Body weight changes and outpatient medical care utilisation: Results of the MONICA/KORA cohorts S3/F3 and S4/F4

Veränderungen des Körpergewichts und Inanspruchnahme ambulanter medizinischer Versorgung: Ergebnisse der MONICA/KORA-Kohorten S3/F3 und S4/F4

Abstract

Objectives: To test the effects of body weight maintenance, gain, and loss on health care utilisation in terms of outpatient visits to different kinds of physicians in the general adult population.

Methods: Self-reported utilisation data were collected within two population-based cohorts (baseline surveys: MONICA-S3 1994/95 and KORA-S4 1999/2001; follow-ups: KORA-F3 2004/05 and KORA-F4 2006/08) in the region of Augsburg, Germany, and were pooled for present purposes. N=5,147 adults (complete cases) aged 25 to 64 years at baseline participated. Number of visits to general practitioners (GPs), internists, and other specialists as well as the total number of physician visits at follow-up were compared across 10 groups defined by body mass index (BMI) category maintenance or change. Body weight and height were measured anthropometrically. Hierarchical generalized linear regression analyses with negative binomial distribution adjusted for sex, age, socioeconomic status (SES), survey, and the need factors incident diabetes and first cancer between baseline and follow-up were conducted.

Results: In fully adjusted models, compared to the group of participants that maintained normal weight from baseline to follow-up, the following groups had significantly higher GP utilisation rates: weight gain from normal weight (+36%), weight loss from preobesity (+39%), maintained preobesity (+34%), weight gain after preobesity (+43%), maintained moderate obesity (+48%), weight gain from moderate obesity (+107%), weight loss from severe obesity (+114%), and maintained severe obesity (+83%). Regarding internists, those maintaining moderate obesity reported +107% more visits; those with weight gain from moderate obesity reported +91%. The latter group also had +41% more consultations with other physicians. Across all physicians, mean number of visits were estimated at 7.8 per year for maintained normal weight, 9 for maintained preobesity, 11 for maintained moderate obesity, and 12 for maintained severe obesity. Among those with weight loss, the mean number of visits were 8.7, 10.6 and 10.8 for baseline preobesity, moderate obesity, and severe obesity, respectively. Finally, those with weight gain from normal weight and preobesity reported 9.4 and 9.3 visits, respectively, and those with baseline moderate and follow-up severe obesity reported 13.1 visits (the most overall). Women reported higher GP and other physician utilisation. While all utilisation rates increased with age, GP utilisation was lower in middle to high SES groups.

Conclusion: Compared to maintained normal weight over a 7- to 10-year period, maintained overweight, weight gain and weight loss are associated with higher outpatient physician utilisation in adults, especially after baseline obesity. These effects only partly became insignificant after inclusion of incident diabetes or first cancer into the model. Future research should further elucidate the associations between

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weight development and health care utilisation by BMI status and the mechanisms underlying these associations.

Keywords: outpatient physician utilisation, obesity, body mass index, cohort studies, body weight maintenance, gain, and loss

Zusammenfassung

Zielsetzung: Es werden Effekte der Erhaltung, Zunahme und des Verlusts von Körpergewicht auf Inanspruchnahme gesundheitsbezogener Versorgung im Sinne ambulanter Besuche bei verschiedenen Ärztegruppen in der erwachsenen Allgemeinbevölkerung untersucht.

Methodik: Selbstberichtete Inanspruchnahmedaten wurden im Rahmen zweier Populationskohorten (Baselinesurveys: MONICA-S3 1994/95 und KORA-S4 1999/2001; Follow-ups: KORA-F3 2004/05 und KORA-F4 2006/08) in der Region Augsburg erhoben und für die Analyse gepoolt. Zur Baseline nahmen N=5.147 Erwachsene (vollständige Fälle) im Alter von 25 bis 64 Jahren teil. Über 10 Gruppen, die nach Veränderungen oder dem Erhalt der Body Mass Index- (BMI-) Kategorie definiert wurden, wurde die Anzahl der Besuche bei Allgemeinmedizinern, Internisten und anderen Fachärzten sowie die Gesamtzahl der Arztbesuche beim Follow-up verglichen. Körpergröße und -gewicht wurden anthropometrisch gemessen. Es wurden hierarchische verallgemeinerte lineare Regressionsanalysen mit negativer Binomialverteilung durchgeführt und für Geschlecht, Alter, sozioökonomischen Status, Survey und für zwischen Baseline und Follow-up inzident aufgetretenen Diabetes und inzident aufgetretener erster Krebserkrankung als Bedarfsfaktoren adjustiert.

Ergebnisse: In den vollständig adjustierten Modellen hatten im Vergleich zur Gruppe der Teilnehmer, die von Baseline zum Follow-up normalgewichtig geblieben waren, folgende Gruppen eine signifikant höhere Inanspruchnahme von Allgemeinmedizinern: Gewichtszunahme nach Normalgewicht (+36%), Gewichtsabnahme nach Präadipositas (+39%), stabile Präadipositas (+34%), Gewichtszunahme nach Präadipositas (+43%), stabile moderate Adipositas (+48%), Gewichtszunahme nach moderater Adipositas (+107%), Gewichtsabnahme nach schwerer Adipositas (+114%) und stabile schwere Adipositas (+83%). Bezüglich Internisten berichteten Personen mit stabiler moderater Adipositas +107% mehr Besuche, und diejenigen mit einer Gewichtszunahme nach moderater Adipositas +91%. Diese letztere Gruppe zeichnete sich auch durch +41% mehr Besuche bei anderen Fachärzten aus. Über alle Ärzte hinweg wurde die mittlere Anzahl von Besuchen p. a. auf 7,8 bei stabilem Normalgewicht sowie auf 9 bei stabiler Präadipositas, 11 bei stabiler moderater Adipositas und 12 bei stabiler schwerer Adipositas geschätzt. Nach Gewichtsabnahme war die mittlere Anzahl der Besuche 8,7, 10,6 bzw. 10,8 bei initialer Präadipositas, moderater bzw. schwerer Adipositas. Diejenigen mit Gewichtszunahme nach Normalgewicht bzw. Präadipositas berichteten 9,4 bzw. 9,3 Besuche, während diejenigen mit initial moderater Adipositas und schwerer Adipositas zum Follow-up 13,1 Besuche (also insgesamt die meisten). Insgesamt berichteten Frauen über eine höhere Inanspruchnahme von Allgemeinmedizinern und anderen Fachärzten. Während alle Inanspruchnahmeparameter mit dem Alter zunahmen, war die Inanspruchnahme von Allgemeinmedizinern bei mittlerem bis höherem sozioökonomischem Status relativ gering.

Fazit: Über einen Beobachtungszeitraum von 7 bis 10 Jahren sind stabiles Übergewicht, Gewichtszunahme und Gewichtsabnahme bei Erwachsenen im Vergleich zu stabilem Normalgewicht mit einer erhöhten ambulanten Inanspruchnahme von Ärzten assoziiert. Dies gilt insbesondere bei initialer Adipositas. Die Effekte waren nur teilweise durch inzi-

denten Diabetes oder eine inzidente erste Krebserkrankung vermittelt. Zukünftige Studien sollten die Assoziationen zwischen Körpergewichtsentwicklung und der Inanspruchnahme von gesundheitsbezogener Versorgung nach BMI-Status sowie die zugrundeliegenden Mechanismen vertiefend analysieren.

Schlüsselwörter: Inanspruchnahme ambulanter ärztlicher Versorgung, Adipositas, Body Mass Index, Kohortenstudien, Erhalt, Zunahme und Abnahme von Körpergewicht

Introduction

Different lifestyle factors, such as the consumption of high-calorie food and sedentary behaviour, have led to substantial increases in body weight both in industrialised and developing countries in recent years, and worldwide the number of obese adults (defined as having a body mass index (BMI) of 30 kg/m² or higher [1]) is rising [2], [3]. In Europe, obesity prevalences ranged from 4.0% to 28.3% in men and 6.2% to 36.5% in women between the late 1980s and 2005 [4], and given a linear trend, overall obesity prevalence is predicted to be 30% in 2015 [5]. In Germany, one study estimated that from 1985 to 2002 the prevalence of moderate obesity (30 kg/m² ≤ BMI <35 kg/m² [1]) increased from 16.2% to 23.5% in women and from 16.5% to 22.5% in men, while severe obesity (BMI >35 [1]) rose from 4.5% to 7.5% in women and from 1.5% to 5.2% in men [6]. Obesity is a major public health concern because it is a key risk factor for a range of chronic diseases, e.g. type 2 diabetes, hypertension, cardiovascular disease, osteoarthritis, stroke, gallbladder disease, sleep apnoea, respiratory problems and some cancers [7], [8], [9], and has major economic consequences for societies. Cost of illness studies in Western European countries have shown that direct and indirect costs associated with obesity range from 0.09 to 0.61% of the total annual gross domestic product [10], and direct health care costs have been estimated to range from 1% in Germany to 12.6% in the US [11], [12]. Thus, while methodological differences in studies, subgroup differences (e.g. higher health care costs in severely obese groups with higher socioeconomic status (SES) [13]), and chances of lower lifetime long-term care costs in obese groups [14], [15] call for differentiated approaches to obesity costs, these costs may be considered substantial [16].

The evidence-based guideline in Germany [17] stresses that general practitioners (GPs) have a key role to play in long-term obesity care. In addition, studies show that primary care physicians do so in preventing overweight as well, as they are easily accessible, monitor changes in health status and weight, and are basically able to consult obese adults on relevant lifestyle factors [18], [19]. Empirically, GP utilisation, like costs, is significantly higher in overweight compared to normal weight adults in Germany [20], [21], [22], [23], [24], [25]. For instance, studies have found that obese adults' odds of contacting a GP are 1.5 times higher than for normal weight adults [21] and that those who are severely obese report nearly

45% more contacts with GPs than normal weight adults due to physical comorbidity [20], [22].

However, these studies were cross-sectional, and both in Germany and internationally, few studies have examined the association between body weight and health care utilisation longitudinally. A recent Danish study examined GP utilisation, hospitalisations and number of bed days as associated with BMI based on an adult survey sample from the 2000 National Health Interview survey combined with Danish register data [19]. The study distinguished between frequent and infrequent users of care and found that obese and, to a lesser extent, preobese infrequent users had substantially increased GP services utilisation at a 5-year follow-up compared to normal weight participants. While this study did not consider *changes* in body weight as a correlate of utilisation, one prospective cohort study, which did analyse the effects of such changes in a population sample of elderly Spanish adults, found no association between higher health care utilisation and weight gain, but did find an association with weight loss in both obese and non-obese subjects of both sexes two years after baseline [26]. However, the Spanish study had only a brief follow-up period, used self-reported rather than measured assessments of weight change, and did not differentiate between moderate and severe obesity. Thus, the results of the study provided no evidence for a higher impact of severe obesity on direct health care costs [27], [28] and, for example, on GP utilisation [20], [29].

Against this background, the present prospective cohort study reports data from a population sample of adults from Germany followed-up over a 7- to 10-year period and stratified into groups by baseline BMI and change in BMI (four weight maintenance in terms of normal weight, preobesity, moderate obesity or severe obesity both at baseline and follow-up, respectively, three weight loss groups in terms of severe obesity at baseline and below at follow-up, moderate obesity at baseline and below at follow-up, or preobesity at baseline and normal weight at follow-up, and three weight gain groups in terms of normal weight at baseline and higher at follow-up, preobesity at baseline and higher at follow-up, or moderate obesity at baseline and severe obesity at follow-up). Focusing on outpatient care obtained from different kinds of physicians, the study aims to elucidate the associations between BMI development and future utilisation of care by adults with normal weight, preobesity, moderate and severe obesity. To account for other variables considered key in theories of health care utilisation [30], [31], se-

lected predisposing (sex and age), enabling (SES) and need factors (physical comorbidities) were adjusted for in statistical modelling.

Methods and procedures

Study population and sampling

The MONICA/KORA (Monitoring of Trends and Determinants in Cardiovascular Disease/Cooperative Health Research in the Region of Augsburg) Surveys S3 (1994/95) and S4 (1999/2001) are population-based health surveys. The participants in each survey were randomly selected from all registered citizens of German nationality aged 25 to 74 years with permanent residence in the region of Augsburg and its two surrounding counties. For S3, a follow-up study F3 was conducted after 10 years, and for S4 after 7 years. Samples of 4,856 participants (S3) and 4,261 participants (S4) participated in the baseline surveys. Of these, 3,006 (F3) and 3,080 (F4) adults also participated in the follow-up studies. For the present analyses, data from both surveys have been combined. Since data on outpatient utilisation were not collected on participants aged 65 years and older in S3, all subjects aged 65 and above at baseline were excluded (n=833). Individuals were also excluded if they had missing data on BMI either at baseline or at follow-up (n=57) or if no information on socioeconomic status (SES) was available (n=9). Also, participants with a BMI ≤18.5 kg/m² either at baseline or at follow-up (n=40) were not included due to small numbers. In sum, from both longitudinal surveys, complete data were available for 5,147 individuals (2,597 from S3/F3; 2,550 from S4/F4). Written informed consent was obtained from all participants, and the studies were approved by the responsible ethics committee (Bavarian Medical Association, Munich).

Measures

Outpatient medical care utilisation

In all surveys, information on age, sex and SES was obtained by professionally trained medical staff during an extensive standardised face-to-face interview [32]. Outpatient utilisation, which was assessed in KORA surveys F3 and F4, referred to visits to GPs, internists, gynaecologists, surgeons, orthopaedists, urologists, otorhinolaryngologists, ophthalmologists, dermatologists, neurologists, psychotherapists, occupational health practitioners and others. In F3, outpatient utilisation was assessed as follows (example for GPs): "How often did you visit a general practitioner in the last 12 months?" In F4, participants were asked: "How often did you visit a general practitioner in the last 3 months?" In order to achieve comparable 1-year time horizons, all F4 utilisation data were extrapolated to 12 months. Since studies show that GPs are the most consulted physicians in Germany (with the exception of gynaecologists by women) and, as noted earlier, GPs

are explicitly mentioned in the German evidence-based obesity guideline [17], physicians were categorized into three physician groups: GPs, internists, and other specialists.

Obesity

In all studies, trained medical staff measured the body weight and height of all participants anthropometrically as part of a standardized medical examination. Calibration of measuring instruments was ensured through weekly or daily inspections using standard weights. BMI was calculated for each participant as weight in kilograms/(height in metres)². In accordance with WHO [1], the following classification was used for the analysis: normal weight: $18.5 \leq BMI < 25$; preobesity: $25 \leq BMI < 30$; moderate obesity (i.e. obesity class 1): $30 \leq BMI < 35$; severe obesity (i.e. obesity classes 2–3): $BMI \geq 35$.

Comorbidities

Incident diabetes and incident first cancer between baseline and follow-up (i.e. S3 and F3 or S4 and F4) were assessed by checking if the values of the follow-up self-report variables *age at diagnosis of diabetes* and *age at diagnosis of first cancer* fell into the time period between the two surveys.

Sociodemographic and socioeconomic factors

Information on sex, age and SES from the follow-up studies (F3 and F4) were used. SES was assessed in structured computer-aided personal interviews conducted by professionally trained medical staff and was defined according the revised version of the SES index proposed by Helmert [33], which is based on scores for educational level, occupational status and income assessed following national recommendations [34]. Five educational levels (including school education and vocational training), nine occupational status groups (ranging from unskilled workers to high ranking managers), and nine income groups (comparing individual with median equivalent household income) are distinguished. Scores for educational level, occupational status and income are summed to provide an overall SES index score. Based on the overall index score, individuals are categorized into one of five SES groups. In the event of missing values for the three scores, if at least one of the scores was available (n=97), missing values for the remaining scores were imputed (based on the information available on educational level, occupational status and income) with a single imputation using the Markov Chain Monte Carlo method in SAS PROC MI to prevent possible systematic loss of data.

Statistical analysis

Characteristics of the baseline BMI groups were compared using analysis of variance (ANOVA) for continuous vari-

Table 1: Sample description by baseline BMI categories

Follow-up (F3/F4)		Baseline (S3/S4)										p-value
		Overall		Normal weight		Preobesity		Moderate obesity		Severe obesity		
		n	(%)[1)	n	(%)[1)	n	(%)[1)	n	(%)[1)	n	(%)[1)	
		5,147	100%	1,913	37.2%	2,249	43.7%	739	14.4%	246	4.8%	
Sex	Men	2,485	48.3%	665	34.8%	1,361	60.5%	381	51.6%	78	31.7%	<.0001
	Women	2,662	51.7%	1,248	65.2%	888	39.5%	358	48.4%	168	68.3%	
SES	1 (low)	874	17.0%	218	11.4%	387	17.2%	187	25.3%	82	33.3%	
	2	1,054	20.5%	341	17.8%	465	20.7%	188	25.4%	60	24.4%	
	3	1,174	22.8%	467	24.4%	499	22.2%	165	22.3%	43	17.5%	<.0001
	4	1,148	22.3%	501	26.2%	480	21.3%	132	16.6%	44	17.9%	
	5 (high)	897	17.4%	386	20.2%	418	18.6%	76	10.3%	17	6.9%	
Age (years)	Mean (SD)	53.7 (11.0)		49.7 (10.4)		55.4 (10.8)		57.7 (10.1)		57.3 (10.4)		<.0001
Incident diabetes	yes	199	3.9%	11	0.6%	78	3.5%	65	8.8%	45	18.3%	<.0001
Incident first cancer	yes	167	3.2%	48	2.5%	76	3.4%	35	4.7%	8	3.3%	0.0341

Normal weight: 18.5≤BMI<25, Preobesity: 25≤BMI<30, Moderate obesity (obesity class 1): 30≤BMI<35, Severe obesity (obesity classes 2–3): BMI≥35; SES: socioeconomic status; SD: standard deviation; Column percentages: per sex, SES, incident diabetes and first cancer.

ables and chi-squared tests for categorical variables. Utilisation of GPs, internists and other specialists were analysed separately. Generalized linear regression analyses were conducted to account for the typically skewed distribution of utilisation data. A negative binomial distribution was chosen since data showed signs of overdispersion. Changes across BMI groups in the same direction were combined, resulting in 10 groups of BMI development: 3 groups of participants who moved to a higher BMI category between baseline and follow-up, 3 groups of participants who moved to a lower category, and 4 groups of participants who remained in the same category. Models were constructed in a hierarchical fashion. Model 1 included age, sex and SES as well as a dummy variable indicating whether the subject participated in the S3/F3 or the S4/F4 study. In Model 2, the BMI development variable was included; incident diabetes and incident cancer were added in the final Model 3. Exponents of the negative binomial regression estimates are reported and can be interpreted as factors (i.e. a covariate with a coefficient of 1.3 is associated with a 30% increase in the number of visits). Analyses were performed using SAS version 9.2. P-values of 0.05 or less were considered statistically significant.

Results

Sample description

Table 1 shows the resulting analysis sample (n=5,147) by BMI categories from the baseline surveys cross-tabulated by sex, age and SES from the follow-up surveys and by incident diabetes and first cancer. Women fell into the normal weight and the severe obesity categories more frequently than men. Higher SES was more frequent in groups with lower vs. higher BMI, and mean age increased with increasing weight category (overall mean age: 53.7 years). The probability of incident diabetes at follow-up increased with BMI (up to 18.3% in the severe obesity group), while incident first cancer was most common among those with moderate obesity (4.7%).

Table 2 shows the number of participants who stayed in the same BMI category and who changed category by gaining or losing weight between baseline and follow-up. While most participants remained in the same BMI category, a total of 1,453 participants had changed categories by follow-up (28.2%). Of these, n=498 who had been normal weight at baseline, n=431 who had been in the preobese group and n=150 who had been moderately obese had gained weight. Thus, 74.3% of "changers" had gained weight. Of the n=374 participants who had lost weight by follow-up, n=220 had been preobese at baseline, n=112 moderately obese, and n=42 severely obese. None of the participants had increased by three BMI categories – that is, no one had gone from normal weight to severe obesity. However, n=2 had lost weight across three categories (i.e. from severe obesity to normal weight).

Associations between BMI development and outpatient health care utilisation

Table 3, Table 4, Table 5 show the hierarchical regression results for the effect of BMI development on the number of visits to GPs, internists, and other physicians in the year before follow-up, respectively. Women and older participants reported significantly more visits to all physician types, with the exception of women's visits to internists. Also, participation in the S4/F4 surveys was associ-

Table 2: Development of weight status from baseline to follow-up

| Follow-up (F3/F4) | Baseline (S3/S4) | | | | | | | | | |
| | Normal weight | | Preobesity | | Moderate obesity | | Severe obesity | | Total | |
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Normal weight	1,415	74.0%	220	9.3%	5	0.7%	2	0.8%	**1,642**	31.9%
Preobesity	480	25.1%	1,598	71.1%	107	14.5%	2	0.8%	**2,187**	42.5%
Moderate obesity	18	0.9%	416	18.5%	477	64.5%	38	15.4%	**949**	18.4%
Severe obesity	0	0.0%	15	0.7%	150	20.3%	204	83.9%	**369**	7.2%
Total	1,913	100.0%	2,249	100.0%	739	100.0%	246	100.0%	5,147	100.0%

Normal weight: 18.5≤BMI<25; Preobesity: 25≤BMI<30; Moderate obesity (obesity class 1): 30≤BMI<35; Severe obesity (obesity classes 2–3): BMI≥35.

Table 3: Impact of BMI development on number of visits to general practitioners (N=5,147)

| Parameter | Model 1 | | Model 2 | | Model 3 | |
	exp(Est)	P>Chi^2	exp(Est)	P>Chi^2	exp(Est)	P>Chi^2
Intercept	**1.53**	0.0083	1.23	0.2130	1.26	0.1548
Sex: female	**1.29**	<.0001	**1.34**	<.0001	**1.36**	<.0001
Age	**1.01**	<.0001	**1.01**	<.0001	**1.01**	<.0001
Survey: S4/F4	**0.80**	<.0001	**0.81**	<.0001	**0.81**	<.0001
SES						
2	0.98	0.8047	0.98	0.8091	0.99	0.9180
3	**0.78**	0.0015	**0.82**	0.0119	**0.83**	0.0148
4	**0.66**	<.0001	**0.71**	<.0001	**0.71**	<.0001
5 (high)	**0.60**	<.0001	**0.66**	<.0001	**0.66**	<.0001
BMI development[a]						
from 2 to 1			**1.44**	0.0033	**1.39**	0.0083
from 3 to 1 or 2			1.30	0.1204	1.29	0.1377
from 4 to 1, 2 or 3			**2.27**	0.0018	**2.14**	0.0037
from 2 to 2			**1.35**	<.0001	**1.34**	<.0001
from 3 to 3			**1.55**	<.0001	**1.48**	<.0001
from 4 to 4			**1.97**	<.0001	**1.83**	<.0001
from 1 to 2, 3 or 4			**1.37**	0.0004	**1.36**	0.0006
from 2 to 3 or 4			**1.44**	0.0001	**1.43**	0.0002
from 3 to 4			**2.08**	<.0001	**2.07**	<.0001
Incident diabetes					**1.48**	0.0017
Incident first cancer					1.25	0.0941
Scale	2.6389	–	2.5836	–	2.5723	–

a) 1: Normal weight (18.5≤BMI<25); 2: Preobesity (25≤BMI<30); 3: Moderate obesity (30≤BMI<35); 4: Severe obesity (BMI≥35).

Reference groups: sex "male", SES "low" (group 1), survey "S3/F3", BMI change "from 1 to 1" (remaining in the normal weight group)

ated with lower utilisation. As for SES, the only significant effects observed involved GP utilisation. Participants in higher SES categories visited GPs less frequently than those in lower categories. Neither the addition of BMI development to Model 2 nor of incident diabetes and first cancer to Model 3 substantially changed the estimates of the effects of these predictors.

Regarding the impact of BMI development on GP utilisation, Model 2, which did not control for physical comorbidities, showed that participants who remained in the same overweight category (preobesity, moderate obesity, severe obesity) reported significantly more visits to GPs than those who maintained a normal weight. Those staying in the preobesity group reported 35% more, in the moderate obesity group 55% more and in the severe obesity group 97% more (see Table 3). Among those who had gained weight and switched to a higher BMI category, those in the normal weight range at baseline reported 37% more visits than the group who had maintained normal weight. Those who were preobese at baseline had 44% more and those who were moderately obese had 108% more visits than those remaining at a normal weight. Finally, those who lost weight after being in the preobesity group at baseline had a 44% higher utilisation rate; those originally in the moderate obesity group had 30% more visits (the only insignificant effect) and those in the severe obesity group had 127% more. This pattern of estimates did not change substantially in Model 3 after adding incident

Table 4: Impact of BMI development on number of visits to internists (N=5,147)

Parameter	Model 1 exp(Est)	Model 1 P>Chi²	Model 2 exp(Est)	Model 2 P>Chi²	Model 3 exp(Est)	Model 3 P>Chi²
Intercept	**0.09**	<.0001	**0.09**	<.0001	**0.10**	<.0001
Sex: female	1.15	0.1604	1.13	0.2211	1.17	0.1174
Age	**1.05**	<.0001	**1.04**	<.0001	**1.04**	<.0001
Survey: S4/F4	**0.57**	<.0001	**0.60**	<.0001	**0.59**	<.0001
SES						
2	1.16	0.3318	1.10	0.5279	1.09	0.5789
3	0.95	0.7394	0.95	0.7337	0.96	0.8158
4	1.02	0.9023	1.12	0.4549	1.11	0.5069
5 (high)	1.14	0.4479	1.23	0.2212	1.23	0.2296
BMI development[a]						
from 2 to 1			1.03	0.9048	0.99	0.9588
from 3 to 1 or 2			**1.93**	0.0431	1.79	0.0724
from 4 to 1, 2 or 3			0.55	0.2816	0.54	0.2658
from 2 to 2			0.99	0.9510	0.97	0.8484
from 3 to 3			**2.34**	<.0001	**2.07**	<.0001
from 4 to 4			**1.78**	0.0231	1.61	0.0639
from 1 to 2, 3 or 4			0.87	0.4401	0.85	0.3787
from 2 to 3 or 4			1.32	0.1389	1.31	0.1544
from 3 to 4			**1.93**	0.0235	**1.91**	0.0255
Incident diabetes					1.43	0.1443
Incident first cancer					**2.15**	0.0033
Scale	10.5337	−	10.1838	−	10.0910	−

a) 1: Normal weight (18.5≤BMI<25); 2: Preobesity (25≤BMI<30); 3: Moderate obesity (30≤BMI<35); 4: Severe obesity (BMI≥35).

Reference groups: sex "male", SES "low" (group 1), survey "S3/F3", BMI change "from 1 to 1" (remaining in the normal weight group)

Table 5: Impact of BMI development on number of visits to other physicians (N=5,147)

Parameter	Model 1 exp(Est)	Model 1 P>Chi²	Model 2 exp(Est)	Model 2 P>Chi²	Model 3 exp(Est)	Model 3 P>Chi²
Intercept	**1.45**	0.0281	1.34	0.0857	**1.41**	0.0455
Sex: female	**1.45**	<.0001	**1.47**	<.0001	**1.51**	<.0001
Age	**1.01**	<.0001	**1.01**	<.0001	**1.01**	.0010
Survey: S4/F4	**0.74**	<.0001	**0.74**	<.0001	**0.76**	<.0001
SES						
2	1.07	0.4141	1.06	0.4973	1.06	0.4457
3	1.12	0.1616	1.14	0.1118	1.13	0.1294
4	1.13	0.1370	1.16	0.0711	1.16	0.0773
5 (high)	0.96	0.6606	1.00	0.9835	0.99	0.9354
BMI development[a]						
from 2 to 1			1.04	0.7370	1.02	0.9107
from 3 to 1 or 2			1.29	0.1522	1.29	0.1452
from 4 to 1, 2 or 3			1.07	0.8101	1.07	0.7891
from 2 to 2			1.08	0.2675	1.09	0.2124
from 3 to 3			1.21	0.0529	1.21	0.0573
from 4 to 4			**1.34**	0.0270	1.29	0.0578
from 1 to 2, 3 or 4			1.20	0.0546	1.20	0.0513
from 2 to 3 or 4			1.07	0.4940	1.03	0.7715
from 3 to 4			**1.41**	0.0268	**1.41**	0.0219
Incident diabetes					1.26	0.0809
Incident first cancer					**2.07**	<.0001
Scale	2.9613	−	2.9499	−	2.9181	−

a) 1: Normal weight (18.5≤BMI<25); 2: Preobesity (25≤BMI<30); 3: Moderate obesity (30≤BMI<35); 4: Severe obesity (BMI≥35).

Reference groups: sex "male", SES "low" (group 1), survey "S3/F3", BMI change "from 1 to 1" (remaining in the normal weight group)

Table 6: Impact of BMI development on number of visits to all physicians (N=5,147)

Parameter	Model 1		Model 2		Model 3	
	exp(Est)	P>Chi^2	exp(Est)	P>Chi^2	exp(Est)	P>Chi^2
Intercept	**2.85**	<.0001	**2.55**	<.0001	**2.67**	<.0001
Sex: female	**1.36**	<.0001	**1.38**	<.0001	**1.41**	<.0001
Age	**1.02**	<.0001	**1.01**	<.0001	**1.01**	<.0001
Survey: S4/F4	**0.75**	<.0001	**0.75**	<.0001	**0.76**	<.0001
SES						
2	1.05	0.4803	1.03	0.5941	1.04	0.5458
3	0.95	0.3964	0.98	0.7799	0.98	0.7630
4	0.91	0.1292	0.96	0.5050	0.95	0.4648
5 (high)	**0.81**	0.0024	0.87	0.0509	0.87	0.0408
BMI development[a]						
from 2 to 1			1.17	0.1173	1.12	0.2696
from 3 to 1 or 2			**1.37**	0.0206	**1.36**	0.0257
from 4 to 1, 2 or 3			1.41	0.1111	1.38	0.1348
from 2 to 2			**1.15**	0.0088	**1.15**	0.0098
from 3 to 3			**1.47**	<.0001	**1.41**	<.0001
from 4 to 4			**1.63**	<.0001	**1.54**	<.0001
from 1 to 2, 3 or 4			**1.22**	0.0073	**1.21**	0.0093
from 2 to 3 or 4			**1.21**	0.0123	**1.19**	0.0262
from 3 to 4			**1.68**	<.0001	**1.68**	<.0001
Incident diabetes					**1.39**	0.0011
Incident first cancer					**1.81**	<.0001
Scale	1.8235	–	1.8005	–	1.7804	–

a) 1: Normal weight (18.5≤BMI<25); 2: Preobesity (25≤BMI<30); 3: Moderate obesity (30≤BMI<35); 4: Severe obesity (BMI≥35).

Reference groups: sex "male", SES "low" (group 1), survey "S3/F3", BMI change "from 1 to 1" (remaining in the normal weight group)

diabetes and first cancer as covariates, even though estimates were numerically reduced and those who developed diabetes between baseline and follow-up had significantly more visits to GPs than those who did not (48%).

Turning to internist utilisation, among the groups that remained in the same weight category at follow-up, only the two obese groups reported more visits than those maintaining normal weight (134% more for the moderately obese and 78% more for the severely obese). Moderately obese participants who had changed their weight category showed a significantly higher number of visits regardless of the direction of this change (93%). When taking comorbidities into account in Model 3, incident first cancer significantly increased internist utilisation by 115%, and the effects of both losing weight among those with moderate obesity at baseline and of staying severely obese were no longer statistically significant.

Regarding other physicians, only participants gaining weight after being moderately obese at baseline and participants staying severely obese reported significantly more visits (41% and 34%, respectively) than those who stayed within normal weight range. Again, incident first cancer predicted higher utilisation in Model 3 (107%), and its inclusion led to a change towards statistical insignificance of the effect of having stayed severely obese (now 29% more visits than staying at normal weight). As shown in Table 6, if visits to GPs, internists and other physicians are combined, all BMI development groups

– except those with preobesity or severe obesity – who had lost weight showed significantly higher utilisation than those having stayed in the normal weight range, and both incident diabetes and first cancer predicted more visits (39% and 81%, respectively). Also, while both female sex and age were associated with higher utilisation, high SES was associated with fewer visits. Figure 1, Figure 2, Figure 3, Figure 4 show group-specific means and confidence intervals for the utilisation of GPs, internists, other physicians and all physicians.

Discussion

The present study aimed to investigate possible associations between maintenance vs. change in body weight and subsequent outpatient health care utilisation in terms of number of visits to physicians. GP utilisation by participants who stayed in the same BMI category increased linearly with BMI category. Consistent with previous cross-sectional studies [23], [24], [25], [27], while among those who moved to a higher category, all overweight groups reported more GP visits than those who had maintained a normal weight (especially those who had been moderately obese), among those who lost weight, those who had been preobese and especially those who had been severely obese at baseline reported higher utilisation. Internist utilisation was highest among the moderately obese at baseline. After inclusion of incident diabetes
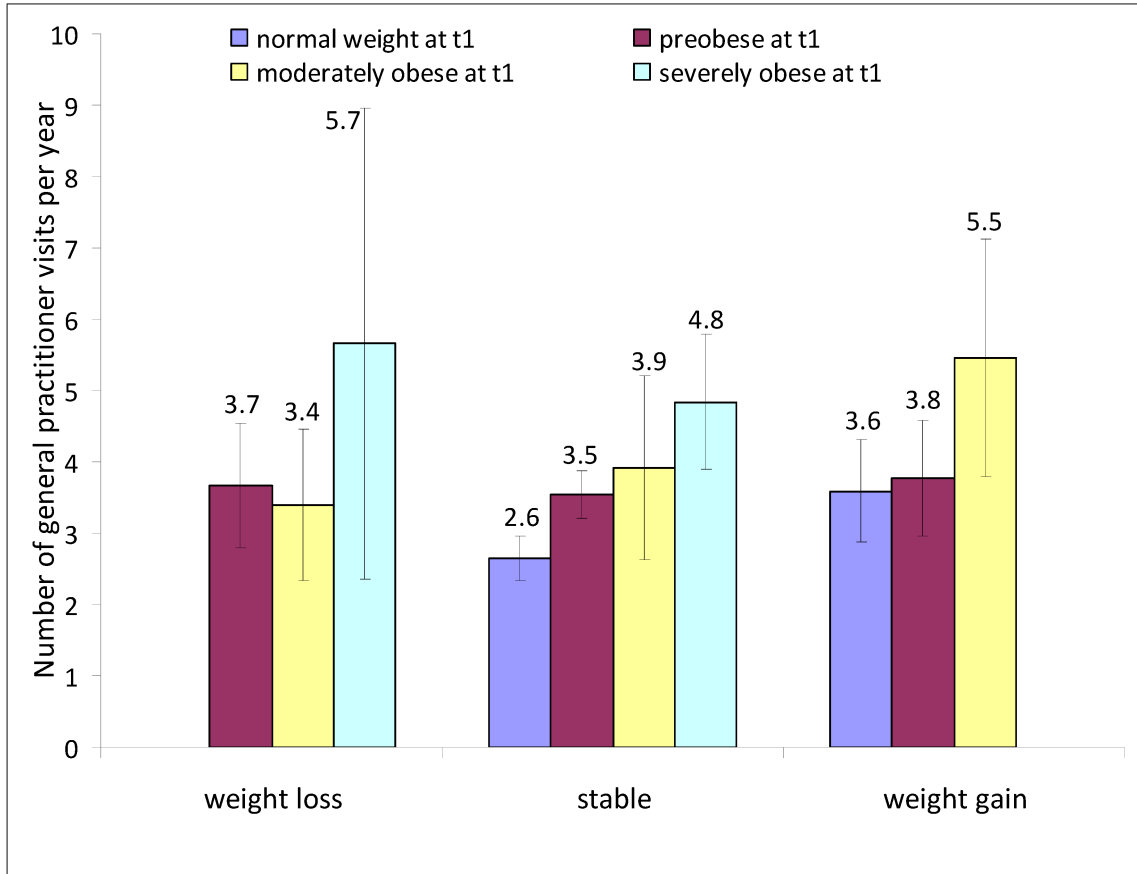
Figure 1: Adjusted mean outpatient utilisation of GPs by BMI development (with 95%-confidence intervals)
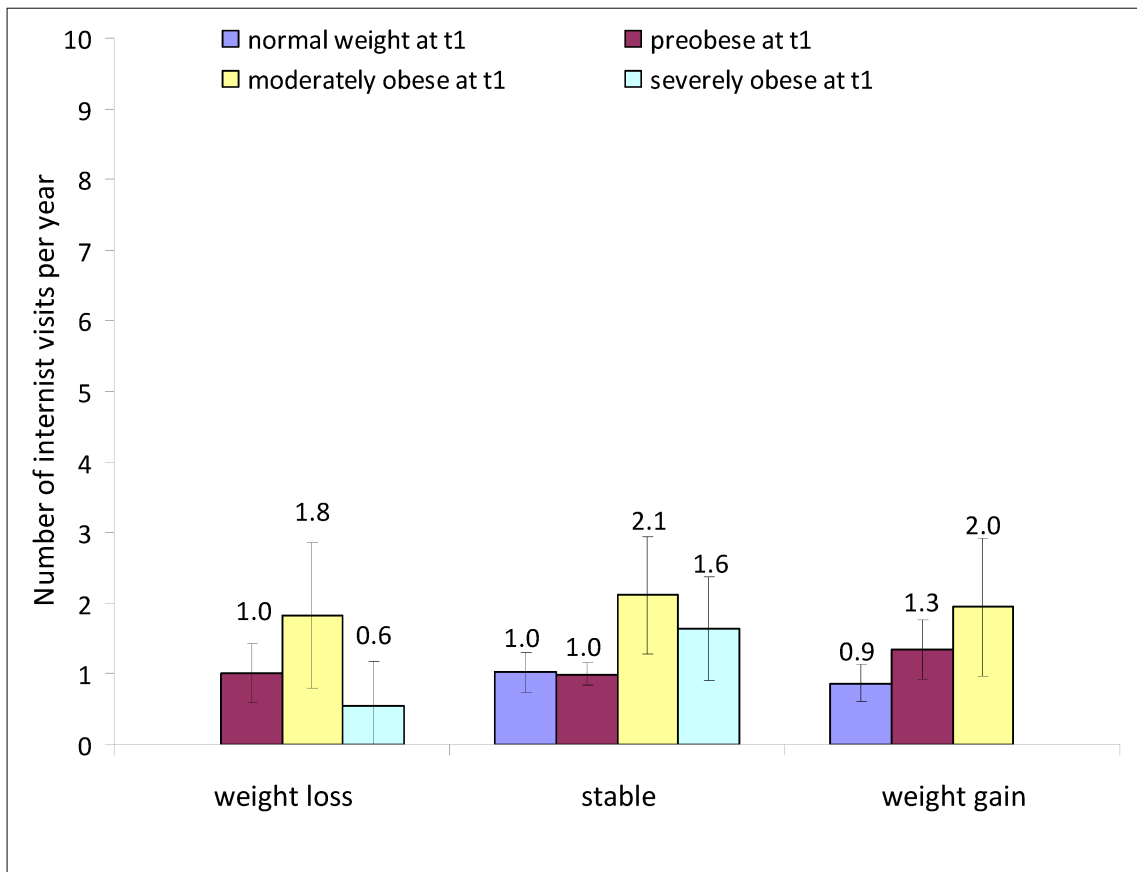

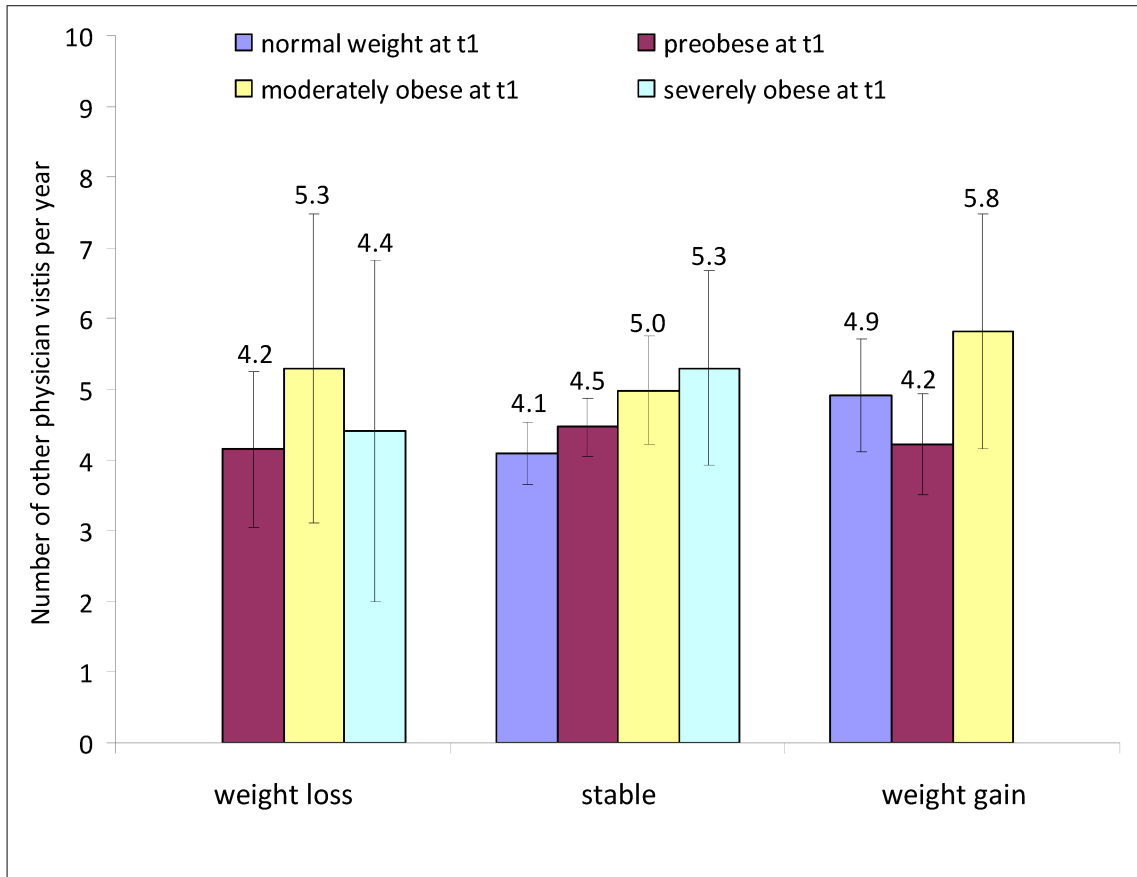**Figure 2: Adjusted mean utilisation of internists by BMI development (with 95%-confidence intervals)**

Figure 3: Adjusted mean utilisation of other physicians by BMI development (with 95%-confidence intervals)
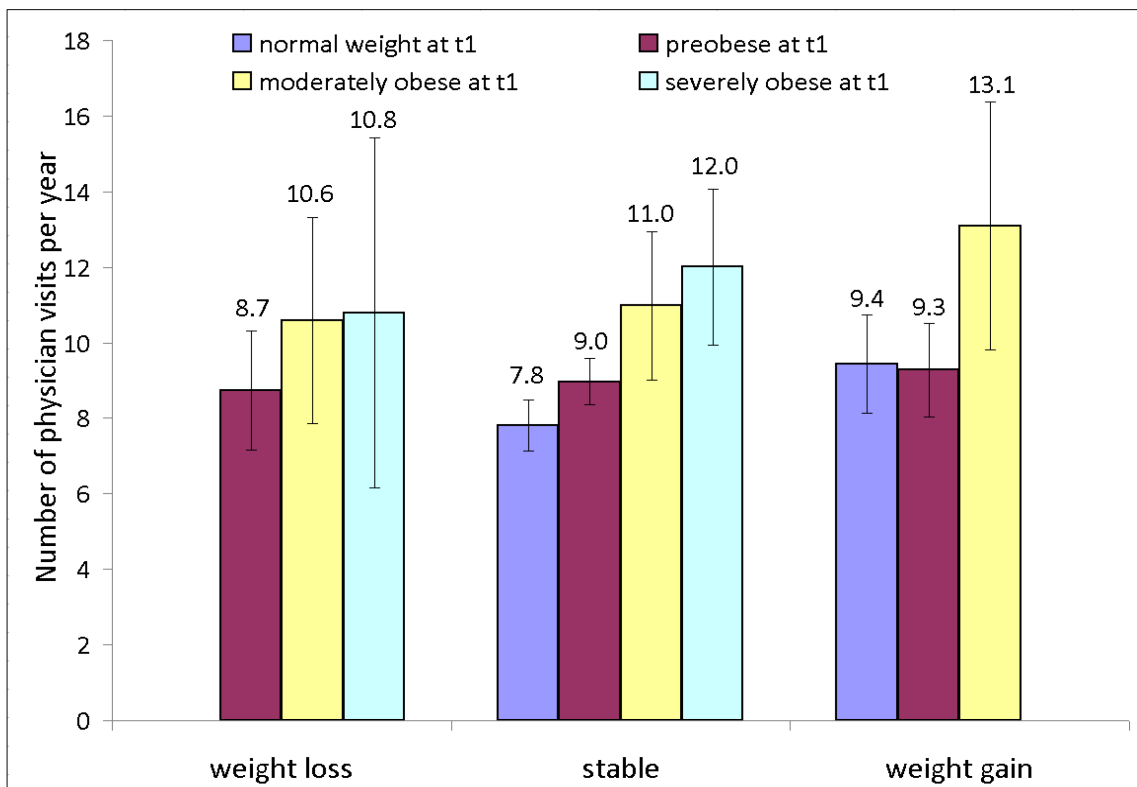

Figure 4: Adjusted mean utilisation of all physicians by BMI development (with 95%-confidence intervals)

and first cancer in the model, those in this group who had either maintained their weight or gained weight by follow-up reported significantly more visits than those who stayed in the normal weight group. Concerning other physicians, only participants that switched from the moderate to severe obesity group reported significantly more visits than those who had stayed in the normal weight group. When summing up utilisation for all physicians, all BMI groups except the preobese and severely obese who lost weight showed increased utilisation.

Several study limitations should be taken into account. First, it is possible that utilisation is underestimated in the present analysis since both baseline and follow-up survey non-response may be associated with higher burdens of morbidity. For instance, a non-response analysis comparing participants in the S4 survey and 49% of its non-responders showed that non-responders more often had a lower level of education (German *Hauptschule*, i.e. low academic level secondary school: 65% vs. 54%) and fair or poor self-rated health (28% vs. 21%), were more often unmarried (34% vs. 29%) and smokers (29% vs. 26%), and more frequently reported physician visits in the last four weeks (46% vs. 38%), myocardial infarction (6% vs. 3%) and diabetes (7% vs. 4%). It is possible that similar patterns may be found for the 3,031 baseline participants who dropped out of the follow-up surveys in the present analysis. For example, among baseline participants aged 64 or less (n=7,296), 37.3% fell into the normal weight range, 42.3% were preobese, 15.2% were moderately obese, and 5.3% were severely obese. At follow-up drop-out was slightly higher among moderately and severely obese groups (14.4% and 4.8%) than among those in the normal weight group. In addition, caution should also be taken when interpreting the effects of changes from normal weight to moderate or severe obesity, preobesity to severe obesity, moderate obesity to normal weight, and severe obesity to preobesity or normal weight due to subsample sizes of 20 participants or less.

Second, the present surveys are restricted to participants of German nationality. Since studies have repeatedly shown that obesity is more prevalent in migrant populations [35], the results cannot be extrapolated to the total resident population of Germany without further assumptions.

Third, utilisation data in follow-up surveys F3 and F4 were assessed retrospectively over time horizons of 12 and 3 months, respectively. Thus, inaccuracies in the self-reported data cannot be excluded. On one hand, the validity of recalls of physician visits over a time period as long as 12 months is uncertain and may render underestimations. On the other hand, the 3-months F4 data were extrapolated to 12 months. Again, underestimation is possible since a response of "no utilisation" was coded as zero for one year even if, e.g. a participant had visited a physician four months ago. This may also explain the significant effects of the study sample in terms of lower outpatient utilisation in F4 compared to F3. On the other hand, if someone had 10 physician visits in the last three

months due to acute illness, this was extrapolated as 40 visits in the year preceding the survey, in which case overestimation cannot be excluded. However, there are no indications that these limitations have biased utilisation differentials between the groups defined by maintenance of or changes in BMI category. Also, the 3-months time-slot in F4 did not refer to one and the same time of the year for all participants of the survey since it was conducted over a time period of 18 months.

Fourth, utilisation was assessed for the year before follow-up only, i.e. a single time period, implying that no changes in utilisation from baseline to follow-up could be modelled and tested for their association with changes in body weight. Thus, utilisation habits – especially those with regards to GP utilisation – which may be only partially related to need factors could not be controlled for. However, we did control for proxy variables for such habits (i.e. sex, age and SES), suggesting that the effects found for the BMI development variable may be attributed specifically to it and possible alternative explanations (i.e. confounding factors), such as aging leading to both weight gain and to higher utilisation, may be ruled out.

Fifth, the present analysis did not adjust for health-related behaviours such as smoking, alcohol consumption, physical activity and diet/nutrition. The rationale for this restriction was twofold. On one hand, such behaviours are antecedents of BMI development, and thus rather more distal than proximal factors in the hypothetical causal chain of behaviours leading to ill-health leading to health care utilization. On the other hand, to account for these factors in a way parallel to that regarding BMI, developments in smoking, alcohol consumption, physical activity and diet/nutrition would have to be modelled, which would have implied an analytical complexity going beyond the present examination. Sixth, incident diseases other than diabetes and first cancer (e.g. gastrointestinal disorders) were not accounted for. However, it is planned to scrutinize the role of a wider range of physical (co-)morbidities using the Physical Functional Comorbidity Index (PFCI) [21], which however is not available for the S3/F3 and S4/F4 longitudinal cohorts as yet.

Lastly, in January 2004, a German health care reform introduced a €10 charge for the first outpatient visit to a physician in each quarter for all adults covered by statutory health insurance. One analysis concerning differences by SES has demonstrated that avoiding a physician visit due to these charges is comparatively common among low income groups [36]. Since utilisation data for the present study had been collected in 2004/05 (F3) and 2006/08 (F4) after the introduction of the €10 fee, it is possible for these charges to have had some impact on participants' visits to physicians, at least at the beginning of the observation period. However, contrary to expectations and public opinion, the effects of this new copayment on decisions to visit physicians have been shown to be rather limited [37], [38], so potential bias should be minor and may not have affected the differences between BMI development subgroups. It should also be noted that this study did not analyse the reasons

for utilisation, and did not focus on the referral system from general practitioners to medical specialists (as one specificity of the German health care system).

Despite these limitations, the findings of this study are largely consistent with the results of previous analyses on associations between predisposing and enabling factors, such as sex, age and SES, and outpatient utilisation. Women had more visits to GPs and "other physicians" than men, which may be explained by the finding that communication and shared decision making are more common between GPs and female patients [39]. Also, similar to the findings of [40], significantly more GP visits were reported by lower SES groups in this study. Interestingly, none of the significant age effects found in the regression analyses were considerably changed by inclusion of BMI development or incident comorbidity into the models, probably reflecting the fact that these selected health conditions are only part of the age-related morbidity spectrum in the German population. At the same time, future studies (optimally with larger samples) should further examine the association between age and utilization for different BMI- and body weight development groups using appropriate indicators (contrast variables). The present study also found that compared to participants who were not overweight at baseline and follow-up, those who went from being moderately obese (baseline) to severely obese (follow-up) showed the most consistent excess utilisation rates across all types of physicians, which was not explained by incident diabetes or first cancer. This finding could suggest that preventing weight gain in already obese groups may potentially prevent comorbidities as well. Those remaining moderately obese tended to visit internists comparatively often, as did those who lost weight after moderate obesity, an effect which became insigificant after inclusion of incident first cancer. Incident first cancer also affected excess utilisation of non-GPs among those with stable severe obesity (again, the latter effect was insignificant after inclusion of this comorbidity). Participants that lost weight after baseline severe obesity were the group with the highest GP utilisation rate, which only partially changed after inclusion of incident diabetes. Future research should examine the needs of this specific subgroup, especially since this group did not report excess utilisation of other physicians and reported fewer (though insignificantly fewer) visits to internists. It is also unclear whether these patterns reflect high utilisation of other health care services (e.g. inpatient health care services) and/or health gains associated with this weight loss.

Conclusion

Compared to normal weight maintenance over a 7- to 10-year period, maintained overweight, weight gain and weight loss were associated with higher outpatient physician utilisation in adults, especially after baseline obesity. These effects only partly became insignificant after inclusion of incident diabetes or first cancer into the model.

Future research should further elucidate the associations between weight gain, loss and maintenance and health care utilisation by BMI status. Such information could be important for the identification of risk groups and the development of effective prevention measures aimed at reducing the burden and costs of illness associated with overweight. Lastly, this analysis of body weight development as a determinant of health care utilisation stresses the importance of considering predisposing, enabling and need factors when attempting to identify patterns of factors driving overweight-associated utilisation and their relative importance. At the same time, future research should expand on this analysis to include contextual factors, i.e. attributes of people's environments [30], [31].

Notes

Competing interests

Acknowledgements

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