

Dietary Intake and Physical Activity in Patients After Invasive Treatment of Hemorrhoidal Disease

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Abstract

Background

Although lifestyle modifications are an integral part of treatment and prevention of hemorrhoidal disease, it is largely unknown how lifestyle factors like diet and physical activity are characterized in patients with a history of advanced and invasively treated hemorrhoidal disease.

Methods

In a Northern German cross-sectional study, clinical characteristics and dietary and physical activity data of 386 patients were assessed via questionnaires at median 10 years after their first invasive hemorrhoidal treatment. Food and nutrient intake and physical activity levels of the hemorrhoid patients were compared with general population controls. Additionally, within the hemorrhoid patient cohort, dietary intake and physical activity were related to clinical characteristics using logistic regression analyses.

results

Whereas in men, there were no statistically significant differences in food intake between hemorrhoids patients and controls, women with a history of hemorrhoids had a significantly higher consumption of potatoes, nuts and animal fat, and a lower consumption of fruits, compared to women from the control group. Hemorrhoid patients reported slightly more gardening activities and less TV watching than controls. Within the hemorrhoid patient cohort, hemorrhoid grade, type of first therapy, need for further treatment, patients' compliance for another surgery if necessary and current anal afflictions revealed individual associations with fiber, alcohol, animal fat and potato consumption and the amounts of home repair activities and sleeping time.

Conclusions

Although we could identify some statistically significant differences in dietary and physical activity behavior between hemorrhoid patients and controls and observed associations between clinical characteristics and lifestyle factors, some findings are, in parts, still inconsistent. Whether patients are following lifestyle recommendations as part of conservative hemorrhoid treatment and tertiary prevention and which patients are more adherent than others (e.g., high-grade vs. low-grade) needs further investigation.

Introduction

Internal hemorrhoids become a disease when the physiological anorectal vascular cushion above the dentate-line enlarges, slides and causes anal symptoms like painless bleeding, itching and fecal soiling (1-3). An epidemiologic study from 1990 reported a prevalence rate of 4.4% for symptomatic hemorrhoids in western society (4,5). In the United States in 2004, hemorrhoids were associated with 3.2 million

ambulatory care visits, 306.000 hospitalizations and 2 million prescriptions of medications (5). In Germany about 50.000 inpatient hemorrhoidectomies are performed annually (6). Reliable prevalence data are lacking due to a high number of unreported cases. Many patients feel ashamed and, therefore, avoid talking about anal problems.

The exact pathophysiology of hemorrhoidal disease development is poorly understood. Possible contributing factors have been suggested, including lack of dietary fiber, excess defecation time, constipation, diarrhea, pregnancy, sedentary lifestyle, pelvic floor dysfunction and a positive family history (7-10). Different grades of the disease can be specified based on the extent of a possible prolapse and reduction of the hemorrhoids. Grade I hemorrhoids prolapse only into the proctoscop, grade II hemorrhoids prolapse beyond the anal verge but reduce spontaneously, grade III hemorrhoids can only be replaced by manipulation after prolapse beyond the anal verge and grade IV hemorrhoids cannot be replaced and prolapse all the time (Goligher's classification) (11). Outclinic procedures can be appropriate for treating grade I-II hemorrhoids. These include rubber band ligation and injection sclerotherapy. Indications for an inpatient surgery are symptomatic hemorrhoids grade III-IV (12-14). Even though the effects of dietary factors and physical activity on the pathogenesis and disease course of hemorrhoidal disease are not yet completely understood, lifestyle modifications are an integral part of the treatment, may prevent complications and improve the surgical outcome or even reduce the recurrence rate in hemorrhoidal disease (15). Not all recommendations are underpinned with scientific evidence like Reducing overweight, a low intake of alcohol, red meat or spicy foods are postulated like avoiding a sedentary lifestyle (2,8). Garg et al, however, provided evidence in their TONE-Study for an effect of stool habit regulation with reduced lavatory sitting and increasing the amount of fiber and fluids in the diet on reducing the burden at all stages of the disease (16-18). Especially fiber supplementation has been shown to decrease severity of symptoms like bleeding, itching and prolapse of hemorrhoids in several studies (19-21)

We are assuming that especially the experience of symptomatic high-grade hemorrhoids and invasive anal procedures lead to modifications of lifestyle in patients in terms of tertiary prevention. However, to our knowledge, studies investigating lifestyle behaviors in hemorrhoidal disease patients are missing, so far. Thus, first, we compared dietary and physical activity habits in a Northern German cohort of patients with a history of advanced and invasively treated hemorrhoidal disease with those of a population-based, age- and sex-matched control cohort and second, we examined these lifestyle values within the cohort of hemorrhoid patients in relation to clinical characteristics.

Methods

Cohort of patients with a history of hemorrhoidal disease

Initiated by the Department of General and Thoracic Surgery and the biobank PopGen (22) from the Medical Faculty of Kiel University, a cohort of patients with symptomatic hemorrhoids and the need of invasive treatment was established, primarily to investigate the genetic underpinning of hemorrhoidal

disease. In brief, between January 2016 and December 2017, individuals with a prior diagnosis of symptomatic and treated hemorrhoids were identified through medical records of 5 hospitals and offices in Northern Germany using the procedural codes for invasive treatment and surgery. Patients that were exclusively treated conservatively were not included in this study as the aim was to recruit patients with a strong phenotype of advanced hemorrhoids. Eligible patients were contacted via mail by their treating physicians and the PopGen biobank. After agreeing to participate, patients received a study set including a questionnaire about clinical and sociodemographic characteristics and a tube set for blood collection. A subset of study participants was asked to fill out an additional questionnaire concerning their dietary behavior (23) and usual physical activity (24). The study protocol was approved by the ethics committee of the Medical Faculty of Kiel University and written informed consent was obtained from all study participants.

A total of 1070 patients agreed to participate in the study and 393 individuals filled out the questionnaire on diet and physical activity. One participant was excluded because he had reported to have been suffering from anorexia nervosa and bulimia for several years, leading to a final analytical sample of 392 individuals for the nutrition-related analyses. For the analyses focusing on physical activity, an additional six patients had to be excluded due to missing information on some physical activities, thus, leading to an analytical sample size of 386 study participants.

Control cohort

Dietary behavior and physical activity of the hemorrhoid patients were compared to a reference (control) sample from the biobank PopGen. The study design of this control cohort has been reported in detail elsewhere (25,26). Briefly, the PopGen control cohort is a prospective cohort study that recruited individuals from the general population by random selection through local population registries and comprised a baseline and two follow-up assessments (2005-2018). Besides undergoing physical examinations in the PopGen study center, the study participants were asked to fill in a standardized questionnaire covering a broad range of clinical information, such as medical history, as well as sociodemographic and lifestyle factors. For comparison with the hemorrhoid patient cohort, data from the control cohort's second follow-up (2016-2018) were used because at this examination cycle the same version of the diet and physical activity questionnaire as in the hemorrhoid study was applied (explained in detail below).

In the control cohort, information on hemorrhoids were obtained by questionnaire at the first follow-up which was about 5 years prior to the second follow-up, when the information on diet and physical activity was assessed. A total of 83 individuals from the reference cohort who reported hemorrhoids at first follow-up were excluded from the analyses. Unfortunately, information on hemorrhoids was not obtained at the second follow-up examination.

Controls were matched (1:1) to hemorrhoid patients based on age (using age categories of 5-year-ranges) and sex. For 297 and 288 hemorrhoids patients, appropriately matching controls could be identified and

included for the diet and for the physical activity analyses, respectively.

Assessment of Diet and physical activity

Usual dietary intake was assessed with a standardized and validated semi-quantitative food frequency questionnaire (FFQ) that was developed and analyzed by the Department of Epidemiology at the German Institute of Human Nutrition in Potsdam-Rehbrücke (23). The FFQ measures the consumption frequencies of a list of foods and beverages in given portion sizes during the last 12 months. The frequencies were provided in four to eleven options ranging from 'never' and 'once a day' to 'eleven times a day or more frequently'. The quantities were quoted as portions, grams, slices, spoons, or milliliters. Out of all FFQ data, intakes in grams per day for each food or food group, daily total energy intake and nutrient content were computed for each participant.

An additional validated questionnaire assessing usual physical activities during the last 12 months was applied (24). Responding to these questions, participants stated the average hours per week that they spent with different activities, including walking, cycling, sports, and gardening, each separately for summer and winter. Weekly hours of housework (e.g. washing, cleaning, cooking) and home repair (do-it-yourself work), as well as stair climbing defined as number of floors per day were enquired non-seasonally. In addition, hours of sleeping at night and at day, respectively, and hours per week spent watching TV were enquired for summer and winter times. To consider different intensities of different activity types, corresponding metabolic equivalent of task (MET) values (27), in accordance to the 2000 compendium of Physical Activity (28), were multiplied with the number of hours per week of each activity (mean number of hours from summer and winter activities, where applicable). One MET is defined as energy expenditure for sitting quietly (resting metabolic rate); and MET-values are the ratio of the metabolic rate for a specific activity divided by the resting metabolic rate (28). The applied MET-values were 3.0 for walking, 6.0 for cycling, 6.0 for sports, 4.0 for gardening, 3.0 for housework, 4.5 for home repair, and 8.0 for stair climbing (27,28). Summing up the MET-hours of walking, cycling, sports, gardening, housework, home repair, and stair climbing resulted in MET-hours per week of total physical activity.

Assessment of clinical and sociodemographic data

Most clinical and sociodemographic characteristics (age, sex, age at hemorrhoid diagnosis, body weight and height, pregnancy, grade of hemorrhoids, hemorrhoid therapy, current affliction, fecal incontinence) were self-reported by the study participants through filling in the general questionnaire. In a subgroup of 294 hemorrhoid patients, information on the grade of hemorrhoids was also available from clinical records so that for these patients, the physician-reported degree of hemorrhoids was used for analyses, whereas for all other patients self-reported data were taken into account. Out of the standardized questions regarding fecal incontinence, the Cleveland Clinic Fecal Incontinence Score/Wexner (CCFIS)

was determined with a higher CCFIS (range 0-20) indicating a higher grade of incontinence (29). Body Mass Index (BMI) was defined as weight in kilograms divided by height in meters squared.

Statistical analyses

First, characteristics of the total cohort of hemorrhoid patients and of the matched hemorrhoid patient and control cohorts were determined, respectively.

Second, average intakes of nutrients, foods, and food groups, separately for men and women, as well as average amounts of physical activities were calculated as median and interquartile range (IQR) for the matched hemorrhoid and control cohorts. Differences in food consumption and physical activities between hemorrhoid patients and controls were tested for statistical significance with the Wilcoxon ranksum test.

Third, within the patient cohort with a history of hemorrhoidal disease, defined clinical characteristics were related to dietary intake and physical activity. Specifically, logistic regression analyses were applied to estimate the associations of hemorrhoid severity (grade 2-4 or unknown grade vs. grade 1), type of first hemorrhoid treatment (surgery vs. rubber band ligation/sclerotherapy), necessity of further treatment after hemorrhoid surgery (yes vs. no), willingness to undergo further hemorrhoid surgery if necessary (no vs. yes), current affliction at the anus (yes vs. no), and the CCFIS for fecal incontinence (6-10 or 11-15 or 16-20 vs. 0-5) with food intake and physical activity. The intake of selected nutrients, foods or food groups and the different physical activities were modeled as above vs. below the cohort-specific median (binary outcome) for these analyses. To control for confounding, all logistic regression analyses were adjusted for age, sex, and BMI. Dietary analyses were additionally adjusted for total energy intake.

The statistical analyses were conducted using SAS version 9.4 software (SAS Institute, Inc., NC, USA). Two-sided p values of < 0.05 were considered statistically significant.

Results

Characteristics of cohorts

The overall cohort of patients with a history of hemorrhoidal disease included a similar proportion of men and women and had a median age of 58 years at data assessment. Clinical, anthropometric and lifestyle characteristics of the sample are provided in **Table 1** and **Table 2**. Diet and physical activity were assessed on average 10 years (IQR: 4 to 17) after the first diagnosis of hemorrhoidal disease.

The vast majority in our samples had a history of hemorrhoids of second or third degree and about 75% of the patients required a surgical treatment. About one quarter (70 out of 293) of those required a follow-up treatment, after the initial surgery, including 56 patients with a second surgery (**Table 1**). At the timepoint of data assessment, in median 10 years after first diagnosis of hemorrhoids, half of the

patients were still experiencing anal afflictions but most patients were not reporting a fecal incontinence (85% CCFIS 0-5). Eighty-eight percent of the patients stated that they would repeat a surgical procedure if necessary (**Table 1**).

Table 1
Clinical Characteristics of the overall cohort of patients with hemorrhoidal disease

	<i>Overall cohort of patients with a history of hemorrhoidal disease</i>
	n = 392
<i>Gender</i>	
<i>Men</i>	198 (51)
<i>Women</i>	194 (49)
<i>Age</i>	58 (51-66)
<i>Age at diagnosis of hemorrhoidal disease</i>	46 (38-54)
<i>Time since diagnosis of hemorrhoidal disease (years)</i>	10 (4-17)
<i>Degree of hemorrhoids</i>	
1	24 (6)
2	141 (36)
3	145 (37)
4	14 (4)
unknown	68 (17)
<i>Type of hemorrhoid treatment (combinations possible)</i>	
Rubber band ligation	144 (37)
Sclerotherapy	70 (18)
Surgery	293 (75)
<i>Further hemorrhoid treatment after preceding surgery¹</i>	
<i>Yes</i>	70 (24)
<i>No</i>	212 (72)
<i>Unknown</i>	11 (4)
<i>Type of further hemorrhoid treatment (after preceding surgery; combinations possible)¹</i>	
Rubber band ligation	38 (36)
Sclerotherapy	13 (12)
Surgery	56 (52)
	247 (84)

<i>Willingness to undergo a further surgery if necessary</i> ¹	31 (11)
Yes	15 (5)
No	
Unknown	
<i>Current affliction at the anus</i> ²	201 (51)
Yes	179 (46)
No	12 (3)
Unknown	
<i>CCFIS</i> ²	322 (85)
No FI (0-5)	41 (11)
Mild FI (6-10)	12 (3)
Moderate FI (11-15)	5 (1)
Severe FI (16-20)	

CCFIS, Cleveland Clinic Fecal Incontinence Score/Wexner; FI, fecal incontinence; Values are absolute (relative) numbers or median (interquartile range).¹Numbers are related to patients with a prior hemorrhoids surgery (n = 293); ²n = 380.

Some key characteristics of the hemorrhoid patients with adequately matched controls for the dietary and physical activity comparison analyses are provided in **Table 2**. Interestingly, the controls had a slightly higher BMI, and a greater energy intake as compared to the patients with a history of hemorrhoidal disease. But they were also slightly more physically active (**Table 2**).

Table 2

Key Characteristics of the overall cohort of patients with a history of hemorrhoidal disease and of the matched cohorts

	<i>Overall cohort of hemorrhoid patients</i>	<i>Matched cohorts</i>	
		Hemorrhoid patients	Controls
	n = 392	n = 297	n = 297
<i>Gender</i>			
Men	198 (51)	166 (56)	166 (56)
Women	194 (49)	131 (44)	131 (44)
<i>Age</i>			
	58 (51-66)	61 (54-68)	61 (54-68)
<i>BMI (kg/m²)</i>			
	25.2 (23.2-28.1)	25.2 (23.3-27.8)	26.7 (23.8-29.7)
<i>BMI Class (kg/m²)</i>			
<25	189 (48)	142 (48)	105 (35)
25-29	136 (35)	107 (36)	127 (43)
≥30	67 (17)	48 (16)	65 (22)
<i>Energy intake (kcal/day)</i>			
Men	2469 (2039-2904)	2430 (1993-2878)	2512 (2072-3039)
Women	1779 (1476-2199)	1794 (1520-2211)	1849 (1510-2217)
<i>Total physical activity (MET-hours/week)¹</i>			
	74 (53-100)	75 (55-100)	78 (53-106)

BMI, Body Mass Index; MET, metabolic equivalent of task. Values are absolute (relative) numbers or median (interquartile range).¹n=386 in the total cohort of hemorrhoid patients and n=288 in the matched cohorts, respectively.

Diet and physical activity in Patients with a history of hemorrhoids and in age- and sex-matched controls

In males, there were no statistically significant differences in the average intake of nutrients, foods and food groups between patients with a history of hemorrhoids and controls. In women, we observed that those with a history of hemorrhoids had a statistically significantly higher consumption of potatoes, nuts

and animal fat and a lower consumption of fruits, as compared to women from the control group (**Table 3**).

Table 3

Median intake of nutrients, foods and food groups, separately for men and women, in patients with a History of hemorrhoidal disease and in age- and sex-matched controls (n=297, respectively)

<i>Food/food group</i>	<i>Men</i>		<i>p value¹</i>	<i>Women</i>		<i>p value¹</i>
	<i>Patients</i>	<i>Controls</i>		<i>Patients</i>	<i>Controls</i>	
<i>Cohort</i>	<i>Patients</i>	<i>Controls</i>		<i>Patients</i>	<i>Controls</i>	
	n = 166	n = 166		n = 131	n = 131	
<i>Total cereals</i>	188 (137-2929)	200 (143-292)	0.30	134 (102-199)	127 (100-203)	0.26
<i>Potatoes</i>	75 (51-122)	74 (51-100)	0.21	67 (34-85)	45 (26-85)	0.05
<i>Total vegetables</i>	107 (82-139)	111 (92-143)	0.06	107 (84-139)	109 (88-143)	0.24
<i>Fruits</i>	115 (69-164)	118 (74-177)	0.15	136 (96-195)	154 (102-239)	0.049
<i>Total fiber</i>	21 (17-27)	22 (17-28)	0.23	18 (14-22)	17 (14-22)	0.46
<i>Nuts</i>	2 (1-5)	2 (1-5)	0.15	3 (1-8)	2 (1-3)	0.02
<i>Total dairy products</i>	211 (146-308)	219 (144-368)	0.24	201 (121-294)	188 (135-297)	0.40
<i>Total meat</i>	141 (90-202)	141 (98-214)	0.21	74 (46-115)	82 (45-121)	0.26
<i>Processed meat</i>	72 (45-88)	73 (51-102)	0.06	41 (20-43)	33 (22-55)	0.18
<i>Fish</i>	19 (14-37)	19 (14-37)	0.39	13 (4-28)	12 (4-28)	0.30
<i>Animal fat</i>	16 (5-21)	10 (4-19)	0.06	9 (3-11)	6 (2-10)	0.045
<i>Savory snacks</i>	4 (1-9)	4 (1-9)	0.06	2 (0-6)	2 (0-6)	0.39
<i>Sugar and confectionery</i>	46 (26-79)	49 (29-74)	0.46	28 (17-54)	33 (21-56)	0.13
<i>Water</i>	900 (300-1500)	700 (300-1100)	0.10	1100 (700-1500)	1100 (700-1500)	0.21
<i>Tea</i>	55 (12-227)	34 (5-223)	0.10	119 (25-450)	208 (43-450)	0.41
<i>Coffee</i>	367 (177-525)	227 (177-525)	0.36	225 (177-416)	213 (177-413)	0.11
<i>Soft drinks</i>	5 (0-57)	7 (0-57)	0.44	3 (0-16)	3 (0-16)	0.32
<i>Alcohol (ethanol)</i>	9 (3-20)	10 (4-26)	0.12	8 (2-16)	7 (2-16)	0.41

Values are median (IQR) in g/day or ml/day.¹p value for difference in distribution of food and nutrient intake between hemorrhoid patients and controls, separately for men and women; calculated with the Wilcoxon ranksum test.

Regarding physical activity levels, hemorrhoid patients reported statistically significantly more gardening activities and less TV watching time as compared to matched controls (**Table 4**).

Table 4
Median amounts of physical activities in patients with a History of hemorrhoidal Disease and in age- and sex-matched controls (n=288, respectively)

<i>Matched cohorts</i>			
	Hemorrhoid patients	Controls	p value ¹
	n = 288	n = 288	
<i>Total physical activity</i> ²	75 (66-100)	78 (53-106)	0.20
<i>Walking</i> ²	12 (6-21)	14 (7-24)	0.09
<i>Cycling</i> ²	9 (0-19)	9 (0-24)	0.09
<i>Sports</i> ²	12 (0-24)	12 (0-24)	0.43
<i>Gardening</i> ²	8 (2-14)	6 (0-13)	0.02
<i>Home repair</i> ²	5 (0-9)	5 (0-9)	0.09
<i>Housework</i> ²	14 (6-30)	15 (6-30)	0.44
<i>Stair climbing</i> ²	0.5 (0.3-1.6)	0.5 (0.3-1.6)	0.46
<i>Sleeping at day</i> ³	0 (0-1)	0 (0-1)	0.13
<i>Sleeping at night</i> ³	7 (6.5-8)	7 (6.5-7.75)	0.26
<i>TV watching</i> ⁴	11 (5-16)	12 (6-19)	0.049

¹Test of significance of differences in value distribution between hemorrhoid patients and their matched controls calculated with Wilcoxon ranksum test.² Values are medians (IQR) in MET-hours per week.³ Values are medians (IQR) in hours per day.⁴ Values are medians (IQR) in hours per week.

Associations of Disease Severitiy, invasivity of the therapy, Necessity and willingness of re-treatment and current anal symptoms with dietary intake in Patients with a history of treatment for hemorrhoids

Compared to patients with grade I hemorrhoids (referent), patients with higher grade hemorrhoids (grades II-IV) had greater odds of a fiber intake above the cohort-specific median and lower odds of a high alcohol consumption (**Table 5**).

Table 5
Odds ratios¹ for a nutrient, food or food group intake above the median according to Grade of hemorrhoids (n=392)

<i>Severity of hemorrhoids</i>					
	<i>Unknown</i>	<i>Grade I</i>	<i>Grade II</i>	<i>Grade III</i>	<i>Grade IV</i>
	n = 68	n = 24	n = 141	n = 145	n = 14
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<i>Potatoes</i>	1.17 (0.42-3.24)	1 (Ref.)	0.63 (0.24-1.62)	0.58 (0.23-1.51)	1.49 (0.35-6.40)
<i>Total vegetables</i>	1.45 (0.54-3.90)	1 (Ref.)	1.48 (0.58-3.76)	1.26 (0.50-3.21)	2.26 (0.55-9.34)
<i>Fruits</i>	1.63 (0.60-4.43)	1 (Ref.)	1.61 (0.63-4.13)	2.42 (0.94-6.20)	1.74 (0.44-6.95)
<i>Nuts</i>	0.77 (0.30-2.00)	1 (Ref.)	1.28 (0.53-3.11)	1.53 (0.63-3.70)	2.38 (0.60-9.46)
<i>Total dairy products</i>	1.50 (0.53-4.23)	1 (Ref.)	3.40 (1.28-9.01)	1.64 (0.62-4.36)	1.82 (0.44-7.48)
<i>Total meat</i>	0.63 (0.23-1.74)	1 (Ref.)	0.94 (0.36-2.42)	0.83 (0.32-2.13)	0.48 (0.12-2.04)
<i>Processed meat</i>	0.77 (0.28-2.12)	1 (Ref.)	0.90 (0.35-2.32)	0.81 (0.32-2.09)	0.52 (0.12-2.16)
<i>Animal fat</i>	1.37 (0.51-3.70)	1 (Ref.)	1.60 (0.63-4.06)	1.36 (0.54-3.46)	2.53 (0.61-10.42)
<i>Water</i>	0.93 (0.35-2.46)	1 (Ref.)	0.55 (0.22-1.37)	0.69 (0.28-1.71)	2.23 (0.48-10.48)
<i>Alcohol (ethanol)</i>	0.33 (0.12-0.91)	1 (Ref.)	0.43 (0.17-1.11)	0.34 (0.13-0.88)	0.19 (0.04-0.79)
<i>Total fiber</i>	4.45 (1.01-19.60)	1 (Ref.)	4.64 (1.11-19.35)	4.66 (1.13-19.19)	6.70 (1.03-43.64)
<i>Total energy</i>	1.50 (0.57-3.94)	1 (Ref.)	1.17 (0.47-2.89)	2.33 (0.94-5.75)	2.02 (0.52-7.88)

¹Calculated with logistic regression; adjusted for age, sex, BMI and total energy intake.

Compared to patients who received either rubber band ligation or sclerotherapy (which are considered to be less invasive procedures), patients with a history of hemorrhoidectomy (surgery) were 76% more likely to have a higher alcohol consumption (>median). No significant associations with respect to the consumption of the other nutrients, foods or food groups in relation to treatment groups were observed (**Table6**).

Table 6

Odds ratios¹ for a nutrient, food or food group intake above the median according to type of hemorrhoid therapy (n=385)

	<i>Hemorrhoid therapy</i>	
	<i>Rubber band ligation or sclerotherapy, only</i>	<i>Surgery</i>
	n = 92	n = 293
	OR (95% CI)	OR (95% CI)
<i>Potatoes</i>	1 (Ref.)	1.38 (0.83-2.30)
<i>Total vegetables</i>	1 (Ref.)	0.62 (0.38-1.02)
<i>Fruits</i>	1 (Ref.)	1.07 (0.66-1.73)
<i>Nuts</i>	1 (Ref.)	0.88 (0.55-1.41)
<i>Total dairy products</i>	1 (Ref.)	1.26 (0.78-2.06)
<i>Total meat</i>	1 (Ref.)	0.78 (0.47-1.30)
<i>Processed meat</i>	1 (Ref.)	1.04 (0.63-1.73)
<i>Animal fat</i>	1 (Ref.)	0.88 (0.54-1.44)
<i>Water</i>	1 (Ref.)	0.77 (0.48-1.24)
<i>Alcohol (ethanol)</i>	1 (Ref.)	1.76 (1.07-2.89)
<i>Total fiber</i>	1 (Ref.)	0.55 (0.29-1.02)
<i>Total energy</i>	1 (Ref.)	1.33 (0.83-2.13)

¹Calculated with logistic regression; adjusted for age, sex, BMI and total energy intake.

Patients that had further hemorrhoid therapy after an initial surgical treatment did not present statistically significant higher or lower odds of a high nutrient or food intake in comparison to patients that did not need therapy again (**Supplemental Table 1**). Concerning the willingness of patients to undergo a further hemorrhoid surgery if necessary, those patients who were not willing were significantly more likely to have a higher intake (> median) of animal fat (OR 3.26 (95% CI 1.37-7.74)) than patients who would undergo another surgery if required (**Supplemental Table 1**).

Patients with current anal afflictions had a higher probability of eating more potatoes (OR 1.55 (95% CI 1.00-2.41)) than the reference group without current anal afflictions (**Supplemental Table 2**). Among the categories of the Cleveland Clinic Fecal Incontinence Score we did not observe any statistically significant associations with the consumption of nutrients, foods or food groups (**Supplemental Table 2**).

Associations of Disease Severitiy, invasivity of the therapy, Necessity and willingness of re-treatment and current anal symptoms with physical activity in Patients with a history of treatment for hemorrhoids

Calculating odds ratios for physical activity above the median, separately for different types of physical activity, according to the grading of prior hemorrhoidal disease revealed no statistically significant associations (**Supplemental Table 3**). For the type of hemorrhoid therapy, patients who underwent a surgical procedure had higher odds of sleeping more hours at night (OR 1.71 (95% CI 1.05-2.80)) when compared to patients who underwent only rubber band ligation or sclerotherapy (**Supplemental Table 4**).

Patients that required further treatment after initial hemorrhoidal surgery had significantly higher odds of doing more home repair activities (OR 1.90 (95% CI 1.03-3.51)) and of sleeping more hours at day (OR 1.79 (95% CI 1.04-3.07)) than the patients without further treatment (**Supplemental Table 5**). No statistical differences have been observed in terms of physical activity between the two groups that are or are not willing to undergo surgical hemorrhoidectomy again if necessary (**Supplemental Table 5**).

Patients with current anal afflictions had statistically significantly higher odds (OR 1.63 (95% CI 1.02-2.61)) of spending more time (> median) with home repair activities than patients without current anal afflictions after invasive treatment of hemorrhoidal disease. No other differences were seen in analyzing the physical activity in our patient subgroups according to current affliction or fecal incontinence (**Supplemental Table 6**).

Discussion

In a Northern German cohort of patients with a history of invasive treatment of hemorrhoidal disease we observed the following main results. First, whereas in males there were no statistically significant differences in food intake between hemorrhoid patients and age- and sex-matched controls, female hemorrhoid patients had a higher intake of potatoes, nuts and animal fat than female controls. Additionally, patients with a history of hemorrhoidal disease reported significantly more gardening activities and less time watching TV when compared to matched controls. Second, within the hemorrhoid patient cohort, individuals with higher hemorrhoid grades had greater odds of higher fiber and lower alcohol intake than patients with grade I hemorrhoids. In contrast, patients who have had surgery instead of rubber band ligation or sclerotherapy were more likely to have a greater alcohol intake and more sleeping hours at night. Patients that required another treatment after first hemorrhoid surgery revealed higher odds of more sleeping hours at day, but also a higher amount of home repair activities when compared to those without a further therapy. The odds of an animal fat intake above the cohort-specific median was significantly higher in patients who would not be willing to undergo another surgery, if

necessary, compared to those who would be willing. Furthermore, patients with current afflictions at the anus had a higher probability of eating more potatoes and of doing more home repair activities than the patient group without anal afflictions.

Diet and physical activity of patients after invasive treatment of hemorrhoids in comparison with control individuals

Several lifestyle habits with beneficial or harmful effects on hemorrhoids are being discussed. Most of them aim to prevent hard stool where a lot of pressure is needed for defecation which some authors see as part of pathogenesis in hemorrhoidal disease. Nevertheless, the discussion about constipation or even diarrhea as a risk factor is controversial (4,7,30,31). Several studies show a benefit of a high fiber diet in preventing or treating hemorrhoids, even though the effect is not yet completely clear (12,19,21,32). However, according to the official German colo-proctologist guidelines, a high intake of fiber with an appropriate amount of liquids is of sufficient evidence to be a part of conservative treatment for symptomatic hemorrhoids (Level of Recommendation B, Level of Evidence Ia) (14). In our study, we observed a higher intake of potatoes and nuts but also a higher animal fat consumption and a lower intake of fruits in women after invasive treatment of hemorrhoidal disease compared with age-matched controls. In men, no differences in fiber intake or any fiber-rich foods, such as vegetables or fruits, were seen. There were also no significant differences observable in fluid intake between hemorrhoid patients and the control group. However, to follow the recommendations of an increased fiber intake for hemorrhoid treatment and prevention it is also important to meet the recommended daily fluid intake. The consumption of ~25 g of pure fiber without the sufficient intake of water would rather cause hardening of the stool (17).

Limiting the consumption of other dietary factors such as alcohol and red meat are also often recommended by physicians to hemorrhoid patients, although reported data are still inconsistent. A high intake of alcohol and spicy foods have been identified as possible risk factors for hemorrhoidal disease in only one previous study retrospectively analyzing ~1000 hemorrhoids patients and the same number of controls (8). For these mentioned dietary risk factors, it is assumed that a triggered inflammation could be involved in the pathophysiology of developing hemorrhoidal disease (1,8) No study on the consumption of red meat in relation to hemorrhoidal disease has been published so far. Nevertheless, the U.S. American National Institute of Diabetes and Digestive and Kidney Diseases, for example, recommends to avoid red meats and alcohol as a part of conservative treatment of hemorrhoids (33). However, in our study, we did not find any significant differences in alcohol intake between the cohort of patients with a history of hemorrhoidal disease and the general population controls. In terms of meat intake, we only observed a higher intake of animal fat in the female hemorrhoid group when compared to female controls but no significant differences in the intake of meat or processed meat products. Unfortunately, we did not ask for the preferences of spicy foods in our questionnaire.

A sedentary lifestyle is also suspected to be a risk factor for developing symptomatic hemorrhoids, as physical activity is needed for regulating stool habits and avoid fecal retention which may lead to constipation (31,34). However, in a study from Peery et al. on primary risk factors for hemorrhoids, where the hemorrhoids were diagnosed during screening colonoscopy, sedentary behavior was even associated with a reduced risk of hemorrhoidal disease (OR 0.80, 95% CI 0.65-0.98) while physical activity did not reach statistical significance (OR 0.83, 95% CI 0.66-1.03) (9). Studies and publications on physical activity programs or increased levels of activity as therapeutic approach for hemorrhoidal disease are not available, so far. Nevertheless, gastroenterologists commonly recommend to avoid a sedentary lifestyle (2). In the matched cohort analyses, we observed that the patients after hemorrhoidal treatment spent significantly more time with gardening activities and slightly less time watching TV than the controls, with the latter may be indicating a reduced sedentary lifestyle in the patient cohort. However, the amount of total physical activity and of other individual types of activities were not statistically significantly different between patients and controls.

The median BMI of 25.2 kg/m² and median energy intake (men 2430 kcal/d; female 1794 kcal/d) was significantly lower in the patient than in our control cohort (BMI 26.7 kg/m², men 2512 kcal/d, female 1849 kcal/d) where the BMI equals the average BMI of the German general population in the age group of 55-60 years (35). Even though obese people are suspected to have a higher prevalence of symptomatic hemorrhoids, only one study in Korea could support this theory with evidence so far (36). We did not find studies on the effects of reducing obesity in preventing or treating hemorrhoids.

Associations of clinical characteristics with dietary factors and physical activity in patients after invasive treatment of hemorrhoids

In terms of tertiary prevention, we conducted analyses concerning the question of differences in diet or physical activity according to the severity of the disease or extent of the treatment. Taking the patients with grade I hemorrhoids as reference we observed a significantly higher probability for a higher intake of fiber and a lower intake of alcohol in the groups that have been treated for high grade hemorrhoids. Thus, it can be assumed that the patients with a more advanced hemorrhoidal disease might have had a higher level of suffering and are more motivated to change their lifestyle. A higher fiber intake and a lower alcohol consumption could be an indication that patients follow dietary recommendations given by clinicians for tertiary prevention. However, there was no association of disease grades with physical activity habits, and an opposite association was identified between alcohol consumption and the invasivity of the treatment (higher alcohol intake in patient after surgery versus rubber band ligation or sclerotherapy). Often, surgery provokes anxiety before a procedure and may lead to physiological problems after the procedure, regardless of the disease (37,38). An ano-rectal surgery, however, is even more associated with painful defecation in the first post-operative days and fear of disturbed continence (39,40). This led to the hypothesis that anxiety and a possible recurrence of experienced pain in the past

motivate patients to change their lifestyle more often and with higher compliance than patients who experienced only low-grade hemorrhoidal disease and less invasive treatment. However, while the disease grade provides initial evidence to support this hypothesis, the association of the type of therapy with alcohol intake rather suggests the opposite. Though, no other dietary factors, except for alcohol, were in any way associated with hemorrhoids treatment.

As patients who have had a further hemorrhoid therapy after initial surgery revealed more home repair activities than patients who did not have another hemorrhoid treatment, but also spent more time of sleeping at day, it remains unclear whether patients who underwent another hemorrhoid therapy either increase their physical activity, as recommended, or have a higher sedentary lifestyle, or whether these two habits simply compensate each other.

Patients that were not willing to undergo a further necessary hemorrhoid surgery had a significant higher likelihood to consume more animal fat than the group that was willing. This finding might suggest that these patients have a lower compliance and are generally less health conscious. In contrast, patients that were still having anal problems had a higher likelihood to consume more potatoes and were more likely to be physically active, at least in home repair activities. Those few associations lead to the careful assumption that (re-) current symptoms may lead to a better adherence to lifestyle modifications as a part of conservative hemorrhoid treatment. A continuous reminder of a healthy lifestyle, as for example applied in Australia as regular text messages, has shown to improve the diet and elevate the level of physical activity in patients with coronary heart disease (41). When comparing recurrent symptoms with an internal reminder, an improvement of adherence could be postulated.

Strengths And Limitations

To our knowledge, no prior study examined diet and physical activity after invasive treatment of hemorrhoids so far. Further strengths of our study are the use of a control cohort from the same geographical region as the patient cohort, established and validated diet and physical activity questionnaires and physician-stated disease grade and treatment method for hemorrhoidal disease in most cases. Concerning age, our patient cohort is likely to be representative of the source population with a median age of 58 years, assessed on average 10 years after first diagnosis of symptomatic hemorrhoids, and a generally noted peak prevalence of hemorrhoidal disease in western societies in the ages of 45-65 years (2). On the other hand, most of the data were self-administered by the study participants which may be accompanied by misclassification and recall bias. Also, some categories of characteristics included only small numbers of individuals (e.g. Grade IV (n=14) of disease grade) which fosters broad confidence intervals and less precise effect estimates. In addition, the lifestyle factors (diet and physical activity) have only been measured once after hemorrhoid diagnosis and treatment so that there were no data on pre-diagnosis lifestyle behavior available to investigate changes in lifestyle and to adjust for pre-diagnosis values. We only adjusted for age, sex, BMI and total energy intake in the logistic regression analyses due to uncertainty about other relevant confounding factors. The analyses of this

study should be considered as initial analysis with a hypothesis-generating character rather than an evidence-producing character while further prospective study is needed.

Conclusion

In median 10 years after first diagnosis of symptomatic hemorrhoids, female hemorrhoid patients revealed a significantly higher consumption of potatoes, nuts and animal fat, and a lower consumption of fruits when compared to female controls, whereas no such differences were observed in men. In addition, hemorrhoid patients reported slightly more gardening activities and less TV watching than controls. Within the hemorrhoid patient cohort, hemorrhoid grade, type of first therapy, need for further treatment, patients' compliance in terms of another surgery if necessary and current anal afflictions revealed individual associations with fiber, alcohol, animal fat and potato consumption and the amounts of home repair activities and sleeping time. While some of these findings suggest beneficial lifestyle adaptations according to recommendations, generally in patients after invasive hemorrhoid treatment and in patients with more advanced disease, other findings suggest a clustering of less health-conscious behaviors in some patient subgroups. Thus, further investigations are needed to disentangle whether patients are following recommendations of lifestyle modifications as a part of a conservative hemorrhoid treatment and tertiary prevention and which patient groups are more adherent than others (e.g., high grade vs. low grade).

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