not significant

Daily energy intake differed between men and women ($p<0.001$; Table 3). No differences were noted for age. Energy intake below the individual requirement had 63% of men and 58% of women. Also, absolute daily intake of protein was significantly lower in women ($p<0.001$; Table 3) but without

difference for age. When protein intake is related to BW, mean intake amounted to 1.0 g/kg BW (Table 3), but 24% of male and 26% of female participants consumed less than 0.8 g protein/kg BW.

Table 2
Eating problems of study participants

	Male (n=128)	Female (n=225)	p[1]
Appetite (%)			
Very good	22	12	n.s. [2]
Good	44	49	
Moderate	27	31	
Poor	7	7	
Eating dependency (%)			
Independent	48	59	<0.01
Needs help	42	29	
Dependent	10	12	
Chewing problems (%)			
Occasionally	31	36	n.s.
Always	13	20	
Swallowing problems (%)	33	26	n.s.
Xerostomia (%)	45	49	n.s.

1. Gender differences using chi-square test; 2. Abbreviation: n.s.-not significant

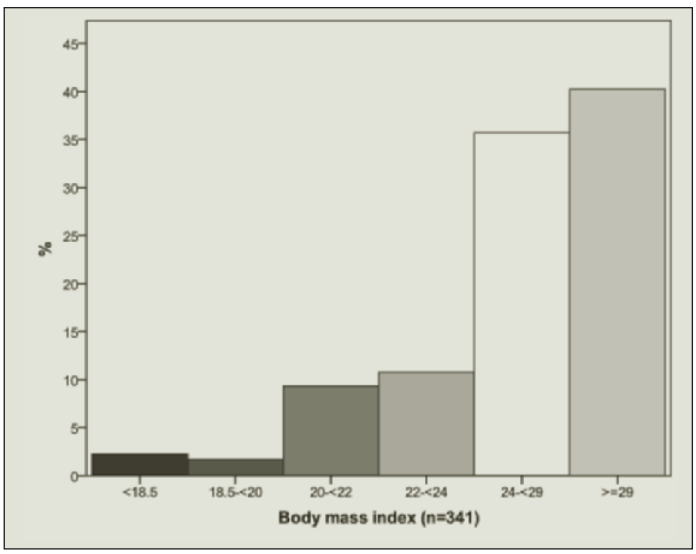
Table 3
Anthropometric values, energy and protein intake of elderly in home-care

	Male mean ± SD[1] (n)	Female mean ± SD (n)	p°
BMI (kg/m²)	28.3 ± 5.7 (124)	28.2 ± 6.5 (217)	n.s.
MUAC (cm)	29.5 ± 4.4 (125)	28.5 ± 5.0 (221)	n.s.
<22 cm (%)	4.8	7.2	n.s.
CC (cm)	35.6 ± 4.3 (122)	34.7 ± 5.0 (221)	n.s.
<31 cm (%)	10.7	21.3	<0.05
Energy (kcal/d)	2017 ± 528 (123)	1731 ± 451 (216)	<0.001
Protein (g/d)	81.2 ± 21.1 (123)	69.0 ± 21.3 (216)	<0.001
(g/kg BW)	1.0 ± 0.3 (119)	1.0 ± 0.4 (209)	n.s.

1. Abbreviations: SD-standard deviation; BMI-body mass index; MUAC-mid-upper arm circumference; CC-calf circumference, BW-body weight, n.s.-not significant. °Gender differences using chi-squared test, unpaired Students' t-test, or Mann-Whitney U-test

Relations between anthropometrics and disease burden and eating problems are presented in Table 4. Body mass index was negatively associated with an increase in care level, hospitalization in the previous year, prevalence of dementia, poor appetite, eating dependency, nausea and vomiting, and chewing and swallowing problems. Most factors that were significantly associated with BMI also correlated with MUAC and CC. Contrary to expectations, no significant association with decreased anthropometric data was found for acute infection within the last 3 month, and chronic diseases like stroke, respiratory disease, gastritis, cancer, or symptoms like obstipation, diarrhoea and xerostomia.

Figure 1
Body mass index (kg/m²) distribution of elderly home-care receivers living in Germany



Discussion

In this cross-sectional multi-centre study, the nutritional status and disease burden of home-cared older adulds in Germany were assessed for the first time. As expected, the study population consists predominantly of elderly women (64%), similar to all home-cared seniors in Germany (67%; 2). The care level allocation (I, II, III) of the study participants (59%, 30%, 11%) is also comparable with those of the official German home-care statistics (63%, 30%, 7%; 2).

The mean BMI of the study participants was within the normal range of healthy elderly (Table 3; 26). However, in comparison with nursing home residents, whose BMI was on average between 21 and 26 kg/m² (6,7), the mean BMI was distinctly higher and therefore the risk for undernutrition seems lower in home-cared elderly. In a multi-centre cross-sectional study recently performed in 10 German nursing homes the average BMI was 25.7 kg/m^2 and 11% had a low BMI (<20 kg/m^2) (30,31). Studies in America and Finland have reported mean BMI values of 27-29 kg/m^2 for elderly home-care receivers (17, 32, 33) and thus in the same range as the BMI of the present study. However, compared to prevalence of BMI values below 18.5 kg/m^2 in the US (4%; 33) and Finland

Table 4
Body mass index (BMI), mid-upper arm circumference (MUAC) or calf circumference (CC) (mean ± SD[1]) in dependence on disease burden and eating problems - results of univariate ANOVA (age as covariate, sex as fixed factor)

Associated parameters°		BMI [kg/m²] (n=341)	MUAC [cm] (n=346)	CC [cm] (n=343)
Care level	I	29.1 ±6.4	29.6 ±4.7	35.9 ±4.4
	II	27.6 ±6.0	28.4 ±4.8	34.5 ±4.8
	III	25.1 ±4.5	26.2 ±4.2	31.9 ±5.2
	OR (95CI)	-1.9 (-2.8; -1.0)	-1.6 (-2.3; -0.9)	-1.8 (-2.5; -1.2)
	p	<0.001	<0.001	<0.001
Hospitalization in the previous year	No	28.8 ±7.0	29.1 ±4.9	35.4 ±5.0
	Yes	27.9 ±5.7	28.7 ±4.8	34.8 ±4.6
	OR (95CI)	-1.3 (-2.7; 0.0)	-0.9 (-1.8; 0.1)	-1.0 (-2.1; -0.4)
	p	≤0.05	n.s.	<0.05
Nausea/vomiting	No	28.6 ±6.5	29.2 ±4.9	35.3 ±5.1
	Yes	26.4 ±4.5	27.2 ±3.8	32.9 ±3.6
	OR (95CI)	-2.5 (-4.2; -0.8)	-2.3 (-3.5; -1.1)	-2.6 (-3.8; -1.4)
	p	<0.05	<0.05	<0.01
Dementia	No	29.2 ±6.7	29.7 ±4.8	35.8 ±4.6
	Yes	26.3 ±4.8	27.2 ±4.3	33.7 ±4.8
	OR (95CI)	-2.4 (-3.8; -1.1)	-1.9 (-2.9; -0.9)	-1.7 (-2.7; -0.7)
	p	<0.01	<0.001	<0.01
Appetite	Very good	30.1 ±5.9	30.7 ±4.5	36.4 ±4.6
	Good	28.9 ±6.9	29.3 ±5.0	35.7 ±4.7
	Moderate	27.4 ±5.1	28.2 ±4.4	34.3 ±4.7
	Poor	23.4 ±3.9	25.2 ±3.4	31.3 ±3.0
	OR (95CI)	-1.8 (-2.5; -1.0)	-1.4 (-2.0; -0.8)	-1.4 (-2.0; -0.8)
	p	<0.001	<0.001	<0.001
Eating dependency	Independent	29.3 ±6.1	29.7 ±4.6	36.0 ±4.6
	Needs help	27.7 ±6.3	28.7 ±5.0	35.0 ±4.3
	Dependent	23.8 ±4.3	25.4 ±3.7	30.6 ±4.0
	OR (95CI)	-2.5 (-3.4; -1.6)	-1.8 (-2.5; -1.2)	-2.2 (-2.9; -1.5)
	p	<0.001	<0.001	<0.001
Chewing problems	No	29.2 ±6.6	29.7 ±4.8	36.3 ±4.9
	Occasionally	28.3 ±5.9	28.6 ±4.8	34.7 ±4.4
	Always	25.2 ±4.9	27.2 ±4.5	32.4 ±3.8
	OR (95CI)	-1.5 (-2.4; -0.6)	-0.7 (-1.4; 0.0)	-1.5 (-2.2; -0.8)
	p	<0.001	n.s.	<0.001
Swallowing problems	No	29.0 ±6.2	29.3 ±4.7	35.6 ±4.6
	Yes	26.3 ±5.9	27.8 ±5.0	33.5 ±4.8
	OR (95CI)	-3.1 (-4.5; -1.6)	-1.9 (-3.0; -0.9)	-2.4 (-3.5; -1.3)
	p	<0.001	<0.001	<0.001

°all parameters are significantly associated with at least one anthropometric variable; 1Abbreviations: SD-standard deviation; BMI-body mass index; MUAC-mid-upper arm circumference, CC-calf circumference; n.s.-not significant; OR (95CI)-odds ratio (95% confidence interval)

(8%; 17), such a low BMI was less frequent in German home-cared seniors (2%, Figure 1).

We were able to analyze MUAC and CC as indicators of fat and muscle protein stores (34, 35). Previous studies identified MUAC to be a significant and independent predictor of mortality in older people (8, 36). Frequently used cut-offs for MUAC and CC are those reported by the Mini Nutritional Assessment (MNA; 25). According to the MNA, MUAC should not be less than 22 cm and the CC not less than 31 cm. Rolland et al. corroborated a value of less than 31 cm for CC as a better clinical indicator signifying sarcopenia than other anthropometric values, such as the BMI (37). In our data CC values in critical range reached 8% in elderly with BMI values above 22 kg/m^2 (data not shown). As indicated in Table 3, CC

was more often reduced in the study participants than MUAC. A previous study by Volkert et al. also reported CC values much more often reduced than MUAC values (52% vs. 13%) in older nursing home residents (6). Less pronounced muscle mass in upper extremities changes less as a result of inactivity (6).

We formerly published an analysis of functional data from a subgroup of this study population – of whom we were able to obtain functional data - in relation to MNA (38). Functional status deteriorated significantly from the well nourished to the malnourished group in all functional measures (i.e. timed-up-and-go test, TUG, short physical performance battery, SPPB, and hand grip strength, HGS). Performance data correlate with anthropometric data (BMI and TUG (r: 0.15, $p<0.05$), BMI and HGS (r: 0.12, $p<0.05$); MUAC and HGS (r: 0.17, $p<0.05$); CC and SPPB (r: 0.19, $p<0.01$), CC and HGS (r: 0.25, $p<0.001$), thus, the anthropometric findings of this study are in line with functional capacity.

The assessment of individuals' energy intake shows that approximately 60% of participants do not reach the recommended levels. Yet a probably increased nutrient or energy demand due to illness or low body weight (39) was not considered, thus, the number of subjects with insufficient energy-consumption can potentially be higher. Mean protein intake was above the recommended levels (Table 3). How high protein and amino acid intake levels should be to maintain optimal muscle-mass in frail elderly, remains an open question (40) and a final conclusion on adequacy of the protein intake is, therefore, impossible. As protein-energy undernutrition often is caused by inadequate food intake (11) we hypothesized that energy and protein intake would decrease within lower BMI categories. This was not confirmed by our observations (data not shown). Either, people did not report their food consumption correctly, or the higher or lower BMI values resulted from earlier overnutrition or undernutrition, respectively (i. e. 'treatment effect'). Locher et al. (2008) also found greater likelihood of undereating with increasing BMI values in home-bound older adults (15). We conclude, that nutritional intake assessed with a self-administered 3-day prospective food dairy, is not sufficiently predictive of nutritional status in home care-dependent older adults.

Previous studies have shown that older adults with unintentional weight loss had higher risk of mortality, regardless of BMI (10, 41, 42). In our study, 42% of the participants had lost weight since onset of their care needs, and in 80% of them an unintentional weight loss exceeded 5% of their initial BW (data not shown). However, we did not correct the ANOVA (Table 4) for weight loss data, as weight loss was assessed by questioning and relied on the memory of the respondent and thus data did not have the same validity of measurements performed by our study field team.

To incorporate all information included in our anthropometric data, we examined metric data in the association analyses to detect factors negatively associated with anthropometric values, rather than only using categorized values. Uncertainty on appropriate cut-offs is avoided.

Nutritional status, as assessed by the anthropometric data BMI, MUAC, or CC, correlated negatively with care level, number of hospitalizations in the previous year, nausea/vomiting, cognitive disorders, low appetite, and problems with eating, chewing and swallowing (Table 4). Protein-energy malnutrition is known to affect quality of life negatively and increases morbidity and mortality rates in older patients (5, 10-12). Thus, an early identification of patients with or at risk of malnutrition taking into account health risk factors is very important for setting early preventive actions. Removing the underlying cause and improving the nutritional status by nutritional intervention makes an impact (12, 22, 43, 44).

The higher the help needs, depicted in higher care level, the lower were anthropometric values (Table 4). This is consistent with previous studies which have shown that a higher rate of dependency and decreased functionality increase the likelihood of a poor nutritional status (38, 45, 46). Focussing on eating dependency, our data showed associations between growing need of help and lower anthropometric values. In compliance, further studies reported that older people with eating dependency are at higher risk of developing malnutrition (47, 48). Loss of appetite is frequently observed (Table 2) and is associated with decreased anthropometric data (Table 4). Possible strategies to improve appetite are: checking drug prescriptions, personally chosen food, fortified menus and appetizers (11).

We found lower anthropometric values among participants with dementia (Table 4). Dementia may result in decreased anthropometric values because of problems with e. g. food preparation, forgetting to eat, swallowing abnormalities or higher resting expenditure due to increased activity (35, 49). Patients with cognitive impairment require special attention and nutritional intervention may lead to an improvement in nutritional status (22).

Significant relationships were also observed between the number of chronic disease and the number of drugs, however in the opposite direction than expected (data not shown). The lower the number of chronic disease or regularly ingested drugs, the lower the anthropometric values. Apparently, the influence of the type of chronic disease and drugs seems to be superior to quantity.

Chewing and swallowing problems are widespread in the examined population (Table 2) and significantly associated with decreased nutritional status markers (Table 4), as has been demonstrated earlier (9, 32). Usually these ailments can potentially cause malnutrition by a restricted diet (50, 51). Strategies to improve oral nutrient intake can be dental and oral care check, mushy food, or in case of difficulty with swallowing, adequate training (52).

No association was found between participants with prevalent stroke or cancer, and low anthropometric values, which is in line with results of the Tromsø study (53). A possible explanation, also stated by the Tromsø study, can

be the increased risk of mortality and poor clinical outcome in malnourished acute stroke patients and cancer patients with weight loss (54-56) and, consequently, the participation of survivor patients with stable nutritional status, who have possibly less severe ailments.

Due to the volunteering participation it can not be ruled out that rather health- and nutrition-conscious people have participated in the study. On the other hand, older people with nutritional problems may have participated driven by desire for advice for nutritional improvements. Thus, the study sample cannot be regarded as representative for the German home care population, although the distribution of care levels corresponds well to the German care situation. All comparisons between male and female participants (Tables 1, 2, and 3) have to be interpreted in view of the age difference between men and women (Table 1). Another limit of this study is the 'yes-no' assessment of most of the disease variables. In this way it is impossible to consider the severity of disease complications differentially.

Intake assessment by self-administered 3-day prospective food dairies seems to lack predictive power for nutritional status in our study population of elderly home-care receivers. Considering the BMI, home-cared older people have a lower risk for undernutrition in comparison with nursing home residents. However, many negative associations between anthropometrics and disease burden exist in the examined study population. The cross-sectional study design does not allow conclusions about causality. However, regardless of the direction of cause-effect relationships, older adults with disease burden negatively associated to poor nutritional status (i. e. high care level, hospitalization in the previous year, nausea/vomiting, cognitive disorders, low appetite, and problems with eating, chewing and swallowing) need special attention. In particular a professional treatment of widespread chewing and swallowing problems may lead to nutritional improvement. Both the home-cared senior and particularly the private nursing personnel should be educated about adequate nutrition and the handling of risk factors for nutritional deficiencies. Professional care staff needs to be allowed enough care time to spend on nutrition related needs. Raising awareness on nutrition needs of care dependent elderly has proofed efficient in decreasing malnutrition (57, 58). Practical guidelines for adequate nutritional interventions are needed. Possibly, consulting ambulatory nutritionists could achieve therapeutic effects.

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