Magnesium and zinc deficiency of nursing home residents caused by malnutrition?

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Zusammenfassung

Die alimentäre Mg- und Zn-Zufuhr von 11 Bewohnern eines Stuttgarter Alten- und Pflegeheimes wurden mittels quantitativer computerunterstützter Auswertung (EBIS®) von 7-Tagesprotokollen und Messung von Essensproben nach der Duplikatmethode untersucht. Zusätzlich konnte der Serum-Mg- und Serum-Zn-Spiegel von 25 Bewohnern des gleichen Heimes gemessen werden. Die durchschnittliche Mg- und Zn-Zufuhr nach der Duplikatmethode betrug rund 55% der RDA-/DGE-Empfehlungen. Während die bei der computerunterstützten Auswertung berechneten Zn-Werte mit den Analysenergebnissen weitgehend übereinstimmten, war für Mg eine um 30% erhöhte Zufuhr zu verzeichnen. Aufgrund dieses Vorkommens wurden die Tagesprotokolle von zwei Heimbewohnern aufgelistet, um die Berechnungen nach EBIS® mit anderen computerunterstützten Ernährungsprogrammen in verschiedenen Ländern vergleichen zu können. Bezüglich der Blutserumauswertung wurden bei 32% eine Hypomagnesiämie und bei 28% eine Hypozinkämie ermittelt. 20% der Teilnehmer wiesen sowohl eine Hypomagnesiämie als auch eine Hypozinkämie auf. Hypermagnesiämie und Hyperzinkämie traten nicht auf.

Summary

The nutritional Mg and Zn intake of 11 nursing home residents (NHR) in Stuttgart was estimated by quantitative calculation of 7-day-protocols as well as by measuring food samples with the duplicate technique on seven subsequent days in 1996. In addition, the serum-Mg and serum-Zn of 25 blood samples from NHR of the same facility were determined. The mean Mg and Zn intake of 11 NHR measured by duplicate technique amounted to only 55% of the RDA and DGE recommendations.The calculated total Zn intake was similar to the total Zn intake measured by the duplicate technique. In contrast the calculated Mg intake was 30% higher. Because of this phenomenon the protocols of two NHR are presented. This allows to apply other calculations than EBIS® and to see whether there exists a local or worldwide problem. Hypomagnesemia was detected in 32% and hypozincemia in 28% of all cases. Both hypomagnesemia and hypozincemia occurred in 20%. None of the subjects revealed hypermagnesemia or hyperzincemia.

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Introduction

Individuals need an adequate daily dietary intake of magnesium (Mg) and zinc (Zn). The current daily recommended intake is 300 mg Mg and 12 mg Zn for women and 350 mg Mg and 15 mg Zn for men in Germany (*DGE*, 1995). If the intake is habitually less than the daily requirements, deficiency can develop. Typical symptoms of Mg deficiency are calf cramps, cardiac arrhythmias and heart failure and the symptoms of Zn deficiency are impaired immune functions, decreased wound healing and reduced appetite (*Classen*, 1992; *Durlach* et al., 1997; *Kruse-Jarres*, 1995; *Rimbach* et al., 1996).

Investigations of Mg and Zn intake in elderlies arose considerable interest in the last decade. Especially the Zn status has been focused in the last few years (*Ortega* et al., 1995; *Schmuck* et al., 1996). *Rudman* et al. (1995) has identified Zn, Mg, copper and manganese as the elements with the highest prevalence of inadequate intake in 34 eating-dependent nursing home residents in Milwaukee, USA. The mean intake of Mg amounted to 50% of the recommended dietary allowance (RDA) and the mean intake of Zn was 40% of the RDA. Comparable studies haven't been available in Germany.

To evaluate the Mg and Zn intake of nursing home residents (NHR) in Germany, the nutritional intake of 11 NHR was investigated in 1996. In addition, the serum-Mg and serum-Zn as well as serum-Ca, serum-Na and serum-K of 25 NHR were determined. Mineral intake was both calculated and measured. Since the calculated Mg intake has been previously shown to exceed the measured intake, the protocols of two NHR are presented. This allows to apply other calculation programs than EBIS® and to see whether there exists a local or worldwide problem.

Subjects and methods

Subjects

11 nursing home residents (NHR, 10 women, 1 man, 87±6y) of a 107 bed facility were selected randomly to participate in the nutritional study and 25 blood samples from NHR of the same facility were collected. NHR over 70 years old with written consent were included in the study. Subjects reporting the presence of acute illnesses, eating out of house, using parental or tube feedings or taking Mg and Zn supplements were excluded from the study.

Methods

The nutritional Mg and Zn intake was estimated by quantitative calculation of 7-day-protocols as well as by measuring food samples with the duplicate

technique on seven subsequent days. Food and drink duplicates of each meal – even consumption of food and drinks besides the main meals – from each subject were collected, weighed and documented. Food remaining on the plates, which hadn't been eaten, was also weighed and the equivalent was taken from the duplicate. On every evening all food duplicates of each subject were put together and transported to the University. The samples were frozen at –21°C. Food and drinks were collected separately. After homogenizing all food samples, aliquots were freeze-dried and dry-ashed at 560°C. The ashes were taken up with 3.2% HCl solution. The drink samples were prepared with trichloracetic acid according to the method of a protein precipitation. Mg and Zn were assayed by atomic absorption spectrometry (AAS) using a Perkin Elmer 1100M.

The documented weights of every item represented the basic data for the quantitative calculation, by using the computer program EBIS®. This program, based on the data of the German food code version II.2 (BLS), was developed at the University of Hohenheim (*Erhardt*, 1991). The German food code (BLS) consists almost 12,000 food items with about 150 components, respectively.

Blood samples were collected between 7 and 11 a.m. using a vacuum serum separation tube with metal-free silicon stoppers (SST®-Vacutainer, Becton Dickinson, France). The filled tube was gently inverted five times and centrifuged within 30 minutes. Serum was stored in polystyrene metal-free tubes at –21°C for analysis. Serum-Mg, serum-Zn and serum-Ca were assayed by AAS using Perkin Elmer 1100M. Serum-K and Serum-Na were assayed by flame emission spectrometry (FES) using a Eppendorf FCM 6341. Reference plasma (Qualitrol® HSN; Merck) was assayed with each run to validate the results. During sample collection, processing and analysis contamination with minerals and trace minerals had to be avoided. Serum-albumin was photometrically determined by using a complete and ready-for-use reagent kit based on the method of bromcresolgreen.

Quality control for analysis of Mg and Zn in food, drinks and serum was performed. Following data were found as detection limit, precision, accuracy and recovery:

Results

Table 1 summerizes the clinical and individual data of the 11 NHR. 10 women and 1 man with a mean age of 87 ±6 years participated the nutritional study. 3 subjects had a body mass index >23 kg/m², 5 subjects between 20 and 23 and 3 subjects <20. According to the need of care, 6 subjects belong to the group 2, one to the group 1 and four to the group 0 (see table 1).

	Mg	Zn
detection limit:	**<0.001 mg/l**	**0.002 mg/l**
precision (serum; day by day):	0.24%	1.4%
precision (serum; in row):	0.65%	0.87%
accuracy (Qualitrol® HSN):	94.5%	119.2%
recovery (serum):	102.4%	97.2%
recovery (food):	90.1%	104.0%
recovery (drinks):	93.1%	107.8%

Tab. 1: Clinical data of the nursing home residents (NHR).

Initials	Sex	Age (y)	Primary diagnosis	Body mass index (kg/m²)	need of care*
HELU	w	88	heart failure, arthrosis	26.8	0
SCEL	w	86	heart failure, stenocardia	17.7	0
HAMA	w	92	heart arrhythmia	17.3	2
MAEL	w	88	dementia, heart failure	20.2	0
PAES	w	88	heart failure, stenocardia	20.0	0
DAAN	w	95	hypertension. heart failure	17.6	1
WEWI	w	80	gastrectomy, post-stroke	20.8	2
VIHI	w	98	heart failure, dementia	23.4	2
RAHI	w	80	Parkinson's disease	28.0	2
FLPA	w	80	diabetes mellitus, post-stroke	20.2	2
STFR	m	89	hypertension, decubitus	22.6	2

*scoring system (0 to 3) of needed care in Germany: 0 means no care is needed; 3 means highest care is needed, which includes parenteral and tube feeding.

Tab. 2: Mean consumption of food and drinks (wet weight, mean ± SD) and mean intake of energy (mean ± SD) calculated on seven subsequent days by EBIS®.

Initials	mean daily consumption of food (g/day)	mean daily consumption of drinks (g/day)	mean daily intake of energy (kcal/day)
HELU	1031 ± 174	1357 ± 240	1727 ± 413
SCEL	803 ± 108	1015 ± 154	1215 ± 258
HAMA	780 ± 106	918 ± 59	1365 ± 128
MAEL	699 ± 158	984 ± 140	1134 ± 201
PAES	1076 ± 97	733 ± 242	1506 ± 222
DAAN	1176 ± 162	1361 ± 93	1818 ± 325
WEWI	1203 ± 236	795 ± 168	1664 ± 208
VIHI	998 ± 155	971 ± 174	1519 ± 293
RAHI	861 ± 168	748 ± 188	1365 ± 222
FLPA	689 ± 156	975 ± 169	1272 ± 103
STFR	1139 ± 140	1215 ± 238	1549 ± 270

The results of the calculated and analyzed daily intake for the 11 NHR are schown in tables 2, 3 and 4. In Germany, the recommended intake of energy is 1700 kcal per day for women over 65 years and 1900 kcal per day for men over 65 years (*DGE*, 1995). Except two subjects the intake of energy was less than the recommendations. It differs from 2 to 33 percent. The mean consumption of food ranged between 689 g and 1203 g per day, drinking ranged between 733 g and 1357 g per day. All subjects consumed less food and drinks than recommended.

The mean Mg and Zn intake (n=7 days) didn't cover the recommended dietary allowance (RDA). The highest **calculated** individual intake amounted to 430 mg Mg and to 13.0 mg Zn, the lowest amounted to 120 mg Mg and to 3.6 mg Zn. The **calculated** mean intake of all NHR was 220 ± 52 mg Mg and 6.8 ± 1.7 mg Zn.

The mean Mg intake of all NHR **measured by duplicate technique** amounted to 169 ± 35 mg, and Zn intake amounted to 6.6 ± 2.0 mg. The highest individual intake was 202 mg Mg and 8.1 mg Zn, the lowest intake was 131 mg Mg and 4.3 mg Zn.

The mean consumption per day of Mg and Zn measured by the duplicate technique amounted to only 55% of the RDA and DGE recommendations. The calculated total Zn intake was almost similar to the total Zn intake measured by the duplicate technique (table 4). **In contrast the calculated Mg intake was 30% higher** (table 3). Both, food and drinks, counted higher calculated Mg values. Same results were reported by *Anke* and *Glei* (1991, 1995) and *Luz* (1997). Amazingly, the measured Zn intake of drinks were higher than the calculated ones. This difference could be caused of the various Zn concentrations in German drinking water ranging form 0.01 to 2.2 mg Zn per liter (*Schimatschek*, 1998).

Tables 5 and 6 show the Mg, Zn, Ca, K and Na intake of WEWI and HELU calculated by EBIS® day by day. Comparing the calculated intakes of both subjects HELU had a higher total Mg, Ca, Zn and K intake on five or more days. According to the Ca and K supply HELU corresponded to the RDA. Compared with the RDA the Mg and Zn intake were too low and the Na intake too high. Except the K intake WEWI never attained the RDA of Mg, Ca, Zn and Na. HELU also consumed more food and drinks.

To analyze the reasons of the different intakes by HELU and WEWI the kind of food and beverages, their weights, Mg and Zn content are listed in table 7. The main Mg suppliers were wholemeal bread, yoghurt, cheese, vegetarian menus and enriched mineral water. The main Zn suppliers were wholemeal bread, cheese, eggs and meat. The higher Mg, Zn, Ca and K intake of HELU was caused by consuming these items except meat. Remarkably was the great different intake of HELU on Saturday mainly caused by the consumption of milk with chocolate.

25 serum samples of a 107 bed facility (23 female, 2 male) were collected and evaluated. The mean age was 86 ± 5 years. Nine of 11 NHR, who participated in the nutritional investigation, gave consent to collect blood samples, too. Following reference ranges of serum concentrations are shown in table 8.

Tab. 3: Calculated and analyzed mean Mg intake per day (mean ± SD, n = 7 days).

Initials	Calculation by EBIS®-Program			Analysis by duplicate technique		
	Mg intake drinks (mg)	Mg intake food (mg)	Mg intake total (mg)	Mg intake drinks (mg)	Mg intake food (mg)	Mg intake total (mg)
HELU	47 ± 29	228 ± 49	275 ± 72	32 ± 16	170 ± 27	202 ± 34
SCEL	65 ± 44	124 ± 21	188 ± 48	38 ± 23	128 ± 17	166 ± 34
HAMA	66 ± 9	128 ± 23	194 ± 28	51 ± 8	106 ± 15	157 ± 18
MAEL	61 ± 28	110 ± 24	171 ± 27	44 ± 15	87 ± 18	131 ± 19
PAES	44 ± 31	191 ± 27	235 ± 25	38 ± 19	157 ± 24	195 ± 32
DAAN	78 ± 43	180 ± 14	258 ± 51	55 ± 17	146 ± 25	201 ± 22
WEWI	30 ± 6	184 ± 42	214 ± 39	11 ± 2	134 ± 30	145 ± 29
VIHI	92 ± 34	154 ± 34	246 ± 55	59 ± 18	110 ± 29	169 ± 39
RAHI	42 ± 12	141 ± 34	183 ± 38	31 ± 10	109 ± 17	140 ± 18
FLPA	63 ± 30	147 ± 33	210 ± 28	39 ± 14	125 ± 34	164 ± 30
STFR	58 ± 11	187 ± 27	245 ± 32	39 ± 5	145 ± 24	184 ± 26
Mean	59 ± 31	161 ± 45	220 ± 52	40 ± 19	129 ± 33	169 ± 35

Tab. 4: Calculated and analyzed mean Zn intake per day (mean ± SD, n = 7 days).

Initials	Calculation by EBIS®-Program			Analysis by duplicate technique		
	Zn intake drinks (mg)	Zn intake food (mg)	Zn intake total (mg)	Zn intake drinks (mg)	Zn intake food (mg)	Zn intake total (mg)
HELU	0.5 ± 0.5	8.2 ± 1.9	8.7 ± 2.3	1.7 ± 1.4	4.6 ± 1.2	6.3 ± 1.7
SCEL	0.6 ± 0.7	5.9 ± 1.1	6.4 ± 1.5	1.8 ± 1.0	6.3 ± 2.3	8.1 ± 2.7
HAMA	1.4 ± 0.3	5.1 ± 1.3	6.5 ± 1.4	3.2 ± 1.6	3.2 ± 0.7	6.4 ± 1.7
MAEL	0.4 ± 0.5	5.6 ± 1.3	6.1 ± 1.1	1.9 ± 1.3	4.7 ± 1.3	6.6 ± 1.6
PAES	0.4 ± 0.5	6.9 ± 0.8	7.3 ± 0.8	1.7 ± 1.5	5.2 ± 0.7	6.9 ± 1.8
DAAN	0.8 ± 0.7	6.4 ± 0.7	7.1 ± 1.0	2.3 ± 1.7	4.2 ± 0.9	6.4 ± 1.5
WEWI	0.2 ± 0.1	6.2 ± 1.5	6.4 ± 1.5	1.0 ± 0.9	3.4 ± 0.9	4.3 ± 1.5
VIHI	1.3 ± 0.6	6.2 ± 1.3	7.6 ± 1.4	3.8 ± 1.7	3.4 ± 1.8	7.2 ± 2.5
RAHI	0.3 ± 0.1	5.0 ± 1.0	5.2 ± 1.0	2.9 ± 2.8	3.6 ± 1.1	6.5 ± 2.4
FLPA	0.5 ± 0.6	4.5 ± 1.5	5.0 ± 1.1	3.3 ± 1.5	3.0 ± 1.6	6.2 ± 1.5
STFR	0.2 ± 0.1	8.0 ± 1.5	8.2 ± 1.5	2.3 ± 1.1	5.4 ± 1.7	7.7 ± 1.9
Mean	0.6 ± 0.6	6.2 ± 1.7	6.8 ± 1.7	2.3 ± 1.7	4.3 ± 1.7	6.6 ± 2.0

If the reference ranges of Mg and Zn were set as shown in table 8, hypomagnesemia was detected in 32% and hypozincemia in 28% of all cases. Both hypomagnesemia and hypozincemia occurred in 20%. None of the subjects revealed hypermagnesemia or hyperzincemia.

In addition, serum-Ca, -K and -Na were measured, too. 56% of all subjects exhibited hypocalcemia, 8% hypokalemia and 28% hyponatremia. Hypercalcemia, hyperkalemia and hypernatremia didn't occur. Each subject, which combined hypomagnesemia and hypozincemia, also exhibited hypocalcemia.

Hypoalbuminemia was present in only 12% of all cases. In view of this low prevalence it is concluded that decreased serum electrolyte levels were not caused by lowered serum-albumin concentrations, respectively simply by dilution.

Tab. 5: Weights, Mg and Zn intake of WEWI and HELU on seven days calculated by EBIS®.

Initials	Day	Weight drinks [g]	Weight food [g]	Weight total [g]	Mg intake drinks [mg]	Mg intake food [mg]	Mg intake total [mg]	Zn intake drinks [mg]	Zn intake food [mg]	Zn intake total [mg]
WEWI	Sa	744	1117	1861	31.5	143.2	174.7	0.1	6.2	6.3
	Su	518	1496	2014	18.6	243.7	262.3	0.2	8.6	8.8
	Mo	647	969	1616	24.9	177.6	202.5	0.1	4.7	4.8
	Tu	831	1563	2394	31.1	232.6	263.7	0.3	6.8	7.1
	We	945	983	1928	32.5	132.7	165.2	0.2	4.1	4.3
	Th	974	1119	2093	35.7	172.0	207.7	0.3	6.8	7.1
	Fr	904	1180	2084	34.1	184.5	218.6	0.3	6.3	6.6
HELU	Su	852	1235	2087	47.5	195.9	243.4	0.4	7.4	7.8
	Mo	1244	1006	2250	41.2	171.3	212.5	0.4	5.4	5.8
	Tu	851	1237	2088	28.6	208.1	236.7	0.3	6.9	7.2
	We	990	1605	2595	33.0	245.0	278.0	0.3	9.6	9.9
	Th	941	1713	2654	31.3	252.3	283.6	0.3	8.1	8.4
	Fr	1065	1402	2467	35.1	209.4	244.5	0.3	8.7	9.0
	Sa	1277	1304	2581	110.3	319.6	429.9	1.6	11.4	13.0

Tab. 6: K, Na and Ca intake of WEWI and HELU on seven days calculated by EBIS®.

Initials	Day	K intake drinks [mg]	K intake food [mg]	K intake total [mg]	Na intake drinks [mg]	Na intake food [mg]	Na intake total [mg]	Ca intake drinks [mg]	Ca intake food [mg]	Ca intake total [mg]
WEWI	Sa	65	1684	1749	26	1936	1962	94	346	440
	Su	68	2923	2991	11	2147	2158	53	600	653
	Mo	75	1716	1791	17	2226	2243	72	241	313
	Tu	101	2951	3052	21	2751	2772	90	321	411
	We	96	1654	1750	23	6313	6336	95	282	377
	Th	123	2068	2191	23	2777	2800	103	567	670
	Fr	108	2229	2337	23	2159	2182	99	229	328
HELU	Su	513	1861	2374	21	1192	1213	99	767	866
	Mo	385	1675	2060	31	1433	1464	77	421	498
	Tu	247	2078	2325	24	1646	1669	60	792	852
	We	294	2654	2948	27	2983	3010	68	1292	1360
	Th	276	3368	3644	26	2931	2957	65	1071	1136
	Fr	308	2178	2486	29	2169	2198	73	996	1070
	Sa	722	2922	3644	210	1560	1770	331	1118	1449

Discussion

The duplicate technique and the quantitative calculations of 7-day-protocols are direct methods to study daily nutritional intakes. The results of these methods are more accurate than the results of an indirect method, for example retrospective 24-hour-recall. To study small groups and to perform daily intakes individually are advantages of the duplicate technique and quantitative calculation. On the other hand both methods require a lot of time, money and personal effort (*Leitzmann*, 1996).

Seven subsequent days were choosen as the study time for each subject because the individual eating habits are changing within one week profoundly. In contrast nutritional surveys with 3-day-protocols don't consider changing eating habits and a higher error range is indicated (*Luz*, 1997).

All subjects of this nutritional study presented insufficient daily intakes of Mg and Zn. At least 8 NHR exhibited an analyzed mean daily intake of Mg and Zn below 60% of the RDA. These findings concur with other results reported in the literature. *Rudmann* et al. (1995) found that in 88% of 34 eating-dependent NHR the daily intakes of Mg and Zn was below 75% of the RDA. Intakes under 50% of the RDA were found in at least 50% of the subjects. *Schlierf* et al. (1989) found in hospitalized elderlies with acute or chronical diseases mean daily intakes of 134 mg Mg. The lower intake of Mg is probably caused by additional eating problems and dysphagia. In contrast healthy, free-living elderlies presented an adequate or only marginal inadequate intake of Mg and Zn. The results of the NVS (1985–1988) amounted to 90–93% of the RDA for Mg and about 75% for Zn (*DGE*, 1996). Interim findings of a longitudinal study with 76 women (71 ± 5Y) and 32 men (69 ± 3y) exhibited sufficient daily Mg intakes and 93% of the RDA for Zn (*Neuhäußer-Berthold*, 1997).

These results let assume that eating-dependent NHR suffer under nutritional Mg and Zn deficiency and have lower daily intake of Mg and Zn than healthy, free-living elderlies. The intake levels of hospitalized aged persons with acute or chronical diseases were even lower.

Tab. 7: Meals and beverages of HELU and WEWI on seven subsequent days.

HELU, Sunday	weight [g]	Mg (mg)	Zn (mg)
wholemeal bread with butter and jam	68	25.2	1.0
yoghurt with cereals	99	25.7	0.7
canned mixed fruit	10	0.4	0.0
rice and vegetable soup clear	122	11.0	1.1
potato croquettes with carrots and pea	68	12.2	0.4
salad with vinegar and oil dressing	28	2.8	0.1
zucchini, cooked	45	9.9	0.1
cauliflower, cooked	48	7.2	0.1
macaroni	150	31.5	0.9
basic sauce, light or dark	23	0.7	0.0
mixed fruits of berries, fresh	98	8.8	0.1
sauce of vanille, sweet	46	5.1	0.3
yoghurt (full fat) with mixed fruits	114	12.5	0.5
thick gruel	140	15.4	0.7
crispbread with butter and hard cheese (Emmenthaler)	42	12.6	1.2
red tomato, fresh	5	0.7	0.0
leavened bread (low fat)	33	5.6	0.3
grapes, fresh	96	8.7	0.1
orange nectar	223	17.8	0.2
coffee with milk and sugar	135	8.1	0.0
herb tea	133	1.3	0.0
tea black	49	1.5	0.0
coffee with tinned milk and sugar	312	18.7	0.0
total daily amount (mg) calculated by EBIS®:		**243.4**	**7.8**
total daily amount (mg) with duplicate technique:		**230.9**	**7.3**

HELU, Monday	weight [g]	Mg (mg)	Zn (mg)
yoghurt with cereals	140	36.4	1.0
fresh mixed fruit	14	2.3	0.1
wholemeal bread with butter and jam	82	30.3	1.3
noodle soup/vermicelli soup	115	13.8	0.3
fresh boiled egg	20	2.4	0.3
baked apples with cream	176	17.6	0.7
vanilla sauce, sweat	30	3.3	0.2
apple, fresh and peeled	73	4.4	0.1
orange fruit	125	17.5	0.2
brown bread	50	20.0	0.7
fresh boiled egg	20	2.4	0.3
red tomato, fresh	10	1.3	0.0
roll of bread	40	9.6	0.4
grapes, fresh	111	10.0	0.2
coffee with tinned milk and sugar	455	27.3	0.0
carbonated mineral water	67	7.4	0.0
fruit tea	84	0.8	0.0
herb tea	571	5.7	0.0
total daily amount (mg) calculated by EBIS®:		**212.5**	**5.7**
total daily amount (mg) with duplicate technique:		**140.9**	**4.4**

HELU, Tuesday	weight [g]	Mg (mg)	Zn (mg)
brown bread with butter	45	17.6	0.6
strawberry jam	10	0.6	0.0
yoghurt with cereals	136	35.4	1.0
fresh mixed fruits	20	3.2	0.1
soup with eggs	131	14.4	0.4
bread dumpling	84	14.3	0.7
cooked mixed vegetables, fresh	65	11.1	0.3
cooked red cabbage, fresh	111	12.2	0.3
white sauce with herbs	26	2.8	0.1
oatmeal porridge	106	17.0	0.6
yoghurt (high fat)	106	12.7	0.5
sugar	19	0.0	0.0
cinnamon	1	0.6	0.0
red tomato, fresh	7	0.9	0.0
cucumber, fresh	7	0.6	0.0
wholemeal bread with butter and hard cheese	68	29.9	1.9
pear, fresh	121	8.2	0.2
kiwi, fresh	89	21.4	0.4
apple, peeled and fresh	85	5.1	0.1
coffee with tinned milk and sugar	284	17.0	0.0
carbonated mineral water	66	7.3	0.0
herb tea	436	4.4	0.0
total daily amount (mg) calculated by EBIS®:		**236.7**	**7.2**
total daily amount (mg) with duplicate technique:		**184.2**	**6.0**

HELU, Wednesday	weight [g]	Mg (mg)	Zn (mg)
yoghurt with cereals	118	30.7	0.9
canned mixed fruits	15	0.6	0.0
wholemeal bread with butter and jam	92	34.0	1.5
tomato soup with cream	100	5.0	0.1
bread dumpling	23	3.9	0.2
green salad with vinegar and oil dressing	94	9.4	0.3
basic sauce, light or dark	86	2.6	0.1
cooked potatos, fresh	100	20.0	0.3
cream (30% fat)	50	4.5	0.2
hard cheese (Emmenthaler)	71	21.3	3.3
pudding made with curd cheese	171	15.5	0.5
sugar	20	0.0	0.0
apple purée	75	3.0	0.1
thick semolina gruel	75	8.3	0.4
pudding made with curd cheese	75	6.8	0.2
butter	11	0.3	0.1
red tomato, fresh	4	0.9	0.0
wholemeal bread	46	26.2	1.1
uncooked vegetarian food with oil	84	24.4	0.3
grapes fresh	204	18.4	0.2
plums fresh	91	9.1	0.1
coffee with tinned milk and sugar	338	20.3	0.0
carbonated mineral water	69	7.6	0.0
herb tea	515	5.2	0.0
total daily amount (mg) calculated by EBIS®:		**278.0**	**9.9**
total daily amount (mg) with duplicate technique:		**207.8**	**5.6**

HELU, Thursday	weight [g]	Mg (mg)	Zn (mg)
yoghurt with cereals	133	34.7	0.9
canned mixed fruits	10	0.4	0.0
wholemeal bread with butter and jam	65	24.1	1.0
cooked mixed vegetables	40	6.9	0.2
tomato soup with cream	70	4.9	0.1
potatos, cooked and peeled	150	30.0	0.5
curd with herbs (high fat)	107	18.3	1.0
radish salad with vinegar and oil dressing	53	11.2	0.2
butter	9	0.3	0.1
canned mixed fruits	106	4.3	0.1

crispbread with butter and hard cheese	73	22.3	2.0
red tomato, fresh	41	5.4	0.1
cucumber fresh	9	0.8	0.0
sugar	23	0	0.0
cinnamon	1	0.6	0.0
yoghurt (high fat)	90	10.8	0.5
thick semolina gruel	90	9.9	0.5
pear, fresh	133	9.3	0.3
plums, fresh	89	8.9	0.1
grapes, fresh	171	15.4	0.2
kiwi, fresh	85	20.4	0.4
apple fresh and peeled	87	5.3	0.1
nectarine, fresh	80	8.1	0.1
coffee with tinned milk and sugar	316	19.0	0.0
carbonated mineral water	67	7.4	0.0
herb tea	492	5.0	0.0
total daily amount (mg) calculated by EBIS®:		**283.6**	**8.4**
total daily amount (mg) with duplicate technique:		**200.3**	**4.5**

HELU, Friday	**weight [g]**	**Mg (mg)**	**Zn (mg)**
brown bread with butter	60	23.4	0.8
strawberry jam	12	0.7	0.0
sugar	20	0.0	0.0
yoghurt with cereals	89	23.1	0.7
canned mixed fruits	10	0.4	0.0
clear soup	95	12.4	0.8
buttermilk with fruits	148	16.3	0.6
baked noodles with cheese	148	25.2	1.9
tomato sauce	68	7.5	0.8
green salad with vinegar and oil dressing	65	9.1	0.2
sugar	19	0.0	0.0
cinnamon	1	0.6	0.0
yoghurt (high fat)	91	10.9	0.5
thick semolina gruel	91	10.0	0.5
hard cheese (Emmenthaler)	15	4.5	0.7
brown bread with butter	49	19.1	0.6
red tomato, fresh	12	1.6	0.0
cucumber, fresh	14	1.1	0.0
kiwi, fresh	81	19.5	0.4
pears, fresh	141	9.9	0.3
nectarine, fresh	89	8.9	0.1
apple, fresh	84	5.1	0.1
coffee with tinned milk and sugar	352	21.1	0.0
carbonated mineral water	77	8.5	0.0
herb tea	559	5.6	0.0
total daily amount (mg) calculated by EBIS®:		**244.5**	**9.0**
total daily amount (mg) with duplicate technique:		**201.4**	**7.6**

HELU, Saturday	**weight [g]**	**Mg (mg)**	**Zn (mg)**
wholemeal bread with butter and jam	82	30.3	1.3
yoghurt with cereals	141	36.7	1.0
canned mixed fruits	15	0.6	0.0
hot-pot with vegetables	350	122.5	3.2
hard cheese (Emmenthaler)	18	5.4	0.8
yoghurt (high fat) with fruits	118	13.0	0.5
wholemeal bread	34	19.4	0.8
wholemeal bread with butter and hard cheese	73	32.1	2.0
sugar	19	0.0	0.0
cinnamon	1	0.6	0.0
yoghurt (high fat)	120	14.4	0.6
thick semolina gruel	128	14.1	0.6
red tomato, fresh	5	0.7	0.0
kiwi, fresh	94	22.6	0.5
pears, fresh	106	7.4	0.2
coffee with tinned milk and sugar	366	22.0	0.0
carbonated mineral water	130	14.3	0.0
herb tea	409	4.1	0.0
milk with chocolate	241	69.9	1.5
total daily amount (mg) calculated by EBIS®:		**429.9**	**13.0**
total daily amount (mg) with duplicate technique:		**248.7**	**8.8**

WEWI, Saturday	**weight [g]**	**Mg (mg)**	**Zn (mg)**
white bread with butter and jam	114	14.8	0.7
banana, fresh	124	44.6	0.2
mandarin organe, fresh	96	10.6	0.1
potatos, cooked and peeled	34	6.5	0.1
hot-pot with pork meat	267	18.7	2.4
cheese cake with sprinkled with ground almonds and short pastry	213	23.4	1.5
vegetable soup	97	8.9	0.2
pretzel stick	50	7.0	0.7
butter	15	0.5	0.0
ham sausage	18	2.9	0.3
apple, fresh and peeled	89	5.3	0.1
black tea with sugar	374	11.2	0.0
carbonated mineral water	184	20.2	0.0
total daily amount (mg) calculated by EBIS®:		**174.7**	**6.3**
total daily amount (mg) with duplicate technique:		**145.8**	**3.7**

WEWI, Sunday	**weight [g]**	**Mg (mg)**	**Zn (mg)**
white bread with butter and jam	123	16.0	0.7
banana, fresh	98	35.3	0.2
mandarin organe, fresh	43	4.7	0.1
grapes, fresh	13	1.2	0.0
potatos, cooked and peeled	161	32.2	0.5
cooked mixed vegetable, fresh	146	24.8	0.6
pork meat (middle fat)	35	8.4	1.2
yoghurt with mixed fruits	133	14.6	0.5
soup with macaroni (flädle)	239	16.7	2.2
cheese cake with sprinkled with ground almonds and short pastry	62	6.8	0.4
white bread with butter and hard cheese	38	9.9	0.8
white bread with butter and ham sausage	76	13.7	0.7
noodle soup/vermicelli soup	78	9.4	0.2
banana, fresh	95	34.2	0.2
red tomato, fresh	10	1.3	0.0
cucumber, fresh	9	0.7	0.0
yoghurt (high fat, 3,5%)	73	8.8	0.4
apple, fresh and peeled	84	5.0	0.1
black tea with sugar	398	11.9	0.0
carbonated mineral water	60	6.6	0.0
total daily amount (mg) calculated by EBIS®:		**262.3**	**8.8**
total daily amount (mg) with duplicate technique:		**191.6**	**4.8**

WEWI, Monday	weight [g]	Mg (mg)	Zn (mg)
white bread with butter and jam	104	13.6	0.6
banana, fresh	61	22.0	0.1
mixed fruits, fresh	70	11.2	0.2
green salad with vinegar and oil dressing	13	1.3	0.1
potatos, cooked and peeled	136	27.2	0.4
green rye soup	99	6.9	0.2
baked macaroni with ham amd cheese	101	20.2	1.0
chocolate pudding	127	48.3	1.2
cookies	24	2.6	0.2
white bread with butter and ham sausage	28	5.0	0.3
vegetable soup	94	8.6	0.2
mixed vegetable	21	5.3	0.2
black tea with sugar	432	13.0	0.0
carbonated mineral water	108	11.9	0.0
apple, fresh and peeled	91	5.5	0.1
total daily amount (mg) calculated by EBIS®:		**202.5**	**4.8**
total daily amount (mg) with duplicate technique:		**122.2**	**2.7**

WEWI, Tuesday	weight [g]	Mg (mg)	Zn (mg)
white bread with butter and jam	79	10.3	0.5
roll of bread with butter and jam	59	8.9	0.5
banana, fresh	118	42.5	0.2
mixed fruits, fresh	91	14.6	0.2
cooked cow meat, fresh	23	4.1	1.5
potatos, cooked and peeled	170	34.0	0.5
cooked beetroot, fresh	80	12.8	0.3
horse-radish sauce with cream	128	19.2	0.7
pears, fresh	149	10.4	0.3
apple, fresh and peeled	188	11.3	0.2
noodle soup/vermicelli soup	287	34.4	0.6
cheese cake with sprinkled with ground almonds and short pastry	70	8.4	0.5
white bread with butter and ham sausage	55	9.9	0.5
white bread with butter	7	1.3	0.1
noodle salad with mayonaise	59	10.6	0.5
black tea with sugar	588	17.6	0.0
carbonated mineral water	122	13.4	0.0
total daily amount (mg) calculated by EBIS®:		**263.7**	**7.1**
total daily amount (mg) with duplicate technique:		**164.7**	**4.3**

WEWI, Wednesday	weight [g]	Mg (mg)	Zn (mg)
white bread with butter	76	13.7	0.6
mixed fruits, fresh	86	13.8	0.2
boiled egg, fresh	20	2.4	0.3
tomato soup with cream	199	13.9	0.2
green salad with vinegar and oil dressing	50	7.0	0.2
fruit yoghurt (high fat)	83	9.1	0.4
potatos, cooked and peeled	172	34.4	0.5
leavened bread (low fat)	26	4.4	0.2
white bread with butter	89	16.0	0.7
tomato soup with cream	60	4.2	0.1
sausage (Bockwurst)	34	6.8	0.5
ham	7	1.6	0.1
hard cheese	2	0.6	0.2
apple, fresh and peeled	79	4.7	0.1
black tea with sugar	553	16.6	0.0
carbonated mineral water	145	16.0	0.0
total daily amount (mg) calculated by EBIS®:		**165.2**	**4.3**
total daily amount (mg) with duplicate technique:		**107.4**	**4.2**

WEWI, Thursday	weight [g]	Mg (mg)	Zn (mg)
white bread with butter	75	13.5	0.6
jam	45	2.7	0.1
mixed fruits fresh	65	10.4	0.2
banana, fresh	65	23.4	0.2
mushroom soup with cream	128	6.4	0.2
potatos, cooked and peeled	94	18.8	0.3
tomato salad with oil	61	13.4	0.1
fillet of turkey	72	14.4	1.4
canned ananas	18	2.9	0.1
melting cheese	18	5.4	0.8
cookies	41	4.5	0.3
white bread with butter	56	10.1	0.5
noodle soup/vermicelli soup	205	24.6	0.4
ham sausage	28	4.5	0.5
hard cheese (Emmenthaler)	27	8.1	1.2
apple fresh and peeled	84	5.0	0.1
red tomato, fresh	18	2.3	0.1
cucumber, fresh	19	1.5	0.0
back tea with sugar	715	21.5	0.0
carbonated mineral water	130	14.3	0.0
total daily amount (mg) calculated by EBIS®:		**207.7**	**7.1**
total daily amount (mg) with duplicate technique:		**154.0**	**7.4**

WEWI, Friday	weight [g]	Mg (mg)	Zn (mg)
white bread with butter	86	15.5	0.7
strawberry jam	43	2.6	0.1
mixed fruits, fresh	86	13.8	0.2
banana, fresh	37	13.4	0.1
clear soup	130	17.0	1.1
potatos, cooked and peeled	23	4.6	0.1
mixed fruit salad	87	14.5	0.2
paste squares, Swabian style	84	17.6	1.2
potato salad with vinegar and oil dressing	135	26.8	0.4
mixed fruit cake with short pastry (high fat)	127	15.3	0.5
white bread with butter	74	13.4	0.6
noodle soup/vermicelli soup	109	13.1	0.2
cream cheese	17	3.4	0.5
ham	28	6.5	0.5
apple, fresh and peeled	116	7.0	0.2
black tea with sugar	627	18.8	0.0
carbonated mineral water	139	15.3	0.0
total daily amount (mg) calculated by EBIS®:		**218.6**	**6.6**
total daily amount (mg) with duplicate technique:		**126.9**	**3.2**

The inadequate daily supply resulted not only from low calorie consumption but also from suboptimal nutrient density of the food ingested. In general, the greater the degree of eating dependence, the lower was the caloric intake and the lower was the daily intake of Mg and Zn. High nutritional density is generally hard to guarantee at low caloric intake (*Blumberg*, 1997; *Rudmann*, 1995; *Bidlak*, 1995).

Vegetarians presented an over 50% higher Mg and Zn supply than people with usual mixed diet (*Glei*, 1996). This study confirmed the higher supply of vegetarians. Both vegetarians (HELU, DAAN) obtained the highest Mg intake and one of the better Zn intake. The highest Mg and Zn intakes were obtained, when milk with chocolate was offered. Concerning the Zn supply elderlies should eat balanced mixed diet. High Zn concentrations were found in milk and milk products, meat and fish. The Zn availability from beef is three or four times higher than from cereals probably due to the inhibitory effect of phytate (*Feldl*, 1998).

In conclusion these findings let assume that eating-dependence in the nursing home population is a major risk factor for poor intake of Mg and Zn, meaning malnutrition. The prevalence of hypomagnesemia and hypozincemia is probably multicausal origin. The insufficient supply of Mg and Zn and the prevalence of diseases caused by old age are one of the major reasons for the high frequency of low serum-Mg and serum-Zn levels.

Since the inadequate supply of Mg and Zn has been found in eating-dependent NHR, a supplementation with daily recommended amounts has to be considered. *Bales* (1995) approved a supplementation with a multi-vitamin/mineral supplement of RDA levels, because it is inexpensive and non toxic if only water-soluble vitamins used. The nutritional state of the nursing home population could be improved and its benefits could be remarkable.

Tab. 8: Reference range of serum-Mg, -Ca, -Zn, -K, -Na and -albumin.

serum-Mg	0.76 to 1.10 mmol/l
serum-Ca	2.16 to 2.60 mmol/l
serum-Zn	12.2 to 27.0 µmol/l
serum-K	3.5 to 5.5 mmol/l
serum-Na	136 to 146 mmol/l
serum-albumin	35 to 50 g/l

Tab. 9: Age, sex, serum-Mg, -Zn, -Ca, -K, -Na and -albumin of 25 NHR.

Initials	Age (y)	Sex	Serum-Mg (mmol/l)	Serum-Zn (µmol/l)	Serum-Ca (mmol/l)	Serum-K (mmol/l)	Serum-Na (mmol/l)	Serum-albumin (g/l)
PAES	88	w	0.800	12.3	2.09	4.36	137.0	38.9
KRMA	96	w	0.920	15.1	2.09	4.12	138.8	41.0
DAAN	95	w	0.810	15.7	2.16	4.93	136.1	40.2
HEMA	75	w	0.700	15.7	2.34	4.50	128.9	41.0
BAJO	86	w	0.710	7.4	1.95	3.57	126.0	19.3
GRMA	87	w	0.730	11.9	2.14	3.83	124.2	37.2
HELU	88	w	0.840	16.3	2.21	3.60	129.0	46.9
HOEL	89	w	0.820	13.6	2.07	4.08	145.6	38.6
MEMA	79	w	0.840	18.2	2.23	3.09	131.7	42.9
MUMA	89	w	0.660	11.6	2.10	3.33	118.1	37.2
MAWI	85	m	0.810	13.9	2.29	5.12	138.4	42.9
MAEL	87	w	0.750	10.3	2.11	4.39	136.2	39.9
RAHI	80	w	0.830	12.9	2.13	3.73	133.2	42.9
LAPA	88	w	0.850	11.8	2.19	4.24	136.6	39.9
SIER	85	w	0.800	12.8	2.14	3.83	132.1	37.8
WETH	90	m	0.680	9.8	1.95	3.91	134.9	38.1
VIHI	98	w	0.790	12.2	2.15	4.06	127.4	36.2
FLPA	80	w	0.760	16.6	2.15	3.56	136.1	43.1
WIMA	86	w	0.830	11.9	2.05	3.87	133.0	30.3
WEWI	80	w	0.780	12.4	1.87	3.55	131.7	36.7
SCEL	86	w	0.740	21.8	2.29	5.00	139.2	44.5
MÄHE	88	w	0.860	16.4	2.11	4.51	145.3	38.9
SCUR	80	w	0.780	14.6	2.13	4.08	140.7	37.2
NIFR	85	w	0.760	14.9	2.18	3.81	132.8	33.0
HOGE	87	w	0.720	13.3	2.26	4.20	140.0	38.1

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