



## Research paper

# Vegetarian diet and mental health: Cross-sectional and longitudinal analyses in culturally diverse samples



Kristen Lavallee<sup>a</sup>, Xiao Chi Zhang<sup>a</sup>, Johannes Michalak<sup>b</sup>, Silvia Schneider<sup>a</sup>, Jürgen Margraf<sup>a,\*</sup>

<sup>a</sup> Ruhr-Universität Bochum, Clinical Child and Adolescent Psychology, Bochum, Germany

<sup>b</sup> Witten/Herdecke University, Witten, Germany

## ARTICLE INFO

## Keywords:

Vegetarian  
Vegan  
Plant-based diet  
Mental health  
Cross-cultural  
Depression  
Anxiety  
Stress  
Positive mental health  
Life satisfaction

## ABSTRACT

**Background:** Vegetarianism is linked with better physical health, but also to increased anxiety and depression. The aim of the present study is to examine the relationship between vegetarianism and both positive and negative mental health, across cultures and over time.

**Method:** Self-report questionnaire data were obtained from a large-scale multi-national cross-sectional sample including 2007 representative adult members of the German population, 3020 representative adults from Russia, and 3038 representative adults from the USA. Participants for the longitudinal analyses include university students from Germany (1608) and China (12,744). Statistical models included multiple linear regression, longitudinal linear models and longitudinal logistic models.

**Results:** Vegetarianism diet is not reliably related to positive or negative mental health in US and Russian representative samples or in German representative or student samples. Vegetarianism is related to slight increases over time in anxiety and depression in Chinese students. **Conclusions:** Vegetarianism is not associated with mental health in the US, Russia, or Germany, but is associated with anxiety and depression in China in this study. Future studies should examine the nuances of vegetarianism in more detail and their links with mental health, including dietary composition and cultural beliefs and economic circumstances. Future researchers in this area may also want to consider the effects of experimental manipulation of diet on mental health outcomes over time.

## 1. Vegetarian diet and mental health: longitudinal prediction

Long prevalent in some Asian cultures, the popularity of the plant-based diet is on the rise in the Western world. Vegetarians enjoy multiple physical health benefits from cutting out meat, such as lowered blood pressure and cholesterol in women (Cade et al., 2004), as well as altruistic benefits and peace of mind in the areas of animal ethics (i.e., less harm to animals), and environmental protection (i.e., less acreage is needed to grow plants than to raise animals, and less pollution is caused by plant agriculture than animal). Not often discussed are the mental health correlates, causes, or consequences of being vegetarian.

Cross-sectional research indicates that vegetarian (no poultry, red meat or fish) and semi-vegetarians (no red meat) women tend to be single, urban, exercise more, and show lower BMI than non-vegetarians (Baines et al., 2007). Vegetarians, vegans (no animal products, including eggs and dairy), and semi-vegetarians often cite ethical concerns as the primary reason for their diet. Indeed, ethical concerns supercede the next most common reasons (health, the environment, and weight control) by a large margin in one study (Timko et al., 2012). In

other studies, both ethical and health concerns were commonly cited motivators for becoming vegetarian (Jabs et al., 1998; Fox and Ward, 2008).

### 1.1. Vegetarian physical health

Several large-scale studies and meta-analyses generally point to physical health benefits of a vegetarian diet, with fewer studies showing equivalence or disadvantage of vegetarianism. In a large cohort study of over 35,000 women from the U.K., vegetarians had the least, and meat eaters had the most self-reported physical illnesses, such as heart attack, angina, high blood pressure, high cholesterol, and cancer (Cade et al., 2004). Across 76,000 men and women in the US, UK, and Germany over 10 years and across five studies, and matched for age, sex, and smoking, vegetarians were 24% less likely to die of ischaemic heart disease than meat eaters. When compared with regular meat eaters (who eat meat once a week or more, and not including those who eat meat less than once a week or who eat fish only), the differences were more pronounced, with vegetarians 34% less likely to die of ischaemic heart

\* Corresponding author.

E-mail addresses: [kllavallee@gmail.com](mailto:kllavallee@gmail.com) (K. Lavallee), [juergen.margraf@rub.de](mailto:juergen.margraf@rub.de) (J. Margraf).

<https://doi.org/10.1016/j.jad.2019.01.035>

Received 6 September 2018; Received in revised form 16 January 2019; Accepted 19 January 2019

Available online 29 January 2019

0165-0327/ © 2019 Elsevier B.V. All rights reserved.

disease. There were no differences in other diseases in this study, such as cardiovascular disease, or various forms of cancer (Key et al., 1998). Among 21,000 men and women in the Oxford Vegetarian Study and Health Food Shoppers Study, British vegetarians had lower mortality than the general population, but not lower than matched non-vegetarians who were similar in age, socio-economic status, and smoking (Appleby et al., 2002). However, a more recent and comprehensive meta-analysis of 80 studies on vegetarian diet and disease provides evidence for the link between primarily plant-based diets and lowered risk for cardiovascular heart disease, type 2 diabetes, and cancer, as well as lowered incidence of obesity, and concludes that vegetarian diet is indeed associated with lowered disease incidence (McEvoy et al., 2012). Vegetarian adults also tend to have a lower BMI than omnivorous adults (Burkert et al., 2014). This cross-sectional study of 1320 adults was one of the few studies that showed a negative relationship between vegetarianism and physical health, with vegetarians more likely to have cancer, allergies, a higher need for health care and a poorer quality of life (Burkert et al., 2014).

### 1.2. Vegetarian mental health

In contrast to most studies showing physical health benefits of a vegetarian diet, vegetarian diet often is associated with reduced mental health in previous research. Cross-sectional research indicates that vegetarian women tend to have reduced mental health when compared with non-vegetarians. They have more menstrual symptoms and higher rates of depression than non-vegetarians (Baines et al., 2007). In a large-scale cross-sectional study of adult male partners of pregnant women ( $N > 9000$ ), men who reported being vegetarian (3.6% of sample), reported higher depression and greater proportion of high post-natal depression scores, with an odds ratio of 1.75, even after controlling for a host of potential confounds, such as age, marital status, employment, family history of mental illness, children, and substance use (Hibbeln et al., 2018). In a large cross-sectional representative German sample, vegetarians and predominantly vegetarian eaters reported elevated depression, anxiety, and somatoform disorders as compared with meat eaters, which were not accounted for by socio-demographic characteristics (i.e., females, urban dwellers, singles). In another study, vegetarians reported more psychological symptoms (anxiety and depression) than three different types of meat eaters: those with diets rich in fruits and vegetables, those with diets less rich in meat, and those with diets rich in meat. All three types of omnivores had similarly lower levels of mental illness, as compared with the group of vegetarians (Burkert et al., 2014). Adolescents who are vegetarian are also more likely to be depressed than adolescent omnivores (Larsson et al., 2002) and to have contemplated or attempted suicide (Perry et al., 2001).

Analyses of retrospective reports of onset indicate that onset of mental disorder tends to precede onset of vegetarian diet. Correspondingly, there is no evidence that vegetarian diet is being responsible for the onset of disorder (Michalak et al., 2012). Mediation pathways are not explored and longitudinal data unavailable in this study, but perhaps people who are more emotionally sensitive are more likely to simultaneously be vulnerable to depression and to want to stop the suffering of animals as they are more affected by negative stimuli in the world. It is also a possibility that people who become mentally ill try or adopt dietary changes as a way of treating their mental illness (Michalak et al., 2012). However, in a study among adolescent anorexic patients, vegetarians were more anxious and depressed, and those with lower dietary cholesterol intake were more depressed (Stokes et al., 2011), providing some tentative evidence that there might be a meditational pathway from vegetarianism through fatty acid intake to depression.

However, not all research shows a negative relationship between vegetarianism and mood. Some research shows no significant differences among vegetarians, vegans, semi-vegetarians, and omnivores on

measures of eating disorder or depression, anxiety, and stress (Timko et al., 2012). Further, two studies from one research group indicate a correlation between vegetarian diet and positive mood states (Beezhold et al., 2010) and lowered anxiety and stress (Beezhold et al., 2015). One of these studies (Beezhold et al., 2010) examined members of the Seventh Day Adventist church, a community that highly values vegetarianism and has high rates of vegetarianism. Perhaps the conformity to community values and norms is partly responsible for this relationship between vegetarian diet and positive mood in the Seventh Day Adventists. The second study found that vegetarian and vegan males reported less anxiety than omnivorous males, and vegan (but not vegetarian) females reported less stress than omnivorous females (Beezhold et al., 2015). To date, there is no known study examining the relationship between vegetarianism and mental health in a large-scale, prospective longitudinal study.

### 1.3. The present study

The purpose of the present study was to conduct a more in-depth analysis of the relationship between vegetarian diet and mental health. We examined this relationship cross-sectionally in large representative samples of fully industrialized countries (US and Germany) and a transitional society (Russia). Moreover, we analyzed the relationship longitudinally in two student-population sample in China and Germany. Based on results from the preponderance of the prior research, we expected that vegetarianism would be positively related to concurrent symptoms of depression and anxiety, while controlling for female sex, urbanicity, unmarried partnership status, and eating disorder. Positive mental health was also included as an outcome on an exploratory basis. It is possible that vegetarianism is concurrently related to increased life satisfaction and positive mental health. Over time, vegetarianism was expected to relate to increases in depression. Also, over time, initial depressive symptoms were expected to lead to a greater incidence of becoming vegetarian at a later time. Examination of cross-cultural differences between the fully industrialized US and Germany and people living under the pressure of a transitional society in Russia and China were considered somewhat exploratory.

## 2. Method

### 2.1. Procedure

Data for the present study were drawn from the BOOM (Bochum Optimism and Mental Health) studies, a large-scale, cross-cultural, longitudinal investigation of risk and protective factors in mental health (Maercker et al., 2015; Margraf and Schneider, 2018). The Ethics Committee of the Faculty of Psychology of the Ruhr-Universität Bochum approved the study. Data were collected between November 2012 and February 2014 through three professional opinion research institutes. Four different assessment methods were used in the BOOM study with German representative samples: face-to-face interviews, telephone interviews, online survey, and a mixed-method-approach that allowed individuals to participate either online or via set-top box (a device that allows a person to answer questionnaires via a television and a remote control), and one method was used with representative samples from the USA and Russia: telephone interviews (Zhang et al., 2014). Participants in the present study were recruited via telephone. A random digit number sample selected at the working block of phone numbers, using last birthday method to allow an equal spread. Sample quantities selected across various demographic variables based upon assumed completion rates. Demographic variables with an assumed higher completion rate will have fewer records; demographic variables with assumed lower completion rates will have more sample records associated with them. The assumed rates of demographic variables were based on the federal census data. This results in a sample which represents the population of each country as a whole country. The

response rate according to American Association for Public Opinion Research (AAPOR, the minimum response rate) was reported as 14% in Russia sample, 15% in the USA sample, and 7.6% in Germany.

Trained professional interviewers at three professional research institutes conducted the telephone interviews with computer assistance. Participants gave their informed consent orally after being informed about anonymity and voluntariness of the survey. Participants received no financial compensation. Participation took less than an hour at each time point (average of about 45 min). Representativeness for the adult residential populations in the three countries was based on the register-assisted census data from 2011 regarding age, gender and education, was ensured via systematized sampling procedures. More detailed information about the study and samples can be found in a separate paper describing the study.

## 2.2. Participants

Participants for the cross-sectional analyses included 2007 representative members of the German population, 3020 people recruited as a representative sample from Russia, and 3038 people recruited as a representative sample from the USA. Participants for the longitudinal analyses include university students from Germany (1608) and China (12,744). Table 1 provides an overview of the sample characteristics, including gender, marital status, urbanicity, age, educational level.

## 2.3. Measures

### 2.3.1. Vegetarianism

Vegetarianism was assessed using a single item: “Are you currently vegetarian?” Answer categories were ‘no’, ‘yes: no meat, no fish’, ‘yes: no meat, but fish’, and “yes: vegan.” As all of the yes answers represented some form of limiting meat and animal product intake, and the majority of studies examined in the introduction do not parse out levels of limitation in vegetarianism, for the present analyses, the three latter categories were combined into ‘yes’, which was coded as 1. ‘no’ was coded as 0.

## 2.4. Control variables

### 2.4.1. Relationship status

Relationship status was assessed using a forced-choice item including the categories (1) single and never married, (2) married, (3) separated, (4) divorced, (5) widowed, (6) living with partner (not married). For the present analyses with representative data, the categories were combined into ‘married or live with partner’ (responses 2 and 6), which was coded as 1; ‘single or live alone’ (responses 1, 3, 4, 5)

was coded as 0. For the analyses with student data, the categories were combined into ‘single without steady partner’, which was coded as 0; ‘single with steady partner’ was coded as 1.

### 2.4.2. Socioeconomic status

Socioeconomic status within country was assessed using income data in Germany and the US, and financial position ratings in Russia, and z-scoring within country (thus each country has a mean score of 0 and standard deviation of 1). Financial information was not available for the Chinese student sample. Income was assessed on a monthly basis in Germany using a scale ranging from 1 (up to 500 Euros per month) to 11 (4000 Euros or more per month) Income was assessed on an annual basis in the U.S. using a scale ranging from 1 (\$0–9999 per year) to 12 (\$150,000 or more per year). One question was used as a measure of financial position in Russia: “How would you currently rate currently your financial position?” Response options included “rather good,” “average,” and “rather poor.”

### 2.4.3. Urbanicity

Participants were asked to indicate the size of place of residence they currently live in. Urbanicity for the German samples (available only for student and not representative data) was categorized into the following groups: Towns with less than 20,000 inhabitants, 20,000–99,999, 100,000–499,999, and more than 500,000 inhabitants. Different categories were used in China, Russia, USA. In China, these were: Village: < 5000, Country town and small city 5000–500,000, Mid-sized city 500,000–1,000,000, big city 1–3 million, Large city 3–10 million, Huge city > 10 million. In Russia, the categories were: Village: < 5000, Country town and small city 5000–500,000, Big City 500,000–1,000,000, large city 1–3 million, Moscow or Petersburg 3–10 million. In the USA, the categories were: Less than 5000, 5000–20,000, 20,000 – 100,000, 100,000 – 500,000, 500,000 – 1,000,000, 1,000,000 and more. Responses were z-scored within country to facilitate comparability across countries.

### 2.4.4. Quality of health

Overall current quality of health was assessed using the EuroQol (EQ-5D-3L) (Brooks, 1996; The EuroQol Group, 1990; The EuroQol Group, 2013). First, participants rated current health status on a scale (EuroQol VAS) ranging from 0 (worst imaginable health) to 100 (best imaginable health). Then, participants rated health in five dimensions (EuroQol 5D) (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) using 3 levels ranging from no problems to extreme problems. Scores across the five dimensions were summed in the present study, and used in the analyses. Validity of the five dimensions (EuroQol 5D) is indicated by convergence with the EQ-VAS

**Table 1**  
Demographic characteristics of the samples.

	German representative	Russia representative	USA representative	German student	Chinese student
Gender					
Female = 0	1181(58.8%)	1607(53.2%)	1786(58.8%)	1028(63.9%)	7404(62.1%)
Male = 1	826(41.2%)	1413(46.8%)	1252(41.2%)	580(36.1%)	4525(37.9%)
Marital status					
Single or live alone = 0	978(48.9%)	1122(37.8%)	1006(36.9%)	851(52.9%)	9734(79.4%)
Married or with partner = 1	1023(51.1%)	1849(62.2%)	1720(63.1%)	645(40.1%)	2522(20.6%)
Education					
No high school graduate	416(20.9%)	614(20.3%)	288(10.6%)		
High school graduate	1134(57.0%)	1281(42.4%)	1714(62.9%)		
Bachelor or higher degree	439(22.1%)	1125(37.3%)	724(26.6%)		
Vegetarian					
No = 0	1873(93.6%)	2927(97.2%)	2841(94.2%)	1335(83.0%)	9627(77.8%)
Yes = 1	129(6.4%)	85(2.8%)	175(5.8%)	257(16.0%)	2754(22.2%)
Mean (SD)					
Age	51.95(17.36)	43.24(17.13)	55.12(17.50)	24.57(4.73)	20.63(1.66)
Urbanicity	-	6.65(2.95)	8.56(4.48)	9.65(2.59)	8.04(5.33)
Family affluence scale				5.41(1.72)	2.75(2.15)

(Greiner et al., 2003) and with WHO-5 and known clinical groups across several countries (Janssen et al., 2013).

#### 2.4.5. Body mass index (BMI), height and weight

Body mass index (BMI) was calculated from weight and height as weight divided by height squared ( $\text{kg}/\text{m}^2$ ). Height and weight were assessed via self-report. Self-reported measurements of height and weight have been found to be very reliable, with the exception of highly obese individuals, in which a slight underestimation of weight has been reported (Gorber et al., 2007). Previous research indicated impaired mental health in both underweight and obese individuals (Molarius et al., 2009; Becker et al., 2001), and thus a quadratic polynomial of body mass index was also added to the analyses. BMI was not available for German representative samples.

#### 2.4.6. Family affluence scale

The Family Affluence Scale (Currie et al., 1997) is a valid and objective measure of family wealth. The FAS II asks about four items: Car: does your family own a car, van, or truck (No = 0; Yes, one = 1; Yes, two or more = 2)?; Own bedroom: do you have your own bedroom for yourself (No = 0; Yes = 1)?; Holidays: during the past 12 months, how many times did you travel away on holiday with your family (Not at all = 0; Once = 1; Twice = 2, More than twice = 3)?; Computers: how many computers does your family own (None = 0; One = 1; Two = 2; More than two = 3)? A total FAS II sum score is calculated based on these four items. The higher value of total score indicates high affluence.

### 2.5. Negative mental health

#### 2.5.1. Depression, anxiety and stress scales

The 21-item short version of the Depression, Anxiety and Stress Scales (DASS-21) (Henry and Crawford, 2005), appropriate for cross-cultural research (Scholten et al., 2018), assessed symptoms of depression, anxiety and stress as outcome variables of daily stressors. Psychometric properties for the short version are comparable to the 42-item long version (Antony et al., 1998; Lovibond and Lovibond, 1995). The DASS-21 is composed of three 7-item subscales for depressive, anxiety and stress symptoms over the past week. Items are rated on a 4-point Likert scale from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). Psychometric properties for the short version are shown to be similar to those for the long version, and the scale has been shown to be appropriate for cross-cultural research, with measurement invariance across cultures (Scholten et al., 2018). In the present study, overall Cronbach's alpha was  $\alpha = 0.92$  in Germany, and 0.896 in China. The reliability of each subscale was  $\alpha_{\text{depression}} = 0.89$ ;  $\alpha_{\text{anxiety}} = 0.78$ ;  $\alpha_{\text{stress}} = 0.85$  in Germany, and  $\alpha_{\text{depression}} = 0.88$ ;  $\alpha_{\text{anxiety}} = 0.86$ ;  $\alpha_{\text{stress}} = 0.77$  in China.

### 2.6. Positive mental health

#### 2.6.1. Positive mental health

Positive mental health was assessed with a 9-item Positive Mental Health scale that was developed by our research team for ongoing studies (P-Scale) (Beida et al., in press; Lukat et al., submitted). The scale assesses positive aspects of health and life experiences (e.g., *I am often carefree and in good spirits, I enjoy my life, I manage well to fulfill my needs, I am in good physical and emotional condition*). Items are answered on a 4-point Likert scale ranging from 0 (*do not agree*) to 3 (*agree*). Cronbach's alpha was  $\alpha = 0.89$  in Germany, 0.92 in USA, 0.85 in Russia, and 0.89 across all three countries combined. Cronbach's alpha was  $\alpha = 0.91$  in the German student sample, and 0.91 in Chinese student sample. Research indicates that this scale is appropriate for cross-cultural research, based on analyses indicating measurement invariance across cultures (Beida et al., in press). Retest reliability for one month was  $r = 0.73$ , using the same retest reliability sample used for the Brief

Social Rhythm Scale (i.e., subsample of Germans from BOOM study who took the measure online or on paper, but not used in the present study) (Margraf et al., 2016).

### 2.7. Data analysis and preparation

For statistical analysis, we used SPSS (version 21) (Corp., 2012). Internal consistency was computed with Cronbach's Alpha coefficient. Cronbach's  $\alpha > 0.70$  indicate acceptable,  $> 0.80$  good, and  $> 0.90$  excellent internal consistency (Kline, 2000).  $\chi^2$  independence tests and effect sizes (Cramers V) (Cohen, 1988) were used to assess associations between vegetarianism and cultural groups.  $V > 0.1$  indicates small effect,  $> 0.3$  indicates medium effect, and  $> 0.5$  indicates large effect. Fisher z-tests comparing the strength of correlations between vegetarianism and outcome variables, was conducted to assess between-country differences. Multiple linear regression models were used to evaluate the relationship between vegetarianism and mental health measures, controlling for age, gender, urbanicity (not in the German representative sample), marital status, education level, and socioeconomic status in the representative samples as well as family affluence in the student samples.

Longitudinal linear models were conducted to display the relationships between mental health measures at follow-up and vegetarianism at baseline separately for German and Chinese student samples, controlled for gender, age, urbanicity, marital status, family affluence, and the mental health state at baseline.

Finally, longitudinal logistic models were conducted to display whether vegetarianism at baseline can predict vegetarianism at follow-up separately for German and Chinese student samples after controlling for gender, age, urbanicity, marital status, and family affluence. In the next step, longitudinal logistic models were also conducted to display whether the three mental health measures at baseline can still predict vegetarianism at follow-up, controlling for gender, age, urbanicity, marital status, Family affluence, and vegetarianism at baseline separately for German and Chinese student samples. Significance levels were set at  $\alpha = 0.05$ . For the three multiple linear models in the three representative samples as well as the three longitudinal linear models in the two student samples, a Bonferroni correction was used with  $\alpha_{\text{corrected}} = 0.05/3$ . Analyses were conducted separately by country in order to compare results cross-culturally.

## 3. Results

### 3.1. Descriptive statistics and zero-order correlations

Demographic characteristics of the five samples included in our study are shown in Table 1. The proportion of individuals following a vegetarian diet ranges from 2.8% (representative Russian sample) to 22.2% (Chinese student sample). In Table 2, descriptive statistics for the mental health variables are presented. Descriptive statistics for the follow-up data included in the longitudinal analyses are also shown for the two student samples.

Supplemental Table 1 (available as supplemental online material) presents zero-order correlations among measures. Vegetarian diet was not significantly associated with any of the mental health variables (i.e., positive mental health, depression, anxiety) in any of the German, Russian or US representative samples. Further, in the German student sample, all zero-order correlations at baseline and follow-up were low and not significant. In contrast, in the Chinese student sample, significant correlations emerged between vegetarian diet and all mental health variables. Vegetarian Chinese students tend to be more depressed, anxious and report lower levels of positive mental health at baseline as well as at follow-up. However, the strength of the correlation was low, with no correlation exceeding  $r = 0.11$ .

**Table 2**  
Means of measures.

	German representative	Russia representative	USA representative	German student	Chinese student
Baseline					
Positive mental health	21.90(4.75)	20.92(5.24)	23.35(5.01)	18.18(5.89)	19.90(5.21)
Anxiety	2.02(3.18)	3.09(3.68)	4.43(4.66)	2.99(3.53)	3.19(3.56)
Depression	2.42(3.52)	3.67(3.82)	4.27(5.00)	4.42(4.51)	2.58(3.48)
Follow-up					
Positive mental health				17.72(6.03)	20.16(5.30)
Anxiety				2.62(3.16)	3.17(3.80)
Depression				4.42(4.49)	2.66(3.80)

**Table 3a**  
Fisher Z-Score comparisons of differences between correlations between vegetarianism and health across countries.

	Representative samples			Student samples	
	GE vs USA	GE vs RUS	USA vs RUS	GE vs CHN t1	GE vs CHN t2
Depression	1.311	-0.41	0.988	-1.229	4.485***
Anxiety	-2.136*	-1.96*	-0.192	0.049	3.846***
Positive mental health	0.38	1.34	-1.073	2.495**	0.485

Note. Z-critical: 1.96 for  $p < 0.05$ ; 2.58 for  $p < 0.01$ .  
\*:  $p < .05$ ; \*\*:  $p < .01$ ; \*\*\*:  $p < .001$ .

3.2. Between-country differences in means and correlations

Fisher z-tests comparing the strength of correlations between vegetarianism and outcome variables, indicate some between-country differences (Table 3a). The correlations between depression and vegetarianism did not differ among the three representative samples, nor did they differ between the two baseline student samples in Germany and China. However, they did differ significantly between the two follow-up student samples in Germany and China.

The correlations between anxiety and vegetarianism differed significantly between German and USA representative samples, between German and Russia representative samples, and between the two follow-up student samples in Germany and China. However, they did not differ between German and USA representative samples or between the two baseline student samples in Germany and China.

The correlations between positive mental health and vegetarianism did not differ among the three representative samples as well as between the two follow-up student samples in Germany and China. However, they differed significantly between the two baseline student samples in Germany and China.

Table 3b shows the association between vegetarianism and countries. Vegetarianism differed significantly between the two student samples in Germany and China at baseline and follow-up, as well as among the three representative samples.

3.3. Multiple regression models predicting mental health

Because variables that are associated with vegetarian diet and mental health might have inflated or decreased the zero-order correlations presented above, in a next step we controlled for possible

**Table 3b**  
Cramers V indicating the association between vegetarianism and countries.

Cramers V	Germany vs China	GE vs. USA vs RUS
Vegetarianism t1	0.06***	0.07***
Vegetarianism t2	0.02**	/

\*:  $p < .05$ ; \*\*:  $p < .01$ ; \*\*\*:  $p < .001$ .

confounds (i.e., gender, marital status, urbanicity, and socioeconomics) in multiple regression models. As displayed in Table 4, and in parallel to the zero-order correlations, vegetarian diet was not significantly associated with depression in the German and Russian representative sample as well as in the German student sample. Moreover, the significant association between vegetarian diet and depression in the Chinese student sample remained intact after controlling for confounds. However, in contrast to the zero-order correlations the association between vegetarian diet and depression in the US sample reached significance, when potential confounds were included in the model. Vegetarians from the US tend to be more depressed than US non-vegetarians. However, the association was very small, as indicated by a beta of 0.048.

Inclusion of possible confounds did not change the pattern of results observed in the correlational analyses on anxiety. Also, in the multiple regression models controlling for confounds, vegetarian diet was unrelated to anxiety in the German, Russian and US representative sample as well as in the German student sample. Only in the Chinese students, did vegetarians tend to be more anxious than non-vegetarians.

The inclusion of confounds in the multiple regression models with positive mental health as a criterion changed the results observed in the correlational analyses only marginally. Vegetarian diet tended to be unrelated to positive mental health in the German and US representative samples as well as in the German student sample. In contrast to the results of the zero-order correlations, vegetarian diet was significantly associated with less positive mental health in the Russian representative sample and no longer related to less positive mental health in the Chinese student sample. The significant beta coefficient in the regression model of the Russian representative sample was small ( $= -0.05$ ), indicating only weak links between vegetarian diet and less positive mental health.

3.4. Longitudinal predictions

For both student samples, follow-up data were available for longitudinal analyses. In a first step for the longitudinal analyses, we conducted multiple regression to analyses whether vegetarian diet predicts mental health at follow-up. Controls included potential confounds as well as baseline scores of mental health variables in the regression models (see Table 5). There was no predictive effect of vegetarian diet on any of the mental health variables in the German student sample. In the Chinese student sample, vegetarian diet did not predict positive mental health. However, in the Chinese sample, vegetarian diet was predictive for depression and anxiety. Vegetarians had higher levels of depression and anxiety at follow-up. However, the predictive utility of vegetarian diet was low, as indicated by the small beta coefficients found in the multiple regression models.

In a second step, analyses examined whether mental health could predict diet status (vegetarian diet yes/no) at follow-up. In the hierarchical logistic regression models, controlling for demographic characteristics and baseline diet status, we found no evidence for a predictive utility of mental health for vegetarian diet (see Table 6). In the German as well as the Chinese sample, mental health at baseline did not

**Table 4**  
Standardized regression coefficients (betas) from multiple regressions on health variables.

Depression	German representative	Russia representative	USA representative	German student	Chinese student
R <sup>2</sup>	0.06	0.06	0.04	0.04	0.02
Gender(female = 0)	0.000	-0.052**	0.105***	-0.020	0.109***
Age	0.084**	0.017	0.058*	0.015	-0.02*
Urbanicity		0.02	-0.042	0.043	0.049***
Marital status (single = 0, married/with partner = 1)	-0.057*	-0.066***	-0.024	-0.155***	-0.038***
Education: no high school graduate as reference					
High school graduate	0.009	-0.104***	-0.094*		
Bachelor or higher degree	-0.037	-0.142***	-0.131**		
SES_z	0.203***	0.199***	-0.100***		
FASII				-0.118***	-0.03**
Vegetarian	-0.001	0.018	0.048*	0.035	0.087***
Anxiety	German representative	Russia representative	USA representative	German student	Chinese student
R <sup>2</sup>	0.05	0.08	0.02	0.02	0.01
Gender (female = 0)	-0.015	-0.118***	0.098***	-0.081**	0.04***
Age	-0.033	0.103***	0.034	-0.029	-0.034***
Urbanicity		-0.024	-0.023	0.026	0.047***
Marital Status (single = 0, married/with partner = 1)	0.023	-0.054**	-0.020	-0.079**	-0.026**
Education: no high school graduate as reference					
High school graduate	-0.174***	-0.142***	-0.020		
Bachelor or higher degree	-0.162***	-0.189***	-0.051		
SES_z	-0.143***	.150***	-0.094***		
FASII				-0.093***	-0.032**
Vegetarian	-0.038	0.024	0.019	0.031	0.078***
Positive mental health	German representative	Russia representative	USA representative	German student	Chinese student
R <sup>2</sup>	0.03	0.11	0.01	0.05	0.01
Gender (female = 0)	0.000	0.020	-0.024	0.058	-0.008
Age	0.084**	-0.141***	0.098***	-0.071	0.041***
Urbanicity		-0.052**	0.016	-0.058	-0.02
Marital Status (single = 0, married/with partner = 1)	-0.057*	0.039*	-0.002	0.137	0.044***
Education: no high school graduate as reference					
High school graduate	0.009	0.018	0.030		
Bachelor or higher degree	-0.037	0.005	0.003		
SES_z	0.203***	-0.263***	0.075**		
FASII				0.141	0.081***
Vegetarian	-0.001	-0.050**	0.022	-0.039	-0.002

Note: \*:  $p < .05$ ; \*\*:  $p < .01$ ; \*\*\*:  $p < .001$ .

predict whether student were vegetarians at follow-up.

#### 4. Discussion

The aim of the current study was to examine the relationship between vegetarianism and mental health cross-culturally, and over time. The present study is the first large-scale, multi-national, prospective longitudinal study to examine vegetarianism and mental health known to the authors.

Results indicated that vegetarian diet was not significantly associated with depression in the German and Russian representative samples, nor the German student sample. Moreover, there was no zero-order relationship between vegetarian diet and depression in the US sample. It did reach significance when potential confounds were included in the model, but was very small. However, we observed a significant zero-order association between vegetarian diet and

depression, anxiety, and less positive mental health in the Chinese student sample. For depression and anxiety (but not for positive mental health) this associations remained intact after controlling for confounds, suggesting that in Chinese students, vegetarian diet is related to higher levels of depression and anxiety. However, it should be noted that associations were small and vegetarian diet explained less than 1% of variance in depression and anxiety. Longitudinal analyses indicated no predictive effect of vegetarian diet on any of the mental health variables in the German student sample or on positive mental health in the Chinese students. However, vegetarian diet was predictive for depression and anxiety in the Chinese student sample. Vegetarians had slightly higher levels of depression and anxiety at follow-up. Finally, there was no evidence for a predictive utility of mental health for vegetarian diet. That is, mental health at baseline did not predict whether student were vegetarians at follow-up in either the German or Chinese students. In sum, vegetarian diet does not appear to be a reliable

**Table 5**  
Longitudinal analyses to predict mental health at follow-up.

	Depression follow-up		Anxiety follow-up		Positive mental health follow-up	
	German student	Chinese student	German student	Chinese student	German student	Chinese student
R <sup>2</sup>	.40	0.13	0.41	0.12	0.48	0.19
Gender (female = 0)	-0.066	.139***	-0.071	0.119***	0.016	-0.025*
Age	-0.015	-0.026*	-0.075*	-0.029**	-0.040	0.058***
Urbanicity	0.002	-0.02	-0.004	-0.030*	0.034	-0.004
Marital Status (single = 0, married/ with partner = 1)	-0.086*	0.002	-0.051	0.009	0.035	0.031**
FASII	-0.041	-0.047***	-0.063	-0.062***	0.079*	0.074***
Depression/anxiety/positive mental health baseline	0.601***	0.298***	0.611***	0.299***	0.667***	0.416***
Vegetarian	0.058	0.045***	0.013	0.050***	-0.021	-0.019

Note: Vegetarian: 1 = yes. \*:  $p < .05$ . \*\*:  $p < .01$ . \*\*\*:  $p < .001$ .

**Table 6**  
Longitudinal analyses to predict vegetarian diet at follow-up.

Vegetarian_FU R <sup>2</sup>	German student		Chinese student	
	OR	95% CI	OR	95% CI
Gender (female = 0)	0.185**	[0.060 0.566]	1.332***	[1.182 1.501]
Age	1.012	[0.919 1.114]	1.029	[0.988 1.072]
Urbanicity	1.074	[0.905 1.274]	0.945***	[0.930 0.961]
Marital status (single = 0, married/with partner = 1)	1.840	[0.752 4.500]	0.824*	[0.705 0.962]
FASII	0.885	[0.686 1.140]	0.978	[0.945 1.013]
Vegetarian_BL R <sup>2</sup>	200.200***	[77.711 515.759]	4.367***	[3.867 4.931]
	OR	95% CI	OR	95% CI
Gender (female = 0)	0.182**	[0.058 0.565]	1.311***	[1.162 1.478]
Age	1.012	[0.919 1.114]	1.032	[0.991 1.075]
Urbanicity	1.079	[0.906 1.284]	0.945***	[0.929 0.960]
Marital Status (single = 0, married/ with partner = 1)	1.783	[0.719 4.420]	0.833*	[0.713 0.973]
FASII	0.877	[0.677 1.135]	0.980	[0.946 1.015]
Vegetarian_BL	202.143***	[77.755 525.519]	4.321***	[3.825 4.882]
Depression_BL	0.993	[0.845 1.167]	1.027	[0.996 1.059]
Anxiety_BL	0.988	[0.830 1.176]	0.998	[0.968 1.028]
Positive mental health_BL	1.006	[0.912 1.110]	0.994	[0.982 1.007]

Note: Vegetarian: 1 = yes. \*:  $p < .05$ . \*\*:  $p < .01$ . \*\*\*:  $p < .001$ .

predictor of mental health in German, US, or Russian representative or German student samples. Nor does mental health predict switching to a vegetarian diet in either German or Chinese students. Vegetarian diet does, however, predict slight increases in depression and anxiety over time in Chinese students.

One potential reason for the differences in results across cultures may lie in the differing rates of vegetarianism across cultures. Chinese students were the most likely to report being vegetarian, with a rate of 22%, as compared with 2.8–16% in the other samples. It may be that Chinese students reasons for being vegetarian differ from the reasons for being vegetarian in the other samples. It could be that the Chinese students are more likely to be vegetarian for cultural reasons, or economic reasons (as 67.35 of vegetarian students were in the low FAS group), whereas people in other countries may be more likely to adopt a vegetarian diet for health or ethical reasons. Much research in western countries has shown that altruistic and ethical concerns are primary reasons for becoming vegetarian, but this research on motives has yet to be extended to eastern cultures (Timko et al., 2012; Jabs et al., 1998; Fox and Ward, 2008; Lea and Worsley, 2003). It could be that differences in motivation explain the differences in mental health outcomes across cultures. More cross-cultural research on the reasons for reducing meat intake is needed. If one adopted a vegetarian diet for reasons of hardship, they may not feel happy with this choice, or may not be able to access alternative high quality proteins or fatty acids (Stokes et al., 2011), thus contributing to negative mental health outcomes. This should be an area for future research.

The findings from the Chinese students are in line with past research showing that vegetarianism is linked with higher rates of anxiety, as well as depression (Burkert et al., 2014) in women (Baines et al., 2007), men (Hibbeln et al., 2018), and adolescents (Larsson et al., 2002). The current evidence for vegetarian diet preceding increases in anxiety and depression over time in Chinese students is new and in contrast to prior results from Western countries (Michalak et al., 2012). The rest of the current results are more in line with research indicating no relationship between vegetarianism and mental health, including depression, anxiety, and stress (Timko et al., 2012; Beezhold et al., 2015) and positive mood states (Beezhold et al., 2010).

The present study had several strengths, including the large sample size with high power to detect even small effects, cross-national sample, and the battery of health measures including physical health as well as negative and positive aspects of mental health. At the same time, the study had some limitations. First, the study was self-report. It would be ideal to compare self-reported ratings of vegetarianism with more

objective measures of diet, such as diary methods. It would also be informative to examine the impacts of diet on mental health in an experimental paradigm. Second, there are no data about how people in the study actually structure their diets, and how much dietary fat they take in. It would be helpful to have more information on what exactly is eaten. It is possible that a predominance of carbohydrates would have different effect on the brain than a diet that includes more fats, such as from olive oil and avocados. Third, the battery of mental health measures could have been more comprehensive, including information on eating disorders, in particular, such as Anorexia Nervosa and Bulimia. Moreover, using clinical interviews to assess psychopathology would have strengthened the methodological approaches of our study. Finally, our measure of socioeconomic status was not ideal. It would have been more ideal to have used the same measure across countries.

In conclusion, vegetarianism diet is not reliably related to positive or negative mental health in US and Russian representative samples or in German representative or student samples. It is related to slight increases over time in anxiety and depression in Chinese students. Future studies should examine the nuances of vegetarianism in more detail and their links with mental health, including dietary fat intake, whether or not fish, eggs, or dairy is eaten, and rationale for diet, including cultural beliefs and circumstances. Future researchers in this area may also want to consider the effects of experimental manipulation of diet on mental health outcomes over time.

#### Ethics approval and consent to participate

The Ethics Committee of the Faculty of Psychology of the Ruhr-Universität Bochum approved the study. Participants gave their informed consent orally after being informed about anonymity and voluntariness of the survey. Participants received no financial compensation.

#### Competing interests

The authors have no competing interests.

#### Funding

This study was supported by Alexander von Humboldt Professorship awarded to Jürgen Margraf by the Alexander von Humboldt-Foundation. We also acknowledge support by the DFG Open Access Publication Funds of the Ruhr-Universität Bochum.

## Authors' contributions

Kristen Lavallee was involved in analysis design and writing. Xiao Chi Zhang was involved in analysis design and writing. Johannes Michalak was involved in conducting analyses and writing. Juergen Margraf and Silvia Schneider were involved in study design, conceptualization, and approval of final drafts.

## Acknowledgments

We appreciate the contribution of the participants in this study, as well as Angela Bieda, Julia Brailovskaia, Pia Schönfeld, and Julia Velten for their assistance in data collection and management.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.jad.2019.01.035](https://doi.org/10.1016/j.jad.2019.01.035).

## References

- Cade, J, Burley, V, Greenwood, D, 2004. The UK Women's Cohort Study: comparison of vegetarians, fish-eaters and meat-eaters. *Public Health Nutr.* 7 (7), 871–878.
- Baines, S, Powers, J, Brown, WJ, 2007. How does the health and well-being of young Australian vegetarian and semi-vegetarian women compare with non-vegetarians? *Public Health Nutr.* 10 (5), 436–442.
- Timko, CA, Hormes, JM, Chubski, J, 2012. Will the real vegetarian please stand up? An investigation of dietary restraint and eating disorder symptoms in vegetarians versus non-vegetarians. *Appetite* 58 (3), 982–990.
- Jabs, J, Devine, CM, Sobal, J, 1998. Model of the process of adopting vegetarian diets: health vegetarians and ethical vegetarians. *J. Nutr. Educ.* 30 (4), 196–202.
- Fox, N, Ward, K, 2008. Health, ethics and environment: a qualitative study of vegetarian motivations. *Appetite* 50, 422–429.
- Key, T, Fraser, G, Thorogood, M, Appleby, P, Beral, V, Reeves, G, Burr, ML, Chang-Claude, J, Frentzel-Beyme, R, Kuzma, JW, et al., 1998. Mortality in vegetarians and non-vegetarians: a collaborative analysis of 8300 deaths among 76,000 men and women in five prospective studies. *Public Health Nutr.* 1 (1), 33–41.
- Appleby, P, Key, T, Thorogood, M, Burr, M, Mann, J, 2002. Mortality in British vegetarians. *Public Health Nutr.* 5 (1), 29–36.
- McEvoy, C, Temple, N, Woodside, J, 2012. Vegetarian diets, low-meat diets and health: a review. *Public Health Nutr.* 15 (12), 2287–2294.
- Burkert, NT, Muckenhuber, J, Großschädel, F, Rasky, E, Freidl, W, 2014. Nutrition and health – the association between eating behavior and various health parameters: a matched sample study. *Plos One* 9 (2).
- Hibbeln, JR, Northstone, K, Evans, J, Golding, J, 2018. Vegetarian diets and depressive symptoms among men. *J. Affect Disord.* 225, 13–17.
- Larsson, CL, Klock, KS, Nordrehaug, AA, Haugejorden, O, Johansson, G, 2002. Lifestyle-related characteristics of young low-meat consumers and omnivores in Sweden and Norway. *J. Adolesc. Health* 31, 190–198.
- Perry, CL, McGuire, MT, Neumark-Sztainer, D, Story, M, 2001. Characteristics of vegetarian adolescents in a multiethnic urban population. *J. Adolesc. Health* 29, 406–416.
- Michalak, J, Zhang, XC, Jacobi, F, 2012. Vegetarian diet and mental disorders: results from a representative community survey. *Int. J. Behav. Nutr. Phys. Activity* 9 (67).
- Stokes, N, Gordon, CM, Divasta, A, 2011. 63. Vegetarian diets and mental health in adolescents with anorexia nervosa. *J. Adolesc. Health* 48 (2) S50.
- Beezhold, BL, Johnston, CS, Daigle, DR, 2010. Vegetarian diets are associated with healthy mood states: a cross-sectional study in seventh day adventist adults. *Nutr. J.* 9 (26).
- Beezhold, BL, Radnitz, C, Rinne, A, DiMatteo, J, 2015. Vegans report less stress and anxiety than omnivores. *Nutr. Neurosci.* 18 (7), 289–296.
- Maercker, A, Zhang, XC, Gao, ZH, Kochetkov, Y, Lu, S, Sang, ZQ, Yang, SQ, Schneider, S, Margraf, J, 2015. Personal value orientations as mediated predictors of mental health: a three-culture study of Chinese, Russian, and German university students. *Int. J. Clin. Health Psych.* 15 (1), 8–17.
- Margraf J, Schneider S: Bochum optimism and mental health (BOOM) research program: background, methods and aims. Unpublished manuscript. 2018.
- Zhang, X-C, Kuchinke, L, Margraf, J, 2014. Modellierung von Methodeneffekten in einer populationsbasierten Studie. Manuscript Prep.
- Brooks, R, 1996. EuroQol: the current state of play. *Health Policy* 37 (53–72).
- The EuroQol Group, 1990. EuroQol—a new facility for the measurement of health-related quality of life. *Health Policy* 16 (3), 199–208.
- The EuroQol Group: EQ-5D-3L User Guide. 2013.
- Greiner, W, Weijnen, T, Nieuwenhuizen, M, Oppe, S, Badia, X, Busschbach, J, Buxton, M, Dolan, P, Kind, P, Krabbe, P, et al., 2003. A single European currency for EQ-5D health states. Results from a six-country study. *Eur. J. Health Econ.* 4 (3), 222–231.
- Janssen, MF, Pickard, AS, Golicki, D, Gudex, C, Niewada, M, Scalone, L, Swinburn, P, Busschbach, J, 2013. Measurement properties of the EQ-5D-5L compared to the EQ-5D-3L across eight patient groups: a multi-country study. *Qual. Life Res.* 22 (7), 1717–1727.
- Gorber, SC, Tremblay, M, Moher, D, Gorber, B, 2007. Diagnostic in obesity comorbidities - a comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes. Rev.* 8 (4), 307–326.
- Molarius, A, Berglund, K, Eriksson, C, Eriksson, HG, Linden-Bostrom, M, Nordstrom, E, Persson, C, Sahlqvist, L, Starrin, B, Ydreborg, B, 2009. Mental health symptoms in relation to socio-economic conditions and lifestyle factors - a population-based study in Sweden. *BMC Public Health* 9.
- Becker, ES, Margraf, J, Turke, V, Soeder, U, Neumer, S, 2001. Obesity and mental illness in a representative sample of young women. *Int. J. Obes.* 25, S5–S9.
- Currie, CE, Elton, RA, Todd, J, Platt, S, 1997. Indicators of socioeconomic status for adolescents: the WHO Health Behaviour in School-aged Children Survey. *Health Educ. Res.* 12 (3), 385–397.
- Henry, JD, Crawford, JR, 2005. The short-form version of the Depression Anxiety Stress Scales (DASS-21): construct validity and normative data in a large non-clinical sample. *Brit. J. Clin. Psychol.* 44, 227–239.
- Scholten, S, Velten, J, Bieda, A, Zhang, XC, Margraf, J, 2018. Universal assessment of depression, anxiety and stress? Meas. Invariance Across Eight Countries.
- Antony, MM, Bieling, PJ, Cox, BJ, Enns, MW, Swinson, RP, 1998. Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. *Psychol. Assessment* 10 (2), 176–181.
- Lovibond, PF, Lovibond, SH, 1995. The structure of negative emotional states - comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behav. Res. Ther.* 33 (3), 335–343.
- Bieda, A, Hirschfeld, G., Schönfeld, P., Brailovskaia, J., Zhang, X.C., Margraf, J., 2017. Universal happiness? Cross-cultural measurement invariance of scales assessing positive mental health. *Psychol. Assess.* 29 (4), 408–421. <https://doi.org/10.1037/pas0000353>.
- Lukat, J., Margraf, J., Lutz, R., an der Veld, W., Becker, E.S., 2016. Psychometric properties of the Positive Mental Health Scale (PMH-scale). *BMH Psychol.* 4 (8). <https://doi.org/10.1186/s40359-016-0111-x>.
- Margraf, J, Lavallee, K, Zhang, XC, Schneider, S, 2016. Social rhythm and mental health: a cross-cultural comparison. *Plos One* 11 (3).
- Cohen, J, 1988. *Statistical Power Analysis for the Behavioral Sciences*, edn. Academic Press, New York.
- Lea, E, Worsley, A, 2003. Benefits and barriers to the consumption of a vegetarian diet in Australia. *Public Health Nutr.* 6 (5), 505–511.