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Energy and protein intake, anthropometrics, disease burden and 1-year mortality in elderly home-care receivers living in Germany

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SUMMARY

The demographic structure in Germany has changed remarkably within the last decades. The number of old and very old people rises steadily and subsequently the number of elderly home-care receivers. Quality of life of this population group is decisively dependent upon their health status and, thus, also upon their nutritional status. Current data from studies with nursing home residents and geriatric patients revealed a high risk of underweight that correlates with a high risk of morbidity and mortality. However, to date corresponding data about the situation of elderly home-care receivers living in Germany is lacking.

Therefore, the first aim of this thesis was to capture the nutritional and health status of elderly home-care receivers living in Germany and to identify negative associations between nutritional status and individual disease burden. The cross-sectional study (funded by the Federal Ministry of Food, Agriculture and Consumer Protection, BMELV) investigated the nutritional and health status of 353 elderly home-care receivers in the age of 65 years and above in three urban areas of Germany (Bonn, Nuremberg, Paderborn). Energy and protein intake were monitored by a three-day prospective nutrition diary, the nutritional status was assessed by BMI, mid upper arm and calf circumference measured by researchers. Medical conditions were assessed in personal interviews.

Participants reported an average of 5 chronic diseases, while one third was suffering from dementia. Further, over one third complained about a moderate (30%) or a poor (7%) appetite. More than half (52%) suffered from chewing problems and almost one third (28%) from swallowing problems. Daily mean energy intake was 2017 kcal in men and 1731 kcal in women and mean protein intake amounted to 1.0 g/kg body weight for both male and female participants. Mean BMI was 28.2±6.2kg/m^2, 4% of seniors had a BMI of <20kg/m^2. Critical mid upper arm circumference (<22 cm) was indicated in 6% of subjects while 11% of the male and 21% of the female subjects showed a calf circumference of <31 cm. BMI, mid upper arm and calf circumference were significantly negatively associated with high care level (I: 29.1±6.4; II: 27.6±6.0; III: 25.1±4.5), prevalence of dementia, hospitalization in the previous year, nausea/vomiting, poor appetite, and eating difficulties like dependency, chewing and swallowing problems. Considering the BMI, home-cared elderly have a lower risk for underweight in comparison with nursing home residents. However, the negative association between disease burden and nutritional status underscores the necessity to implement timely nutrional intervention as part of home care.

To date, the relation between BMI and all-cause mortality in older adults has been inconclusive and no study has investigated this interrelation for a German population of elderly home-care receivers. Second aim of the present thesis was to investigate the relationship between BMI and 1-year mortality in the aforementioned study population. Mean BMI of elderly people that deceased within one year was 25.4±4.4 kg/m^2 which was significantly lower than that of survivors (28.7±6.4 kg/m^2). BMI values <20 kg/m^2 at study entry were associated with highest mortality risk (one year mortality rates for BMI <20, 20-30, >30 were 39%, 17% and 9%, respectively).

ZUSAMMENFASSUNG

Die demographische Struktur Deutschlands hat sich in den letzten Jahrzehnten entscheidend verändert. Immer mehr Menschen erreichen ein hohes bis sehr hohes Alter und mit ihnen steigt auch die Anzahl pflegebedürftiger zu Hause lebender Senioren. Die Lebensqualität dieser Bevölkerungsgruppe ist entscheidend vom Gesundheitszustand und somit auch vom Ernährungszustand abhängig. Aktuelle Daten aus Studien bei Altenheimbewohnern und geriatrischen Patienten zeigen ein hohes Risiko für Untergewicht und damit verbunden ein erhöhtes Morbiditäts- und Mortalitätsrisiko; entsprechende Informationen über die Situation bei zu Hause lebenden pflegebedürftigen Senioren liegen bisher nicht vor.
Folglich war das erste Ziel der vorliegenden Dissertation die Erfassung des Ernährungs- und Gesundheitszustands pflegebedürftiger zu Hause lebender Senioren in Deutschland und die Identifizierung negativer Assoziationen zwischen Ernährungszustand und einzelnen Krankheitsbildern. Im Rahmen einer durch das Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV) finanzierten Querschnittsstudie wurde der Ernährungs- und Gesundheitszustand von 353 über 65-jährigen pflegebedürftigen zu Hause lebenden Senioren in Bonn, Nürnberg und Paderborn untersucht. Die Energie- und Proteinaufnahme wurde mittels eines dreitägigen Verzehrsprotokolls, der Ernährungszustand mittels durch die Untersucher erhobenen BMI, Waden- und Oberarmumfang erfasst. Der individuelle Krankheitsstatus wurde in einem face-to-face Interview erfragt.
Die Studienteilnehmer gaben im Mittel fünf chronische Krankheiten an, wobei bei über einem Drittel eine Demenz vorlag. Ebenfalls über ein Drittel klagte über einen mäßigen (30%) oder schlechten (7%) Appetit und über die Hälfte (52%) litt unter Kaubeschwerden und fast ein Drittel (28%) unter Schluckbeschwerden. Die mittlere tägliche Energiezufuhr lag bei 2017 kcal (Männer) bzw. bei 1731 kcal (Frauen), die mediane tägliche Proteinzufuhr beider Geschlechter lag bei 1.0 g/kg Körpergewicht. Der mittlere BMI lag bei 28.2±6.2kg/m^2; 4% der Probanden wiesen einen BMI <20kg/m^2 auf. Ein kritischer Oberarmumfang (<22 cm) wurde bei 6% der Teilnehmer festgestellt, und 11% der Männer bzw. 21% der Frauen hatten einen Wadenumfang <31 cm. BMI, Waden- und Oberarmumfang waren signifikant negativ assoziiert mit steigender Pflegestufe (I: 29.1±6.4; II: 27.6±6.0; III: 25.1±4.5), dem Vorliegen von Demenz, Krankenhausaufenthalten im vergangenen Jahr, dem Vorliegen von Übelkeit/Erbrechen, Kau- und Schluckbeschwerden, einem abnehmendem Appetit sowie einem steigenden Grad an Hilfsbedarf beim Essen. Zu Hause gepflegte Senioren haben ein geringeres Risiko für Untergewicht im Vergleich zu Heimbewohnern. Die negativen Assoziationen zwischen Krankheiten/körperlichen Beschwerden und dem Ernährungszustand unterstreichen jedoch die Notwendigkeit, rechtzeitig Ernährungsinterventionen als Bestandteil der häuslichen Pflege durchzuführen.
Die Beziehung zwischen BMI und Mortalität älterer Menschen ist nicht eindeutig. Bisher gibt es keine Studie die diesen Zusammenhang bei pflegebedürftigen zu Hause lebenden Senioren in Deutschland untersucht. Zweites Ziel der vorliegenden Dissertation war es daher, den Zusammenhang zwischen BMI und der 1-Jahres Mortalität im genannten Kollektiv zu untersuchen. Der mittlere BMI der innerhalb eines Jahres nach der Querschnittserhebung verstorbenen Teilnehmer lag bei 25.4±4.4 kg/m^2 und somit signifikant niedriger im Vergleich zu den überlebenden Teilnehmern (28.7±6.4 kg/m^2). BMI Werte <20 kg/m^2 waren mit der höchsten Mortalitätsrate assoziiert (1-Jahres Mortalitätsrate: BMI <20 (39%), 20-30 (17%), >30 (9%)).

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ABBREVIATIONS

ADL	Activities of Daily Living
ANOVA	Analysis of variance
BH	Body height
BLS	Bundeslebensmittelschlüssel
BMI	Body mass index
BMR	Basal metabolic rate
BW	Body weight
CC	Calf circumference
CI	Confidence interval
ErnSIPP	Ernährungssituation von Senioren in Privathaushalten mit Pflegebedarf
ErnSTES	Ernährung in stationären Einrichtungen für Senioren und Seniorinnen
ESPEN	European Society for Clinical Nutrition and Metabolism
f	Female
IEL	Department of Nutrition and Food Sciences
kcal	Kilocalories
kg	Kilogram
m	Male
m^2	Square meter
MUAC	Mid upper arm circumference
MDK	Medical services of the German Statutory Health Insurance
MDS	Medical services of the Federal Associations of Health Insurance Funds
n	Number
NRC	National Research Council
n.s.	Not significant
ONS	Oral nutritional supplements
OR	Odds ratio
PAL	Physical activity level
SD	Standard deviation
SGB	German Social Insurance Code
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organisation

CHAPTER ONE

General introduction

Within the recent decades, the population in developed countries is increasingly becoming an aged society. Nowadays 16.9 million people in Germany are 65 years or older and by the year 2030 this figure will further increase to estimated 22 million (1). The group of very elderly (aged 80 and older) will increase even more significantly as it currently adds up to 4 million people already and will reach approximately 10 million by the year 2050 (1). Increasing age does in fact cause higher prevalence of chronic diseases and can lead to loss of independence and care and support demands towards relatives or need for professional care specialist. In 2009 the number of people being in need of care – in the sense of the German Social Insurance Code (*SGB* XI) – counted approximately 2.34 million people (2). The majority (1.62 million) are cared for at home; about two-thirds only maintained by relatives. Approximately one-third receives assistance through ambulatory care services partially or even completely (2). By the year 2030, the number of people with care needs will rise up to 3.36 million in Germany (3).

The care dependency in an aging society and the attempt of securing a certain degree of life quality poses a challenge to politicians as well as to health insurances and nursing staff. This challenge includes that both quantitative and qualitative care factors should be improved through continuous revision of the care law. The recently (June 2012) launched healthcare reform tries to contribute to an improvement as it aims to advance financial service for dementia patients and promotes for example new types of residential arrangement (4). However, for implementation of those planned improvements ideas on an efficient optimisation of the health and nutritional status of elderly home-care receivers are needed.

In Germany, extensive data on the disease and nutritional status have already been generated for care dependent seniors living in nursing homes (5). The multi-centre, cross-sectional ErnSTES study recently performed in 10 nursing homes (n=772) throughout Germany revealed a high risk for being underweight – BMI values below 20 kg/m^2 were found with over 11% of the residents (5). This study also discovered significant negative associations between the BMI and eating dependency, chewing and swallowing problems as well as dementia and therefore recommends special attention to these residents. Regarding the German home-care setting, information about the general health status of elderly people with chronic diseases, eating problems, nutritional intake and status, denoted in anthropometrics, is still scarce, though. In fact, only few data on the nutritional status and disease burden of elderly

cared for by ambulatory care services exist due to quality checks of the medical services of the Federal Associations of Health Insurance Funds (MDS) (6). However, there is a complete lack of data concerning elderly care receivers living at home that are maintained by relatives only.

Therefore, a multi-centre cross-sectional study with over 350 elderly home-care receivers (maintained by relatives or partially/completely supported by ambulatory care services) was conducted: The ErnSIPP study is performed in a scientific cooperation of the Department of Human Nutrition (Paderborn University), the Institute for Biomedicine of Aging (Nuremberg University) and the Department of Nutrition and Food Sciences (IEL)-Nutritional Physiology (Bonn University). The study aimed for a comprehensive assessment of the nutritional status and disease burden of the above named population. Inclusion criteria were: minimum age of 65 years, living in a private household, care level I – III, and not being in final weeks of life. Participants were recruited by cooperation with local medical services of the statutory health insurance (MDK), ambulatory care services, press and public relations. Three field investigators from the Universities of Paderborn, Erlangen-Nuremberg, and Bonn 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 data were assessed on two personal visit occasions at the participants' homes approximately two weeks apart. On first visit, subjects' characteristics such as date of birth, gender, living arrangements, duration of care were collected in standardised personal interviews. Nutritional status was assessed by anthropometric measurements and nutritional intake by prospective nutrition diary on 3 consecutive days. On the second home visit, disease burden and eating problems were assessed in a questionnaire-structured interview. After one year, all-cause mortality was assessed by telephone.

One speciality of the ErnSIPP study is, that the investigators visited the home-care receivers and performed all anthropometric measures themselves in a standardized way. Anthropometric measurements are inexpensive, non-invasive and frequently used methods for assessing the nutritional status. They provide information on the different components of body structure, especially muscular and fat components. Numerous studies have shown measurable adverse effects of low BMI on functionality, clinical outcome, risk of morbidity and mortality and, thus, quality of life (7-12). The other way round, disease burden like e. g. mobility restrictions, cognitive

impairments, chewing and swallowing problems, eating dependency, hospital stays, infections, cancer, respiratory diseases or multi-medication may influence both dietary intake as well as the individuals' need of energy and nutrients, and may therefore contribute to worsening the nutritional status. However, early nutritional interventions as well as treatment of the underlying disease, if possible, may prevent health-deterioration and result in higher quality of life for both the patient and his/her family (11,13-15). Knowledge about disease burden that are negatively associated with nutritional status parameters particularly in this vulnerable group of elderly people is very important for a potential initiation of specific preventive or therapeutic actions.

Furthermore, the relationship between BMI and mortality in older adults is non-specified so far. The actual WHO cut-off point of 25 kg/m^2 as a definition for being overweight (16) might be too restrictive for elderly individuals. Numerous studies observed a decreased mortality risk in those with a high BMI irrespective of the examined setting: elderly nursing home residents, geriatric patients or community-dwelling seniors (7,17-25). A Swedish study revealed that elderly people receiving support at home had the lowest risk of death with BMI >28 kg/m^2 (26). Identifying the optimal BMI for elderly home-care receivers is highly relevant for estimating the risk of mortality and for recommendations regarding optimal weight.

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CHAPTER TWO

Purpose of the thesis

The purpose of this study in a population of elderly home-care receivers living in Germany was a comprehensive assessment of the nutritional status and disease burden. In the thesis, the following specific questions were addressed:

Cross-sectional study (Chapter Three):

How are the disease burden and the nutritional status, denoted in anthropometrics, in a population of elderly home-care receivers living in Germany? Which disease burdens are negatively associated with the anthropometrics?

Closed cohort study (Chapter Four):

In which way does the BMI predict a one year follow-up outcome of all-cause mortality in elderly home-care receivers?

CHAPTER THREE

Energy and protein intake, anthropometrics, and disease burden in elderly home-care receivers - a cross-sectional study in Germany[1,2]

[1] Part of the data has been presented as: Pohlhausen S, Uhlig K, Kiesswetter E, Diekmann R, Heseker H, Volkert D, Stehle P, Lesser S (2012): Body Mass Index pflegebedürftiger Senioren in Privathaushalten – Assoziationen mit dem Krankheitsstatus. 11th Three Countries Joint Meeting „Nutrition 2012“ of the German Society for Nutritional Medicine (DGEM), the Austrian Society for Clinical Nutrition (AKE) and the Society for Clinical Nutrition, Switzerland (GESKES); Nuremberg, Germany. Aktuel Ernahrungsmed 2012;37 -V1-1.

[2] The study was funded by the Federal Ministry of Food, Agriculture and Consumer Protection via Federal Office for Agriculture and Food (BMELV/BLE; 114-02.05-20.0099/09-D).

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 in men (n=123) and 1731±451 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. **Conclusions:** We recommend to pay special attention to the nutritional status of elderly persons in home care exhibiting named disease burden.

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 elderly 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 elderly in those settings (3-9). The studies examining the nutritional status in relation to disease burden and showed significant negative associations. A degrade in nutritional status may in turn cause measurable adverse effects on functionality, clinical outcome, risk of morbidity and mortality (4,5,10-13) and, thus, quality of life.

Only few studies were performed in home-care settings (14-17) and no study has examined the nutritional status and 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.

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 by cooperation with local medical services of the statutory health insurance (MDK), ambulatory care services, press and public relations. 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 on two personal visit occasions at the participants' homes approximately two weeks apart.

Participants' care levels reflected the degree of dependency according to the German *SGB* (XI) (i.e., level I 'substantially in need of care', level II 'severely in need of care', and level III 'severest in need of care').

Data collection

Subjects' characteristics such as date of birth, gender, living arrangements, and duration of care were collected in standardised personal interviews on first visit. In case of dementia, interviewers addressed their questions to the health care personnel.

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. (18). In individual cases (n=3) half arm-span measurement was used to estimate BH (19). 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/m², BMI <20 kg/m², BMI <22 kg/m², MUAC <22 cm, CC <31 cm (20-23). Additionally, frequently used cut-offs for higher BMI values are presented graphically (BMI <24 kg/m², BMI <29 kg/m², BMI ≥29 kg/m² (24).

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. (25). 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’ (26). 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, hospitalisations in the last year and acute infections in the last three months were inquired with an answer 'yes – no'. Symptoms such as nausea, vomiting, or constipation were inquired with answers 'never/infrequent – occasionally/always', and the number of all regularly ingested drugs was recorded. The study participant was asked for presence of chewing problems ('no problems – with hard food only – always') and to rate his/her 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, 25^{th} and 75^{th} 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. 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 stroke and respiratory disease ($p<0.01$, $p<0.001$). Two-thirds of the study population took 5 or more prescribed medications. The number of prescribed drugs were higher in men than in women ($p<0.05$). Nearly half of study participants suffered from obstipation. Pressure sores were only observed in 3% of the participants.

Table 2 summarizes the presence of eating problems. More than one-third of the elderly 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 elderly 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 $r_{Pearson}$: 0.80; and BMI *vs.* CC $r_{Pearson}$: 0.63; both $p<0.001$). Furthermore, anthropometric values decreased with increasing age (BMI $r_{Pearson}$: -0.22, MUAC $r_{Pearson}$: -0.26, and CC $r_{Pearson}$: -0.35; all $p<0.001$).

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.

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.

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 month (%)		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.
Obstipation (%)		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

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: Anthropometrics, energy and protein intake of elderly in home-care

	Male mean ± SD[1] (n)	**Female** mean ± SD (n)	**p°**
BMI (kg/m^2)	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

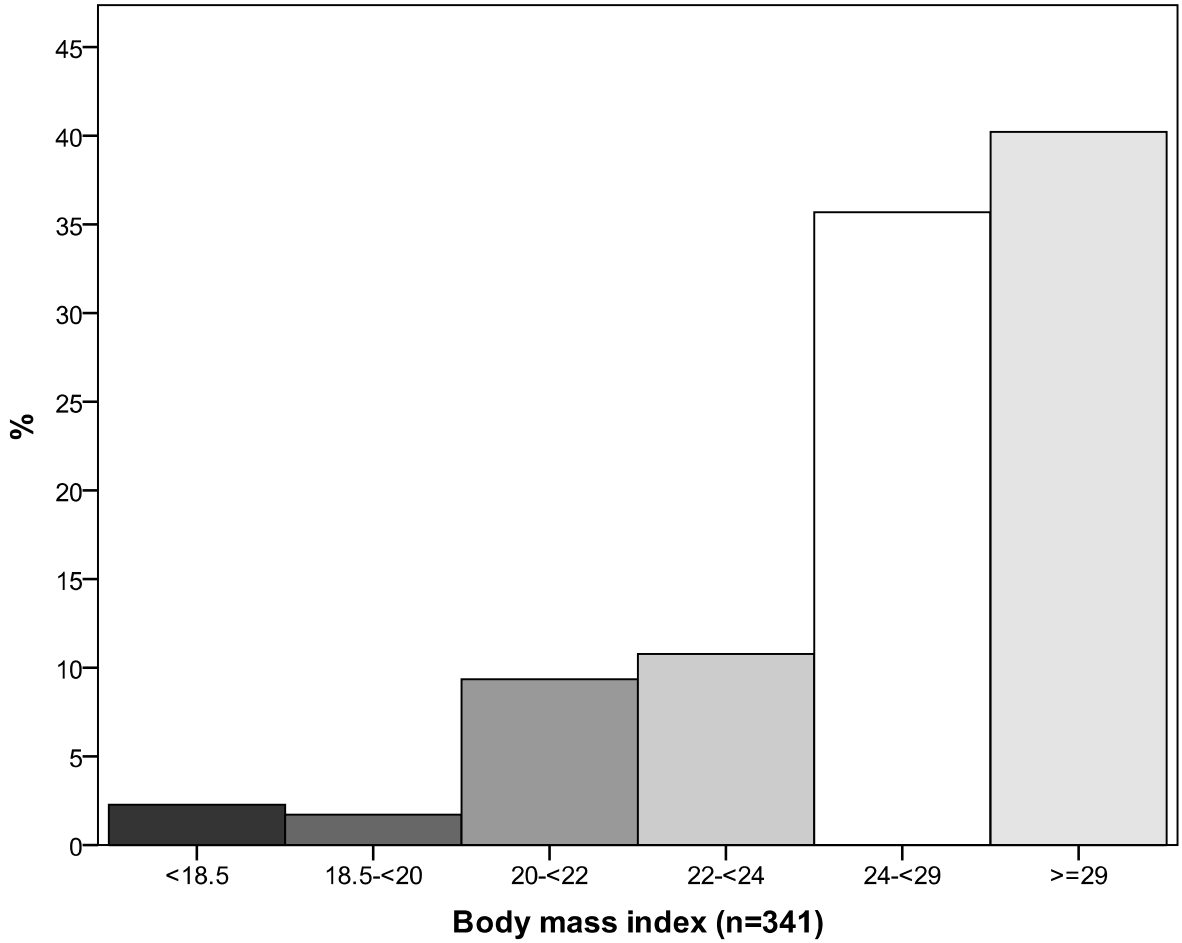
°Gender differences using chi-squared test, unpaired Students' t-test, or Mann-Whitney U-test

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/m^2] (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
		p<0.001	**p<0.001**	**p<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
		p<0.05	**n.s.**	**p<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
		p<0.05	**p<0.05**	**p<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
		p<0.01	**p<0.001**	**p<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
		p<0.001	**p<0.001**	**p<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
		p<0.001	**p<0.001**	**p<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
		p<0.001	**n.s.**	**p<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
		p<0.001	**p<0.001**	**p<0.001**

°all parameters are significantly associated with a t least one anthropometric variable
[1]Abbreviations: SD-standard deviation; BMI-body mass index; MUAC-mid-upper arm circumference, CC-calf circumference; n.s.-not significant

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 elderly in Germany was 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; 24). However, in comparison with nursing home residents, whose BMI was on average between 21 and 26 (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) (28). Studies in America and Finland have reported mean BMI values of 27-29 kg/m^2 for elderly home-care receivers (16,29,30) 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%; 30) and Finnland (8%; 16), 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 (31,32). Previous studies identified MUAC to be a significant and independent predictor of mortality in older people (8,33). Frequently used cut-offs for MUAC and CC are those reported by the Mini Nutritional Assessment (MNA; 23). 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 (34). 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 elderly nursing home residents (6). Less pronounced muscle mass in upper extremities changes less as a result of inactivity (6).

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 (35) 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 (36) and a final conclusion on adequacy of the protein intake is, therefore, impossible. As protein-energy undernutrition often is caused by inadequate food intake (12) 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 elderly (14). We conclude, that nutritional intake assessed with a self-administered 3-day prospective food dairy, is not sufficiently predictive of nutritional status in care-dependent elderly.

Previous studies have shown that older adults with unintentional weight loss had higher risk of mortality, regardless of BMI (10,37,38). 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). 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 anthropometrics BMI, MUAC, or CC, correlated negatively with care level, hospitalization 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 rate in elderly patients (5,10-13). 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 (13,20,39,40).

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 (41,42). Focussing on eating dependency, our data showed associations between growing need of help and lower anthropometric values. In compliance, further studies reported that elderly with eating dependency are at higher risk for development of malnutrition (43,44). 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 (12).

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 (32). Patients with cognitive impairment require special attention and nutritional intervention may lead to an improvement in nutritional status (20).

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 type of chronic disease and drugs seem 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 (9,29). Usually these ailments can potentially cause malnutrition by a restricted diet (45,46). Strategies to improve oral nutrient intake can be dental and oral care check, mushy food, or in case of difficulty swallowing, training (47).

No association were found between participants with stroke or cancer and anthropometric values, which is in line with results of the Tromsø study (48). 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 (49-51) 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, elderly with nutritional problems may have participated driven by desire for advice for nutritional improvements. 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.

Considering the BMI, home-cared elderly 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, elderly 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. Practical guidelines for adequate nutritional interventions are needed. Possibly, consulting ambulatory nutritionists could achieve therapeutic effects.

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CHAPTER FOUR

Association between body mass index and 1-year mortality in elderly home-care receivers living in Germany – a closed cohort study[3]

3

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ABSTRACT

Objective: The association between BMI and all-cause mortality in older adults is not entirely clear and so far data considering this relationship in home-cared seniors living in Germany are lacking. Aim of this study was to investigate the impact of BMI on mortality during a 1-year follow-up.

Design: Closed cohort study.

Setting: Three urban areas of Germany.

Participants: 353 elderly people (128 men aged 79.1 ±7.8 years, 225 women aged 82.0 ±7.5 years) in home care.

Measurements: Age, BMI, care level, and disease burden like cardiovascular diseases, cancer, diabetes mellitus were determined in a home visit at baseline. After one year, all-cause mortality was assessed by telephone. Logistic regression analysis was used to evaluate the association between 1-year mortality and BMI, controlled for age, gender, care level and cancer status. Kaplan-Meier curves were fitted to show the cumulative survival rates within three BMI categories (<20 kg/m^2, 20-30 kg/m^2, >30 kg/m^2).

Results: At baseline, 4% participants had BMI values <20 kg/m^2, 63% had BMI 20-30 kg/m^2, and 33% >30 kg/m^2. Over 10% of the seniors (n=41) refused the participation in the follow up or were not reachable by phone. 45 (14%) participants died during the 1-year follow-up, with a mean BMI (25.4 ±4.4 kg/m^2) which was significantly lower than that of survivors (28.7 ±6.4 kg/m^2; p<0.001), but still within the overweight range according to the WHO (25.0-29.9 kg/m^2). BMI values <20 kg/m^2 at study entry were associated with highest mortality risk (one year mortalities for BMI <20, 20-30, >30 were 39%, 17% and 9%, respectively; p<0.01). Adjusted for age and gender the OR of mortality decreased with each unit increase in BMI (0.89 [0.83-0.95]; OR [95%CI]). Only minimal change was observed in analyses additionally controlled for care level and cancer status (0.92 [0.85-0.98]).

Conclusions: In home-cared seniors higher BMI was associated with lower mortality risk. Our study suggests that the optimal BMI range for older adults might be higher than the current recommendation of the WHO.

INTRODUCTION

Overweight and obesity are accepted risk factors for the development of chronic diseases like hypertension, diabetes mellitus, and cardiovascular disease, which are in turn major contributors for morbidity and mortality (1). Within preventive measures scientific organizations recommend the calculation and monitoring of the body mass index (BMI) (2,3). According to the actual classification of the world health organization (WHO), BMI values of 25.0-29.9 kg/m^2 are categorized as overweight and values >=30 kg/m^2 as obesity (2). Although these recommendations are valid for all age groups over 18 years, the great majority of the underlying studies have been performed in young and middle aged adults. Whether the assessment of BMI in older people (>= 65 y) allows predictions with respect to mortality rates is still under debate.

In few studies the highest mortality rate could be shown at the lowest and highest end of the BMI range, yet the BMI with lowest mortality in elderly people was greater or equal 27 kg/m^2 (4-9). Other studies observed a more linear relationship with increasing survival at higher BMI values irrespective of the examined population like nursing home residents, geriatric patients or community-dwelling elderly (10-19). One study in swedish elderly receiving support at home identified the lowest risk of death at BMI >28 kg/m^2 (20). The authors and numerous other researchers question whether high BMI values are harmful in older adults, especially in chronically ill elderly.

Identification of the optimal BMI in elderly home-care receivers is highly relevant for estimating the risk of mortality and for recommendations regarding optimal weight. The aim of the present study was thus, to explore the asscociation of BMI with mortality in home-cared seniors during a 1-year follow-up.

MATERIALS AND METHODS

Study design

The multi-centre ErnSIPP (*'Ernährungssituation von Seniorinnen und Senioren mit Pflegebedarf in Privathaushalten'*) study examined the nutritional status and disease burden of elderly home-care receivers in three urban areas of Germany (Bonn, Nuremberg, and Paderborn). The study protocol was approved by the universities' ethics committees.

Three field teams were collectively trained in interviewing technique and anthropometric measurement handling. They contacted potential participants by telephone, gave detailed study information and made an appointment for the baseline recording. After the subjects signed informed consent, the teams assessed their data at the participants' homes. After one year, mortality status was checked by calling the study participants or health care personnel, respectively.

Participants' recruitment

Participants were recruited by cooperation with local medical services of the statutory health insurance (MDK), ambulatory care services, press and public relations. Inclusion criteria were: minimum age of 65 years, living in a private household, care level I – III, and not being in final weeks of life. Participants' care levels reflected the degree of dependency according to the German *SGB* (XI) (i.e., level I 'substantially in need of care', level II 'severely in need of care', and level III 'severest in need of care'). It was planned to recruit 150 subjects in each of the three study centres.

Parameters

Subjects' characteristics such as date of birth, gender, smoking status, and care level were ascertained at baseline in standardised personal interviews. In case of dementia, interviewers addressed their questions to health care personnel. All-cause mortality was assessed by telephone interviews after one year. At baseline, body weight was measured with a digital scale (Firma Beurer GmbH, Ulm) in lightweight clothing and without shoes to the nearest 0.1 kg (n=244). An ultrasound stadiometer (Fa. Soehnle Professional, Backnang) was used to measure body height to the

nearest 1 cm (n=216). 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. (21). In individual cases (n=3) half arm-span measurement was used to estimate height (22). When measurements of height or weight were impossible, self-reported values were used (n=125). BMI was calculated (weight/height^2).

In the mortality analysis BMI values were considered both as a continuous variable and three-level variable: BMI values less than 20 kg/m² were considered as low, within 20 and 30 kg/m² as normal/slight overweight, and above 30 kg/m² as obese (10).

Baseline disease burden was assessed in a questionnaire-structured interview. The most prevalent diseases with potential influence on mortality were represented. Prevalence of chronic diseases were inquired with an answer ‘yes – no’, and the number of all regularly ingested drugs was recorded. Characteristics significantly different among the surviving and deceased groups were added as covariates to the logistic regression analyses.

Evaluation strategy and statistical analyses

Categorical data are presented for survivors and deceased persons separately as absolute and relative frequencies. Metric data are given with mean ± standard deviation (SD). After one year, potential associations between baseline characteristics and mortality risk were performed using chi-squared test, Mann-Whitney U-test or unpaired Students’ t-test, depending on the datas’ distribution. Age- and gender-adjusted logistic regression analyses were used to determine the odds ratio (OR) for BMI. In a separate analysis associations were calculated considering known confounders (care level, cancer status). Kaplan-Meier curves were fitted to show the relation between three BMI categories representing underweight (<20 kg/m²), normal/slight overweight (20-30 kg/m²), and obesity (>30 kg/m²) with cumulative survival rates. Differences were considered significant at a $p<0.05$. Data were evaluated with Statistical Package for the Social Sciences (SPSS, version 19.0, Munich) for Microsoft Windows.

RESULTS

353 elderly people participated in the study at baseline (128 men aged 79.1 ±7.8 years, and 225 women aged 82.0 ±7.5 years; p<0.001; participation rate: 78%). Most of the participants were 'substantially in need of care' (level I, 59%), only a few 'severest in need of care' (level III, 11%). Mean BMI at baseline was 28.2 ±6.2 kg/m² (n=341), exhibiting a significant negative age dependency without gender difference. Over 4% of seniors have BMI values below 20 kg/m², and BMI values >30 kg/m² were present in 33%.

At the time of follow-up, 20 elderly (6%) have rejected the interview and 21 participants or respective health care personnel (6%) were not reachable by phone after one year. The mean age of the non-participating seniors (81.4 ±7.0 years), the mean BMI (28.3 ±6.1 kg/m²) and the care level allocation (level I-III 56%, 32%, 12%) were not significantly different to those taking part in the follow-up (81.0 ±7.8 years; 28.2 ±6.3 kg/m²; level I-III 59%, 30%, 11%).

During the 1 year follow-up, 45 (14%) elderly of the follow-up participants (n=312) had died. Characteristics of the surviving and deceased participants and disease burden potentially related to mortality are presented in **Table 1**. The mean age (at baseline) of the deceased participants (83.6 ±7.1 years) was significantly higher than of surviving elderly (80.4 ±7.9 years, p<0.05)

The surviving group showed significantly higher BMI values than the deceased group (28.7 ±6.4 kg/m² vs. 25.4 ±4.4 kg/m²; p=0.001). From 8 survivors, BMI value was missing. Considering the BMI in categories, the highest mortality rate was observed in elderly with BMI <20 kg/m² (39%), followed by those who had BMI 20-30 kg/m² (17%), and individuals with BMI >30 kg/m² had the lowest rate (9%; p<0.01) (Table 1), with only one death in the BMI >35 kg/m² category (n=35).

Mortality rates were not influenced by gender but significantly associated with the individual care level: the higher the care level, the higher the mortality rate (Table 1). Elderly with a confirmed cancer diagnosis had a higher risk to die within the follow-up period (Table 1).

Figure 1 shows Kaplan-Meier survival curves for the three BMI groups. At almost every point, cumulative survival of elderly with BMI <20 kg/m² was substantially lower compared with BMI groups 20-30 kg/m² or >30 kg/m². When using BMI 20-30 kg/m²

as reference category, subjects with low BMI had a more than 3-fold higher risk to die within 1 year (**Table 2**). Comparing the BMI >30 kg/m² with the low BMI group, study participants with low BMI were over six times as likely to decease. Referring to BMI as a continuous variable, per 1 kg/m² increase in BMI the 1-year mortality risk decreased by 11%. Repeating the analyses with additional adjustment for care level and cancer status, only minimal changes in impact on the OR for the relation between BMI and mortality were observed.

Table 1: Baseline characteristics of 1-year survivors and deceased participants

	Survivors n=267 (86%)	**Deceased** n=45 (14%)	**p***
Age at Baseline, mean ±SD	80.4 ±7.9	83.6 ±7.1	<0.05
Sex, n (%)			n.s.
Male	95 (85)	17 (15)	
Female	172 (86)	28 (14)	
BMI (kg/m^2), mean ±SD	28.7 ±6.4	25.4 ±4.4	<0.001
BMI, n (%)			<0.01
<20 kg/m^2	8 (61)	5 (39)	
20 – 30 kg/m^2	157 (83)	31 (17)	
>30 kg/m^2	94 (91)	9 (9)	
Care level, n (%)			<0.01
I	169 (91)	16 (9)	
II	71 (77)	21 (23)	
III	27 (77)	8 (23)	
Drugs taken regularly, mean ±SD	7.1 ±3.5	8.0 ±4.0	n.s.
Cardiovascular diseases, n (%)			n.s.
No	30 (88)	4 (12)	
Yes	237 (85)	41 (15)	
Cancer, n (%)			<0.05
No	238 (87)	35 (13)	
Yes	29 (74)	10 (26)	
Respiratory diseases, n (%)			n.s.
No	205 (88)	29 (12)	
Yes	62 (79)	16 (21)	
Chronic kidney diseases, n (%)			n.s.
No	238 (87)	36 (13)	
Yes	29 (76)	9 (23)	
Chronic liver diseases, n (%)			n.s.
No	254 (86)	41 (14)	
Yes	13 (77)	4 (23)	
Diabetes mellitus, n (%)			n.s.
No	193 (87)	30 (13)	
Yes	74 (83)	15 (17)	
Dementia, n (%)			n.s.
No	177 (86)	28 (14)	
Yes	90 (84)	17 (16)	
Depression, n (%)			n.s.
No	189 (87)	28 (13)	
Yes	78 (83)	16 (17)	
Smoking status, n (%)			n.s.
No	253 (85)	43 (15)	
Yes	14 (87)	2 (13)	

*p value for differences between survivors and deceased using Mann-Whitney U-test, unpaired Students' t-test, or chi-squared test, respectively.

Table 2: Odds ratios (ORs) and 95% confidence intervals (CI) of mortality during 1 year follow up according to BMI (logistic regression analysis; n=304)

	OR	95% CI	p
BMI (kg/m²)			
<20 vs. 20-30[€]	3.49	1.04-11.74	0.043
<20 vs. >30[*]	6.31	1.66-23.94	0.007
BMI (kg/m²)[†]	0.89	0.83-0.95	0.003
BMI (kg/m²)[a]	0.92	0.85-0.98	0.013

[€] statistical comparison between the reference category BMI 20-30 kg/m² and BMI <20 kg/m², age and gender as covariates

[*] statistical comparison between the reference category BMI >30 kg/m² and BMI <20 kg/m², age and gender as covariates

[†] The OR indicates risk of mortality with each step (1 kg/m²) increasing BMI, age and gender as covariates

[a] The OR indicates risk of mortality with each step (1 kg/m²) increasing BMI, age, gender, care level and cancer status as covariates

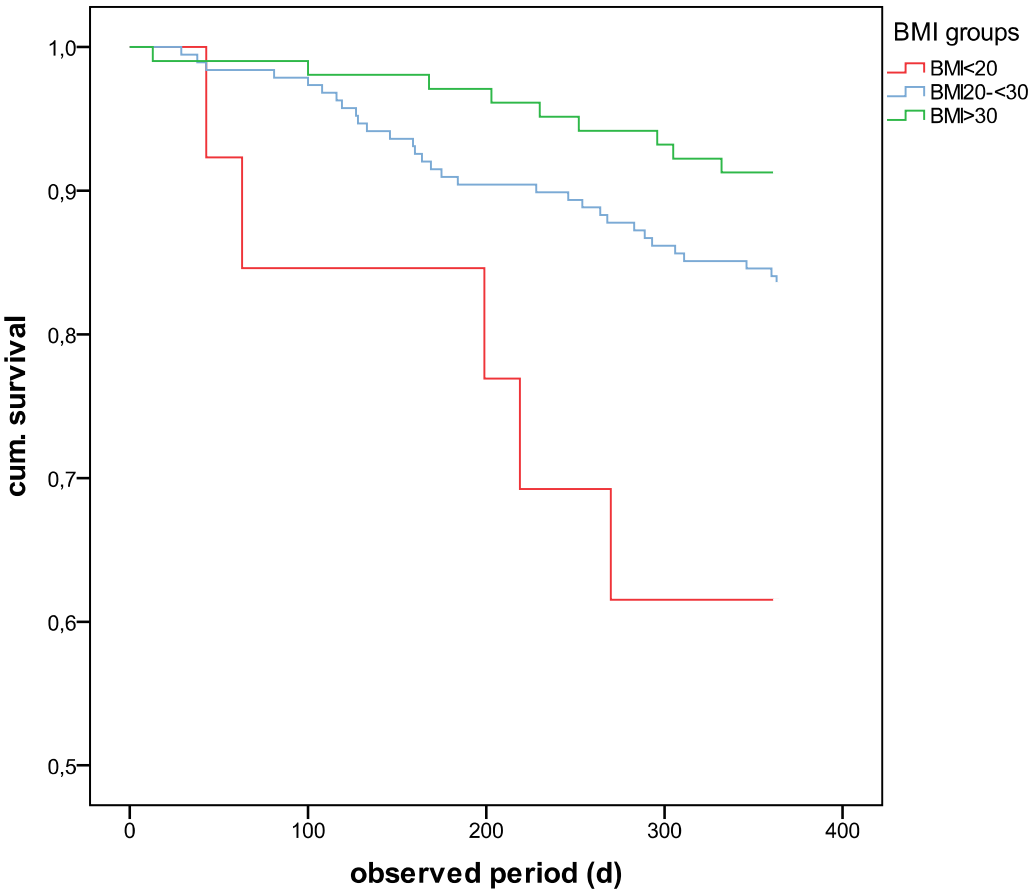

Figure 1: One year cumulative survival of home-cared elderly people with body mass index (BMI) <20 kg/m², 20-30 kg/m², and >30 kg/m², respectively (n=304)

DISCUSSION

From the beginning of March till the end of December 2010, only 353 out of planned amount of 450 participants (150 per city) could be acquired for study participation. The recruitment unfortunately turned out to be extremely complex due to poor access to the target group and reluctance to participate. However, the willingness of the baseline study participants to attend the 1-year follow-up added up to 94% (n=333). Taking those participants into account who could not be reached by phone the final outcomes resulted in 312 elderly.

Analogous to the BMI classification by Kaiser and colleagues (10) we decided to examine the BMI in three groups. A BMI of less than 20 kg/m^2 was considered as low, according to the recommendations of the European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines for nutritional screening (3). A BMI value above 30 kg/m^2 indicates obesity according to the world health organization (WHO) and the ESPEN criteria (2,3).

In this follow-up study the BMI is a predictor of mortality in home-cared elderly people aged 65 years or more, as the 1-year mortality increased with decreasing baseline BMI. No U-shaped relationship could be found and subjects with a baseline BMI >30 kg/m^2 had the best 1-year survival (Table 1, Figure 1). The inverse association between mortality and BMI held true after controlling for gender, age, care-needs, and disease burden (Table 2). The mean BMI of the deceased group was significantly lower than that of survivors (Table 1), however, both mean BMI lie within the overweight category, according to the WHO recommendation (2).

The inverse linear relationship observed in our results (Table 2) is in accordance with findings from other studies from several settings; in nursing home residents (10), in home-cared elderly (20), in geriatric patients (11), and in community-dwelling older adults (13). The WHO cut-off point of 25 kg/m^2 for defining overweight (2) might be too restrictive for elderly individuals. The current recommendation bases only on studies which primarily measured morbidity risk in young and middle-aged populations and did not consider the observed changes in optimal weight for survival in older ages. The results of the present and other studies (17,23-26) suggest a higher optimal BMI for older ages.

A 12 year follow-up study with more than 300,000 participants found that the mortality risk associated with greater BMI is higher among younger subjects (25). The lowest mortality rate for younger subjects was found in the BMI category <20

kg/m^2 and for older subjects in the BMI range 27-29 kg/m^2 (25). Investigators supposed that the weakening association between elevating BMI and mortality with increasing age is due to early death of individuals who are susceptible to the adverse effects of an elevated BMI (18,27,28). Our subjects are drawn from the cohort of survivors and thus elderly in our study with high BMI represent possibly those individuals who are resistant to the dangers of a high BMI. Although the elderly in the highest BMI group showed lower mortality rate, they suffered more often from chronic diseases like diabetes mellitus and hypertension than elderly with normal or low BMI (data not shown). Diabetes and hypertension are frequent causes of death in Germany (29), but nevertheless these overweight and ill elderly survived. In accordance with the already established thesis by Weiss et al. (18) it is possible that these participants survived diseases earlier in life due to longevity genes, which may have protected them also from mortality during the follow-up time. In a review that indicated no association between overweight and increased risk of mortality in seniors, the authors also featured on the hypothesis of diminished detriment of excess body fat in elderly compared to young and middle-aged adults (28), possibly the excess body fat may protect from catabolic processes.

Losonczy and colleagues (30) assumed that the inverse association between BMI and mortality in old age reflects illness-related weight loss coming from heavier weight in middle-age and emphasize how critical the weight history is for understanding weight and mortality relations in old ages. Their results are confirmed by subsequent studies (7,12,31,32). In our study we asked for unintentional weight loss since the onset of care-needs, but we were unable to determine when the weight change occurred or to distinguish between gradual and rapid weight change. However, elderly with unintentional weight loss over 5% of their body weight (34% of the study participants) had a mean BMI of 25 kg/m^2 and deceased significantly more often (data not shown). This could explain the increased absolute mortality risk in the normal weight category and the decreased risk in the obese BMI group (Table 1).
Senescence naturally often goes along with body weight loss; and also low lean mass has been associated with higher mortality. Possibly high lean mass reflects a nutritional preserve during prolonged periods of illness and disease (33,34). Furthermore, high lean mass may indicate higher activity and subsequently elderly in better health. In our study, higher activity (assessed by activity of daily living) was associated with higher BMI (data not shown), and thus possibly higher lean mass. A

1 year follow-up study in nursing home residents (10) corroborates significant associations between obesity, decreased mortality rate, and stable functionality. The authors also hypothesized that those with low and normal BMI are at higher risk of relevant sarcopenia than those with higher BMI (10).

In some studies, increased mortality with low BMI has been observed only among smokers because smokers tend to weigh less and have higher mortality rates than non-smokers (25,35-37). This effect probably occurs more in older than younger people, because they probably have smoked for a longer time than younger smokers and in doing so decrease the relative risk for mortality in older individuals with a high BMI. Smoking status showed no association with mortality in our study (Table 1) and no risk-change was observed when adjusting the regression analyses for smoking status (data not shown). Because smokers vary in the number of cigarettes and the dept of inhalation, the simplified answer modus (smoker/non-smoker) may have been insufficient.

In examining the relationship between diseases and mortality, we found cancer status significantly associated with mortality rate. However, full adjusting of the regression model did not change the relationship between BMI and mortality significantly (Table 2). Some researchers observed that excluding smokers, or persons with cancer or obstructive lung disease resulted in a decrease of the BMI range with the lowest mortality risk, or the association with BMI even disappeared (38,39). This suggests that underlying diseases may cause the association with low BMI. In our data, exclusion of smokers, cancer patients, or elderly with pulmonary diseases has not changed the relationship between BMI and mortality. For all other single clinical diagnoses there were no associations with mortality (Table 1). The severity or combinations of illnesses could be more significant.

We found a relationship between care level and BMI (data not shown). The higher the care-needs the lower the BMI, the lower the survival. The care level could therefore be crucial for the relationship between BMI and mortality. However, adjustment for care level in the logistic regression analyses hardly changed the odds ratio of dying with decreased BMI (Table 2).

This study was limited in some regards. One limit of the study could be the relatively short follow-up time. Some studies excluded early deaths (40) to account for the potential effect of underlying disease. However, Allison et al. have indicated that

excluding subjects dying in the first few years may not be an effective way of handling confounding due to occult disease (40,41).

In conclusion, findings in this study are in agreement with numerous studies examining the relationship between BMI and mortality in elderly people. The fact that mortality risk increased with decreasing BMI brings into question the suitability of actual BMI recommendations for older adults. Subjects who died during follow-up had lower BMI values than survivors. Furthermore, their BMI of 25.4 ±4.4 kg/m^2 lies slightly over the normal range according to the WHO recommendation, and this reinforces the need for a revision of the recommendation.

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CHAPTER FIVE

General discussion

The aim of this thesis was the assessment of disease burden and nutritional status, denoted in anthropometrics, of elderly home-care receivers living in Germany. Investigation of associations between anthropometrics and disease burden suggests to pay special attention to the nutritional status of elderly persons in home care who exhibit named disease burden (CHAPTER THREE). The association between baseline BMI and mortality during a 1-year follow-up were examined in this setting in Germany for the first time (CHAPTER FOUR).

With the present multi-centre study an extensive quantitative coverage of the nutritional and disease situation was possible for the first time. During the term from the beginning of March until the end of December 2010, 353 elderly home-care receivers out of planned amount of 450 could be gathered for study participation in the three centres in Nuremberg, Paderborn and Bonn. The recruitment was very time-consuming, since the target group was difficult to access and the willingness to participate was low. Elderly home-care receivers that were approached during the MDK care level assessment were rarely willing to take part in the survey and only about 3% of the elderly home-care receivers that were contacted by mail responded to the request. Mobile geriatric care providers operate on a very tight time budget preventing them from becoming efficient recruiting partners. Contrary, recruiting elderly home-care receivers who are receiving day care was much more successful. Thus, this group of elderly home-care receivers is over-represented in the study compared to the whole population (15% vs. 2%) (1). Due to the volunteering participation, it cannot be eliminated that rather health- and nutrition-conscious people have participated in the study. On the other hand, there have probably been also participants which, due to the nutritional guidance during the study, hoped to receive help with existing nutritional problems.

The survey instruments were developed closely based on the multi-centre cross-sectional ErnSTES study recently performed in 10 German nursing homes (2,3). Three interview teams from the Universities of Paderborn, Erlangen-Nuremberg, and Bonn were trained extensively in interviewing technique and anthropometric measurement handling to ensure high data quality. Survey instruments were tested in a pilot study (n=4), and written guidelines were created based on this. Elderly home-care receivers suffering from dementia could not take part in the interviews themselves. In these cases the health care personnel are interviewed instead, which

represents an important aspect to ensure that the data is not biased towards specific groups.

Anthropometric measurements are characterised by being easily accessible, cheap, and non-invasive. Measuring body height can be difficult with some seniors, however, if they suffer from scoliosis or are bedridden. In such cases height is determined with the method of Chumlea et al. (4) by measuring knee height (n=105). In few exceptional cases half arm-span measurement (n=3) or even the documented height (n=27) had to be used to determine body height. Body weight was measured with a portable digital scale in lightweight clothing and without shoes. If participants were not able to use the scale due to their condition body weight was taken from the last documented measurement (n=98), which is certainly to be considered less accurate.

The participants or the health care personnel were advised extensively by the interview team how to keep a detailed, prospective nutrition diary on 3 consecutive days, including one weekend day. As a means of quality control the data were checked upon reception. Any implausibilities or irregularities were discussed with the participants and health care personnel. These methods led to the first prospective nutrition data of such a large group of elderly home-care receivers.

The study collective mainly consists of very old women, and the percentage of men with 36% is similar to the common level of home-cared seniors in Germany (33%) (1). Care level distribution (I, II, III) in the study collective (59%/30%/11%) is concordant with the real situation in Germany (63%/30%/7%) (1). With the exception of one person, all study participants had at least one chronic disease, considerably more than in the elderly general population, where nearly half of the people (43%) are free of chronic diseases (5).

Chapter three aimed at the assessment of the nutritional status and disease burden and the investigation of association between these parameters.

To evaluate the nutritional status several anthropometric parameters have been considered, among others the BMI. The mean BMI was 28.2 kg/m^2 (CHAPTER THREE Table 3) and in comparison with nursing home residents, whose BMI was on average between 21 and 26 (6,7) distinctly higher. 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) (2,3). Corresponding to the high mean

BMI in the present study collective, only rarely low BMI values could be measured: 4% had BMI values <20 kg/m^2 and 2% a BMI <18.5 kg/m^2 (CHAPTER THREE Figure 1). Low BMI values were therefore considerably less frequent than with the nursing home residents and also less frequent than with elderly home-care receivers in the USA and Finland, where 4-8% had BMI <18.5 kg/m^2 (8,9).

In contrast, high BMI values were widespread – about one third had BMI ≥30 kg/m^2 (CHAPTER THREE Figure 1), 12% even ≥35 kg/m^2. Regarding the nursing home residents a BMI of ≥30 kg/m^2 was much less frequent (20%) (2,3), whereas in the mainly healthy collective of the National Consumption Study (30%) (10) and in international collectives of elderly home-care receivers (29-35%) (8,9,11) comparably high prevalence were described. With a high BMI it is first and foremost to avoid any further increase in weight. At higher age, body weight reduction is critical and should only be carried out with medical indication and intensive physical activity at the same time because it always leads to a reduction of muscle mass and consequently functional damage.

Nutritional problems like chewing (52%) and swallowing problems (28%) are very common in the collective (CHAPTER THREE Table 2) and much more frequent than with nursing home residents (25%, 8%) (2,3). Generally, avoiding certain foods, these disorders can result in a one-sided nutrition and malnutrition. In the present study, chewing as well as swallowing problems were significantly negatively associated with anthropometric parameters (CHAPTER THREE Table 4). Strategies to improve oral nutrient intake can be dental and oral care check, mushy food, or in case of difficulty swallowing, training (12). In spite of many study participants with chewing and swallowing problems, in the present study strained food was rarely served. It cannot be answered however, whether the problems were not very pronounced or disregarded with respect to the nutrition or whether strained food was rejected by the care receivers. For successful therapy, close interchange between the home-cared elderly, nursing personnel, doctors, dentists and therapists should take place.

Meal presentation is also an important factor regarding decreasing appetite. Over one third of the study participants complained about a moderate or poor appetite and also here significantly negative associations with the nutritional status were shown (CHAPTER THREE Table 2 and 4). Possible strategies to improve appetite are

checking drug prescriptions, personally chosen food, fortified menus and appetizers (13).

We found lower anthropometric values among participants with dementia (CHAPTER THREE Table 4). This may be due to problems with e.g. food preparation, forgetting to eat, swallowing abnormalities or higher resting expenditure due to increased activity (14). Patients with cognitive impairment require special attention and nutritional intervention may lead to an improvement in nutritional status (15).

Due to the high BMI we expected high energy intake in the study collective. The assessment of individuals' energy intake with a three day prospective nutrition diary, showed that approximately 60% of participants do not reach the recommended levels. Possibly not all expended food was indicated or a lesser amount, on the other hand a BMI ≥30 kg/m^2 may have also resulted from former excessive food supply, respectively.

Mean protein intake was 81 g (male) and 68 g (female) per day, respectively 1.0 g/kg BW (CHAPTER THREE Table 3), and in excess of the recommended levels. Since the question of a desirable protein and amino acid intake to optimally maintain the muscle-mass at a certain age is still not resolved, a final evaluation has to remain unsettled.

Aim of chapter four was to analyze the association between BMI and 1-year mortality rate. The mean BMI of the deceased group was significantly lower than that of survivors (28.7 ±6.4 kg/m² vs. 25.4 ±4.4 kg/m, CHAPTER FOUR Table 1), however, both mean BMI lie within the overweight category, according to the WHO recommendation (16). Analysis revealed the highest mortality rate in elderly with BMI <20 kg/m² (39%), followed by those who had BMI 20-30 kg/m² (17%), and individuals with BMI >30 kg/m² had the lowest rate (9%) (CHAPTER FOUR Table 1). The inverse association between mortality and BMI held true after controlling for gender, age, care-needs, and disease conditions (CHAPTER FOUR Table 2). The results of the present study confirm the assumption of other studies (17-21) that higher BMI values provide a survival advantage for older adults possibly through the protective effect of body fat during catabolic processes and suggest a higher optimal BMI for older ages than the current recommendation. The WHO cut-off point of 25 kg/m^2 for defining overweight (16) might be too restrictive for elderly individuals.

Because of the demographic development with increase in number of very old people and home-care receivers, care and accommodation of elderly people will continuously gain importance. For elderly people the familiar atmosphere at home and the individual care involves a greater satisfaction and a greater well-being than the residence in a health care institution and should therefore be supported best possible.

To convey the study findings into private households, improvement and expansion of information and consultation offers regarding all aspects of care would be desirable, i. e. by health insurance companies, doctors or information centres. The home-cared seniors as well as their nursing personnel should be able to recognise nutritional problems at an early stage and should be informed about possible treatment measures. Ambulatory nutritionists could help preemptively or therapeutically, visiting endangered elderly persons, advising them extensively and support them with individualised nutritional strategies. A fundamental condition for the enhancement of a nutritional conscience is to claim a better integration of the sector “nutrition” in the education and training of doctors, ambulatory specialists and therapists.

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