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ORIGINAL ARTICLE

Orthorexic and restrained eating behaviour in vegans, vegetarians, and individuals on a diet

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Abstract

Purpose Orthorexic eating behaviour, restrained eating, and veganism/vegetarianism are food selection strategies sharing several characteristics. Since there are no studies investigating their interrelationships, aim of the present study was to analyse orthorexic and restrained eating behaviour in (1) a sample of vegans and vegetarians and (2) a sample of individuals on a diet to lose weight.

Method Division of samples according to pre-defined criteria in (1) vegans ($n = 114$), vegetarians ($n = 63$), individuals with rare meat consumption ($n = 83$) and individuals with frequent meat consumption ($n = 91$) and in (2) participants on a diet with dietary change ($n = 104$), without dietary change ($n = 37$) and a control group of individuals not on a diet ($n = 258$). Orthorexic eating behaviour was assessed with the Düsseldorfer Orthorexie Skala and restrained eating was assessed with the Restraint Eating Scale.

Results Vegans and vegetarians do not differ in orthorexic eating behaviour, but both groups score higher in orthorexic eating behaviour than individuals consuming red meat. There are no differences regarding restrained eating. Individuals on a diet with dietary change score higher in both orthorexic and restrained eating, than individuals without dietary change and individuals not on a diet.

Conclusions Individuals who restrict their eating behaviour, either predominantly due to ethical reasons or with the intention to lose weight, display more orthorexic eating behaviour than individuals not limiting their food consumption. Further research is needed to investigate whether veganism, vegetarianism, or frequent dieting behaviour serve as risk factors for orthorexia.

Level of evidence Level V, cross-sectional descriptive study.

Keywords Orthorexia nervosa · Restrained eating · Vegetarianism · Veganism · Dieting behaviour

Introduction

Today, a huge amount of high-quality food is available nearly 24 hours a day, 7 days a week in the western world. Consumers might perceive these offerings as both a blessing and a curse. On the one hand, one can easily buy one's favourite food nearly anywhere and anytime. On the other hand, one must choose from an almost unmanageable variety of brands, qualities (e.g., organic, regionally grown), ingredients (e.g., with or without added vitamins), and other options (e.g., gluten-free, low-carb). Furthermore, mass media provide information regarding ecological, ethical, and health-related reasons to either select or avoid specific foods. Nowadays, food selection is no longer mainly based on availability, hunger, or satiation, but on several cognitive aspects as well [1]. Vegetarian and vegan diets are food selection strategies with rising popularity [2] based on mainly ethical, but also health-related aspects. Originally supposed to simplify one's daily food choices, they might complicate and even strain one's eating behaviour due to the development of more rigid rules and an inability to remain flexible in one's eating habits. Selecting food to achieve a low calorie intake or to follow a specific dietary program to

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lose weight is another strategy, that is sometimes associated with restrained eating [3]. While it is a reasonable strategy for people who are overweight, it is tenuous for individuals who are normal or underweight and is, therefore, known as a risk factor for eating disorders [4]. Dieting behaviour might be based on the medical necessity to lose weight as well as on health- or appearance-related reasons. Orthorexic eating behaviour is a rather new variant of food selection strategy, only rendered possible in light of today's surplus of food. In the two presented studies, vegan and vegetarian diets and dieting behaviour to lose weight are analysed in the context of orthorexic and restrained eating behaviour.

The term orthorexia nervosa was coined by US–American physician Steven Bratman in 1997 to describe the fixation on health-conscious eating behaviour [5]. He observed an ongoing mental preoccupation with healthy nutrition, overvalued ideas concerning the effects and potential health-promoting benefits of certain food and rigid adherence to self-imposed nutrition rules as characteristics of orthorexic eating behaviour. Reported prevalence rates vary from 1 to 3% in Germany [6, 7] with slightly more females being affected. Dunn et al. [8] used additional criteria to determine orthorexic eating behaviour after administering the ORTO-15 [9], a questionnaire available in English to assess orthorexic eating behaviour, and revealed a prevalence rate of less than 1% in a US sample. To date, diagnostic manuals for the classification of mental disorders do not include orthorexia as a unique diagnostic category, but there is ongoing research for the development of diagnostic criteria [10–13].

Analysing orthorexic eating behaviour reveals several overlapping characteristics with vegetarianism, veganism, and dieting behaviour. For example, they are all characterized by the reduction of food intake according to specific criteria, and include nutrition rules specifying which foods are "allowed" and which are "forbidden". Moreover, according to Bratman and Knight [21] and anecdotic reports, orthorexic individuals often follow a vegetarian or vegan diet, and sometimes, their eating behaviour resembles restrained eating. A reduced calorie intake and weight loss might be more or less an intended side effect. While there are several assumptions regarding the connection between these eating behaviours and orthorexia, there are no published data. To analyse these relationships in detail, these eating behaviours should first be defined briefly.

Vegetarianism is fundamentally defined as the abandonment of meat [14]. Individuals identifying themselves as vegetarians eat mainly cereals, fruits, vegetables, and dairy products [15]. According to Timko et al. [2], some definitions of vegetarianism also include consumption of fish (pesco-vegetarian) or poultry (pollo-vegetarian). In addition, some vegetarians exclude eggs from their diet, but eat dairy products (lacto-vegetarians) and some others exclude dairy products, but eat eggs (ovo-vegetarians). Most commonly, vegetarians include both, dairy products, and eggs in their diet (ovo-lacto-vegetarians [15]). Some studies also refer to another group called flexitarians, whose members mainly follow a vegetarian diet, but sometimes eat meat as well [16]. However, flexitarianism should be regarded as a form of rare meat consumption rather than a form of vegetarianism. The most extreme form of vegetarianism is veganism. People following a vegan diet do not eat any food of animal origin, which includes dairy products, eggs, and sometimes honey and gelatine [17]. Prevalence rates vary between countries and criteria used to define a vegan or vegetarian diet. In Germany, about 4.3% follow a vegetarian diet [18] and 0.1–1.0% a vegan diet [19]. In 2006, about 2.3% of the US adult population were ovo-lacto-vegetarians and 1.4% followed a vegan diet [20]. Bratman and Knight [21] suggested that a vegetarian or vegan diet might be a contributing factor for the onset of an orthorexic way of eating. The continuous reduction of "allowed" foods might result in a diet with only very few foods considered edible, so individuals might cut down their diet from omnivore to vegetarian and ultimately to vegan. Although the authors assumed that orthorexic eating behaviour does not interfere with dieting behaviour and is not used for weight control, one of our studies revealed that orthorexic eating behaviour is associated with drive for thinness, less body satisfaction, and less body acceptance in females [22]. Therefore, dieting behaviour and restrained eating are analysed in the context of orthorexia in this study as well.

Dieting behaviour refers to the intention to deliberately change one's eating behaviour to lose weight or to prevent weight gain. According to Strychar [23], such diets can be classified into low-calorie diets, low-carbohydrate diets, very-low-calorie diets, and very-low-fat diets, where each specific program requires more or less a change of lifestyle and eating behaviour. Dieting behaviour is closely linked, but not exactly congruent with restrained eating behaviour [24]. This concept has been introduced by Herman and Mack [3] and describes the tendency to rigidly restrict one's eating behaviour in everyday life, but to overeat in some instances, especially after having eaten a small amount of "forbidden" food. As stated above, restrained eating serves as a risk factor for eating disorders [4] and should, therefore, be taken into account when analysing orthorexia as a potential eating disorder [25]. While Bratman and Knight [21] supposed that orthorexia is not linked with the intention to lose weight, it could nonetheless be assumed that orthorexia, due to its dietary restrictions, might be linked to restrained eating. To date, there are no studies investigating these relationships.

To summarize, orthorexic eating behaviour shares several characteristics with vegetarianism, veganism, and dieting behaviour. Furthermore, all of these eating habits include restrictions, which resemble restrained eating, though weight control might not be intended in every case. The aim of

the two presented studies was to investigate orthorexic and restrained eating behaviour in samples of vegans, vegetarians, and dieting individuals. According to pre-set criteria, the samples were divided into subgroups and compared to each other as well as to a group of "normal" eating individuals without restrictions. Vegetarians and vegans were analysed to reveal the influence of avoiding foods of animal origin and dieting individuals were examined to reveal the influence of diets with intended weight loss on orthorexic and restrained eating behaviour. In addition to that, prevalence rates for orthorexic eating behaviour were assessed in all groups. Results of these studies could contribute to identify potential risk factors for orthorexic eating behaviour and to gain a better insight into orthorexia in general.

Methods

Sample selection

Data of both samples were collected in 2012 via online surveys. Participants were recruited via bulletin boards and social networks. They were informed that their participation is voluntary and anonymous and that their data are handled according to privacy policy. Furthermore, participants knew that they could cancel the survey any time by not completing the questionnaire or not sending their data using the "send-button". With sending their data, they agreed to participate in the study.

Sample of vegetarians and vegans

This sample consists of 351 participants (63% female, 36% male, 1% not specified), with a mean age of 32.2 (SD = 11.3) years and a mean BMI of 23.7 (SD = 4.9) kg/m^2. Using predefined criteria (see Table 1 and section "Assessment of eating behaviour and group assignment"), participants were assigned to one of the four groups "vegans", "vegetarians", "rare meat consumption" (similar to the group of "flexitarians" by Forestell et al. [16]), and "frequent meat consumption", considered as a control group without dietary restrictions (see Table 1).

Sample of dieting individuals

This sample consists of 406 participants (79.3% female, 20.7% male, 0.2% not specified), with a mean age of 30.7

Table 1 Criteria for group assignment and descriptive data for the vegan/vegetarian sample

			Meat consumption	
	Vegans	Vegetarians	Rare	Frequent
n	114	63	83	91
Consumption of	Criterion	Criterion	Criterion	Criterion
Red meat	Never	Never	Sometimes at most	At least often
Fish/poultry	Never	Irrelevant[a]	Irrelevant	Irrelevant
Dairy products/eggs	Very rarely at most[b]	Irrelevant	Irrelevant	Irrelevant
Self-defined as[c]	In %	In %	In %	In %
Vegan	99.1	20.6	0.0	0.0
Vegetarian	46.5[d]	92.1	7.2	0.0
Descriptive statistics	$M \pm$ SD	$M \pm$ SD	$M \pm$ SD	$M \pm$ SD
Age (in years)	28.7 ± 8.6	30.7 ± 10.1	37.0 ± 13.7	33.0 ± 11.0
BMI (in kg/m^2)	22.6 ± 4.9	22.1 ± 3.5	24.9 ± 5.9	25.3 ± 5.1
Sex	In %	In %	In %	In %
Male	27.4	27.4	32.9	56.7
Female	71.6	72.6	67.1	43.3

Annotations: in the column "criterion", criteria for group assignment are displayed. Consumption of food of animal origin was measured on a six-point scale ranging from never, very rarely, rarely, sometimes, often to very often

[a]As pesco-vegetarians ($n = 18$) were assigned to the group of vegetarians, there was no cut-off criterion for the consumption of fish

[b]In the group of vegans, a very rare consumption of dairy products and eggs was allowed, to avoid incorrect classifications of participants who state in fairness to eat these products in very rare occasions by accident

[c]In the line "self-defined as", percentage of self-definition as vegan or vegetarian is displayed

[d]Several vegan individuals stated both, being vegan and vegetarian, explaining the high percentage of self-definition as vegetarian in the vegan sample

(SD = 10.92) years and a mean BMI of 24.89 (SD = 5.45) kg/m^2. Using pre-defined criteria, participants were assigned to one of the three groups "diet with dietary change", "diet without dietary change" and "no diet/control group" (see Table 2).

Measures

First, socio-demographic status (e.g., gender, age) and eating behaviour were assessed. Then, the Düsseldorfer Orthorexia Skala [6] and the Restraint Eating Scale [German translation by 26] were administered.

Psychometric measurements

Orthorexic eating behaviour was assessed using the Düsseldorfer Orthorexie Skala [DOS; 6]. It consists of ten statements concerning healthy eating behaviour (e.g., "I feel upset after eating unhealthy foods.") which are to be rated on a four-point scale. Internal consistency with Cronbach's Alpha is 0.83 and convergent validity exists in terms of correlation with self-rated eating behaviour as healthy and subjective importance of healthy nutrition [6].

Restrained eating was assessed with the German Adaptation of the Restraint Eating Scale [RS; 26], consisting of ten items to be rated on a four- or five-point scale. It comprises two subscales (Concern for dieting and Weight fluctuations), but for our analysis, only the sum score was used. Dinkel et al. [26] report a good internal consistency of the scale and evidence for both content and criterion validity.

Assessment of eating behaviour and group assignment

To divide each sample into subgroups, participants had to answer several questions regarding their eating behaviour. Vegetarians and vegans should estimate how often they eat red meat, poultry, fish, dairy products, and eggs on a six-point scale from "never" to "very often". Furthermore, participants were asked to identify themselves as vegan or vegetarian. The sample of dieting individuals should describe their dieting behaviour in detail.

Criteria for group assignment of the vegetarian/vegan sample are listed in Table 1. No consumption of red meat counted as a criterion for both groups, vegans and vegetarians. In addition, no consumption of poultry and fish served as a criterion for the group of vegans, while this was considered to be irrelevant for the group of vegetarians, so each possible variant of vegetarianism [see 2] was assigned to this group. For vegans, a very rare consumption of dairy products and eggs was allowed, to avoid incorrect classifications of participants who state in fairness to eat these products in very rare occasions by accident. For vegetarians, consumption frequency of dairy products and eggs was irrelevant, so the group comprises lacto-vegetarians, ovo-vegetarians, and ovo-lacto-vegetarians. Only consumption of red meat was considered a relevant criterion for the other groups ["very rare" to "sometimes": group "rare meat consumption" (RMC), "often": group "frequent meat consumption" (FMC)].

The dieting sample was divided into three groups. The group "diet with dietary change" (DC) comprises participants who state to follow some kind of dietary program which include a profound change in eating behaviour and lifestyle, e.g., counting calories on a regular basis or following a specific diet program. The group "diet without dietary change" (noDC) consists of participants stating to "eat less" or to "exercise more", indicating a dieting behaviour with comparatively little changes in daily eating habits. The control group includes participants who are not on a diet (see Table 2).

Design and analysis

The study follows a between-subject design. Analyses were conducted with IBM SPSS Statistics 23 for Windows. For DOS and RS, sum scores were calculated. As descriptive data, means (M), standard deviations (SD), relative, and absolute frequencies are reported. Analyses of variance (ANOVA) with factor group for independent samples were used with a p value of 0.05. In the vegetarian/vegan sample, due to differences in distribution of gender and BMI, these two variables were used as covariates in following analyses. In the sample of dieting individuals, no covariates were used, because BMI is considered a relevant factor regarding dieting behaviour, which should not be eliminated, and distribution of gender is comparable between the groups. For post hoc tests, t tests were used, with Bonferroni-adjusted alpha of 0.008 for the vegetarian/vegan sample and 0.017 for the dieting sample. For ANOVAs, partial eta squared $\eta^{2,}$ and for t Tests, Cohen's d are reported as effect sizes. Interpretation follows the recommendation of Cohen [27]. Furthermore, in both samples, correlations of DOS, RS, and BMI were computed using Pearson correlation coefficient. Sample sizes may vary due to missing values.

Results

Sample of vegetarians and vegans

Orthorexic eating behaviour

BMI has a significant influence on the DOS sum score with $F(1,333) = 4.00$, $p < 0.05$, $\eta^2 = 0.01$, whereas gender has no significant influence [$F(1,333) = 1.05$, $p > 0.05$]. After controlling for the effect of BMI, the groups differ significantly and with a medium effect size in the DOS sum score

Table 2 Criteria for group assignment and descriptive data for the sample of dieting individuals

	Dietary change		No dietary change		Control group
n	104		37		258
Type of Diet	Description	*n*	Description	*n*	description
	Low-carb diets	30	Eat less	32	
	Weight Watchers	26	Exercise more	5	No diet
	Change of lifestyle[1]	18			
	Count calorie intake	16			
	Others/combination[2]	14			
Descriptive statistics	*MW* ± *SD*		*MW* ± *SD*		*MW* ± *SD*
age (in years)	33.2 ± 10.6		29.2 ± 10.3		29.8 ± 11.0
BMI (in kg/m^2)	28.0 ± 6.2		24.9 ± 5.1		23.4 ± 4.4
sex	in %		in %		in %
male	10.6		35.1		22.9
female	89.4		64.9		77.1

Annotations: [1]These individuals stated to having a change in their lifestyle, which includes healthy eating and exercise on a daily basis. [2]These individuals described following a combination of several diets.

[$F(3,333) = 16.66$, $p < 0.001$, $\eta^2 = 0.13$]. With $M = 20.96$ (SD = 6.04), vegans score significantly higher than both RMC [$M = 17.13$, SD = 5.83, $t(195) = 4.46$, $p < 0.001$, $d = 0.65$] and FMC [$M = 15.15$, SD = 4.76, $t(203) = 7.50$, $p < 0.001$]. With $M = 20.56$ (SD = 4.70), vegetarians also score significantly higher than both RMC [$t(144) = 3.81$, $p < 0.001$. $d = 0.65$] and FMC [$t(152) = 6.96$, $p < 0.001$, $d = 1.44$]. However, there is no difference between vegans and vegetarians [$t(175) = 0.47$, $p > 0.05$]. The difference between RMC and FMC slightly fails to reach the Bonferroni-adjusted level of significance [$t(172) = 2.46$, $p = 0.015$, $d = 0.36$, see Fig. 1].

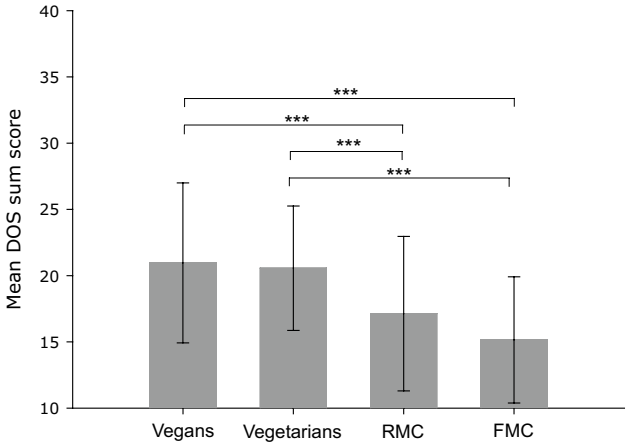

Fig. 1 Means and standard deviations of Düsseldorfer Orthorexie Skala (DOS) for vegans, vegetarians, participants with rare meat consumption (RMC), and participants with frequent meat consumption (FMC). ***$p < 0.001$

Prevalence rates

7.9% of the vegans, 3.8% of the vegetarians, 3.6% of the RMC group, and 0% of the FMC group exceed the preliminary cutoff (> 30 points) for orthorexic eating behaviour. These differences are significant [$\chi(3)^2 = 7.84$, $p < 0.05$].

Restrained eating

With $F(1,305) = 13.82$, $p < 0.001$, $\eta^2 = 0.04$, gender as a covariate has a significant influence on the RS sum score. A post hoc *t* test reveals that females ($M = 12.88$, SD = 5.86) score higher than males [$M = 10.83$, SD = 5.46; $t(317) = -3.11$, $p < 0.01$, $d = 0.36$]. Furthermore, BMI has a significant influence as a covariate [$F(1,305) = 36.91$, $p < 0.001$, $\eta^2 = 0.11$]. After controlling for these effects, the groups do not differ significantly in the RS sum score [$F(3,305) = 1.57$, $p > 0.05$]. Descriptively, the RMC group scores highest with $M = 13.16$ (SD = 6.69), followed by vegetarians ($M = 12.55$, SD = 5.27). Vegans ($M = 11.68$, SD = 5.5.2) and the FMC group ($M = 11.35$, SD = 5.46) have comparable scores.

Correlations

There are significant correlations between DOS and BMI ($r = -0.214$, $p < 0.001$), and RS sum score ($r = 0.399$, $p < 0.001$). In addition, BMI correlates with the RS sum score ($r = 0.283$, $p < 0.001$).

Sample of dieting individuals

Orthorexic eating behaviour

The DOS sum score differs significantly and with a large effect size between the groups [$F(2,397) = 42.15$, $p < 0.001$, $\eta^2 = 0.175$]. With $M = 21.92$ (SD = 5.09), the group DC scores higher than the group NoDC [$M = 19.00$, SD = 5.56; $t(139) = -3.17$, $p < 0.01$, $d = 0.59$], and higher than the control group [$M = 16.61$, SD = 4.96; $t(361) = -9.26$, $p < 0.001$, $d = 1.07$]. Furthermore, the group NoDC scores higher than the control group without dieting behaviour [$t(294) = -2.48$, $p < 0.05$, $d = 0.41$, see Fig. 2].

Prevalence rates

6.7% on a diet with dietary change, 2.7% on a diet without dietary change, and 1.5% of the control group exceed the preliminary cut-off score for orthorexic eating behaviour, revealing a significant difference in prevalence rates between the groups [$\chi(2)^2 = 6.87$, $p < 0.05$].

Restrained eating

Regarding the RS sum score, there is a significant difference between the groups [$F(2,361) = 71.52$, $p < 0.001$, $\eta^2 = 0.28$]. Post hoc t tests reveal that with $M = 19.24$ (SD = 4.26), the group DC scores higher than the control group [$M = 11.98$, SD = 5.61, $t(326) = -11.39$, $p < 0.001$] and higher than the group NoDC [$M = 17.00$, SD = 4.55, $t(130) = -2.64$, $p < 0.01$]. Furthermore, there is a significant difference between the NoDC group and the control group [$t(266) = -0.51$, $p < 0.001$].

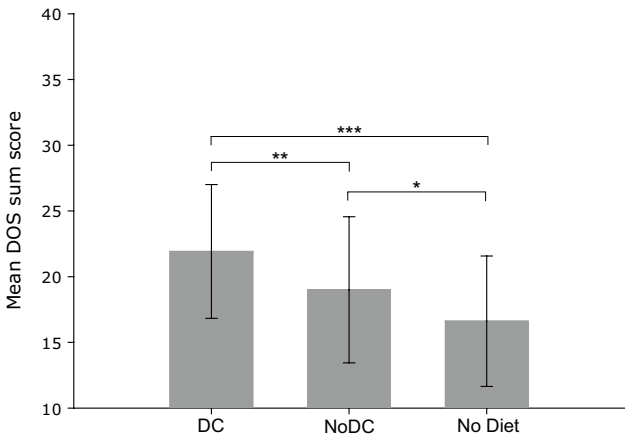

Fig. 2 Means and standard deviations of Düsseldorfer Orthorexie Skala (DOS) for participants on a diet with dietary change (DC), without dietary change (NoDC) and the control group (no diet at all). ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Correlations

DOS sum score correlates with both RS sum score ($r = 0.565$, $p < 0.001$) and BMI ($r = 0.101$, $p < 0.05$). Moreover, BMI correlates with the RS sum score ($r = 0.427$, $p < 0.001$).

Discussion

Aim of the presented studies was to analyse orthorexic and restrained eating behaviour in two samples. Vegetarians and vegans were investigated to analyse the influence of avoiding foods of animal origin and dieting individuals were analysed to reveal the influence of diets with intended weight loss on orthorexic and restrained eating behaviour.

Vegans and vegetarians display higher levels of orthorexic eating behaviour than individuals who consume red meat. Nonetheless, their mean score on the DOS does not exceed the preliminary cutoff for orthorexic eating behaviour as a pathological condition [6], indicating that even a vegan diet with several restrictions does not lead directly to a disordered eating behaviour. Nonetheless, prevalence rates for orthorexia in the vegan and vegetarian group are higher than in the groups not restricting their eating behaviour and higher than in the German normal population, which is about 3% [6]. This could indicate that restricting one's eating behaviour regarding food of animal origin might serve as a risk factor for developing orthorexic eating behaviour. However, unpublished data from our workgroup suggest that in vegans, only health-related motives are associated with orthorexic eating behaviour, whereas ethical reasons are not, indicating that underlying motives and beliefs might moderate this effect. As there is an ongoing controversy regarding the influence of the consumption of red meat on several diseases [28–30], it is an intuitive assumption that orthorexic individuals avoid it. Interestingly, there is no difference in orthorexic eating behaviour between vegans and vegetarians, but prevalence rates differ with more vegans being affected. Though the total amount of avoided foods might not play a role, individuals following a vegan diet seem more likely to display orthorexia as a pathological condition.

Regarding restrained eating, no differences between the groups were found, indicating that vegans and vegetarians do not restrict their eating behaviour for weight control. Quite a few studies investigated the relation between restrained eating and vegetarianism and came to different conclusions. Martins et al. [31] report that vegetarianism might be used as a mask for dieting behaviour, whereas Forestell et al. [16] and Timko et al. [2] suggest that not

vegetarianism itself, but related subtypes ("flexitarians" or "semi-vegetarians"), display more pronounced restrained eating. As descriptive data suggest, also in our study, the group of individuals consuming red meat on rare occasions display the highest rates of restrained eating. As all these results depend on the criteria for group assignment, more research is needed to reveal the true relation between restrained eating and vegetarianism. Furthermore, our study revealed a correlation between orthorexic eating behaviour and restrained eating, indicating that at least in parts, restricting one's eating behaviour due to health-related reasons is also associated with the intention to control one's weight. This corresponds to results indicating a relationship between orthorexic eating behaviour and a drive for thinness [25] and could be assumed to reflect the intention to avoid being unhealthy and overweight.

Dieting behaviour, as displayed by the other investigated sample, is also related to orthorexia. Results indicate that diets with a profound change in eating behaviour result in more orthorexic eating behaviour than diets without this change in everyday eating habits. Though orthorexia might be a pathological condition when followed strictly and may lead to personal distress, it might to a smaller extend be helpful for people trying to lose weight. Much foods considered healthy (e.g., vegetables and fruits) are also low in calorie count, so dieting individuals might benefit from changing their diet to a more healthy one. As there is a rather high correlation between orthorexic eating behaviour and restrained eating, a known risk factor for eating disorders, this result might also indicate that orthorexia could be a risk factor for eating disorders as well. Nonetheless, in anorexic individuals, orthorexic eating behaviour might even serve as a coping strategy [10], indicating that orthorexia as a new phenomenon of potentially pathological eating behaviour is more complex than previously assumed. Not surprisingly, individuals following a diet with more restrictions display more restrained eating, reflecting that they rather use cognitive than hunger- and satiety-related aspects to control their eating behaviour.

Limitations

In both studies, group assignment is the most critical point. It is based on subjective estimations of food consumption frequency and dieting behaviour, both of which are highly influenced by errors in recalling and willingness to report the consumption of food that might contradict one's personal beliefs (e.g., when someone identifying herself as a vegetarian must admit eating meat on rare occasions). Certainly, the choice of our criteria influences the composition of the groups as well. As there are no generally accepted definitions of vegetarianism and its diverse subtypes, our results cannot be generalized to studies using other criteria. Another limitation refers to the samples, which cannot be regarded as representative of the German population due to the recruitment strategy used. To increase representativeness of the results and enhance reliability of the prevalence rates for orthorexic eating behaviour in specific subgroups, more research is needed. Nonetheless, our consistent results allow first conclusions about orthorexic and restrained eating behaviour in vegetarian, vegan, and dieting individuals.

Further research could include daily records of eating behaviour over a week to identify consumption frequency of foods of animal origin and dieting behaviour more accurately. Another limitation of the studies refers to the low male participation. As disordered eating behaviour is known to be more prevalent in females, this aspect is not too crucial for the interpretation of the results. However, our results can only be generalized to samples containing predominantly females and not to the general population.

Conclusion

In general, the results imply that orthorexic eating behaviour varies with the amount of dietary restrictions people display. Food selection strategies like veganism, vegetarianism, and dieting behaviour are accompanied by more pronounced orthorexic eating behaviour, indicating that cognitive control and restrictions of food intake play a role in orthorexia, too. Further research is needed to investigate whether these food selection strategies serve as risk factors regarding the development of orthorexic eating behaviour.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Local ethics committee approval was not required for the studies that only included surveys. Surveys are common used research tools and the technique itself received ethical approval several times. Participants were asked about their eating behaviour, and questions like these are not supposed to cause any harm to adult human beings. Even in the very unlikely case that participants felt uneasy while answering the questions, they could easily cancel the survey at any time without any disadvantages. Participants were informed that their participation is voluntary and anonymous, and that their data is handled according to privacy policy. Furthermore, participants knew that they could cancel the survey any time by not completing the ques-

tionnaire or not sending their data using the "send-button". With sending their data, they agreed to participate in the study. All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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