Original Article

Physical Health Complaints in Adolescents

Findings From the 2018 Brandenburg HBSC Study

Avelina Lovis-Schmidt[1], Ludwig Bilz[2], Kyra Pahlke[3], and Heiner Rindermann[1]

[1]Department of Psychology, Chemnitz University of Technology, Germany
[2]Institute of Health Sciences, Brandenburg University of Technology Cottbus-Senftenberg, Germany
[3]Dr Fontheim Health System, Liebenburg, Germany

Abstract: *Background*: Some of the physical health complaints adolescents have, such as headaches and stomachaches, cannot be explained on a somatic level. It is unclear which psychological factors can explain these complaints: stress and social support are often discussed, but emotions rarely are. *Aims*: This cross-sectional study aims to use social support, stress, the tendency toward negative emotions, and health behaviors to predict physical health complaints in adolescents. *Method*: The 2018 HBSC (Health Behavior in School-aged Children) data from the German state of Brandenburg was analyzed via structural equation and path modeling (N = 3,068, age M = 13.05). *Results*: Results showed that the tendency toward negative emotions seems to be a better predictor for health complaints (β = .35) than stress (β = .17), and even better suited than social support (β = −.08) or health behavior (β = −.06 to β = .16). In the analysis of specific emotions (anger, sadness, and fear), correlations were low and between sadness and complaints they were highest (average β = .19). *Limitations*: The present cross-sectional study could not examine long-term outcomes. In addition, the results are limited to only a few physical complaints. Future long-term studies should examine multiple disease symptoms in adolescence. *Conclusion*: The investigated *tendency toward negative emotions* demonstrated promising results to better understand the relationship between psychological factors and physical health complaints. As negative emotions were particularly important in predicting physical health, prevention programs for adolescents should focus on dealing with negative emotions to improve their health.

Keywords: emotion and stress, social support, health complaints, HBSC-study, adolescents

Surveys have shown that between 5% and 13% of adolescents often suffer from headaches and stomach aches, most of which cannot be explained on a somatic level (Eminson, 2007). Finding the decisive psychological factors for explaining disease development in clinical practice could help make more precise decisions and help patients in the long-term (Niles & O'Donovan, 2019). Health in adolescence is a good indicator of health in adulthood since most unfavorable behavior from adolescence becomes entrenched (Eminson, 2007; Kinnunen et al., 2010). Although psychological factors have already been discussed as influencing factors, there is disagreement about the decisive predictor: stress (McEwen, 2008), social support (Cohen, 2004), and emotions (Salovey et al., 2000) have proven to be valuable in this regard. Nevertheless, emotions as predictors are still rather neglected in research on developing and treating physical diseases (Mikolajczak et al., 2015; Niles & O'Donovan, 2019). In addition, the findings from emotional research with adults cannot simply be transferred to young people (Gross & Cassidy, 2019). Therefore, independent study is needed for adolescents.

Stress and Physical Health Complaints

Stress is described as an unspecific response of the organism to a disturbance of the inner balance, and it can be a key variable for various physical diseases (Pinel et al., 2019). Through the two stress systems (*anterior pituitary adrenal cortex system* and the *sympathetic adrenal medulla system*), hormones and neurotransmitters are released that are supposed to help the body defend itself against parasites (Hostinar et al., 2014; McEwen, 2008) but cause harm in the long-term (Pinel et al., 2019). According to the *Transactional Model* of Lazarus and Folkman (1987), stress can lead to emotional, cognitive, and behavioral changes and results, as already described above, in changes that are detrimental to health in the long-term. There are initial studies confirming the assumptions on adolescents between 11 and 15 years of age (e.g., Torsheim & Wold, 2001). Pupils who reported high stress levels were characterized by less favorable health behavior and more frequent psychological (tension, nervousness, depression) and physical health complaints (PHC; headaches, stomach aches, backaches,

dizziness; Torsheim & Wold, 2001). We want to replicate those findings and therefore propose the first hypothesis: stress favors the occurrence of PHC in adolescents (Hypothesis 1, H1).

Social Support and Physical Health Complaints

Social support is valuable in predicting physical health in past studies (Chen et al., 2017; Cohen, 2004). Perceptions of social support are based on information that suggests a person is cared for, loved, valued, and a network member with mutual obligations (Bilz et al., 2016). Some works have pointed to the close link between stress and social support (Hostinar et al., 2014; Miller et al., 2011). The *Stress Buffer Model* (Chen et al., 2017) assumes that close family relationships can be a stress-buffering factor, which can be associated with physical health in adolescence and adulthood (Chen et al., 2017; Miller et al., 2011). School-related stress (promoting PHC) and social support (buffering) is related to PHC (Torsheim & Wold, 2001), but in this study, social support has not been divided by family and friends. Especially in adolescence, differences can be expected (Chen et al., 2017; Jovic-Vranes et al., 2005), which is why it will be considered differentiated in the present work. The second hypothesis focuses on the relationship between social support and PHC of adolescents, assuming a negative association (Hypothesis 2, H2).

Health Behaviors and Physical Health Complaints

Health behaviors are used in some studies to predict health (e.g., Braverman et al., 2017; Mikolajczak et al., 2015). It was consistently shown that health-promoting behaviors (HPB), such as a healthy diet and physical activity, have a positive effect on physical health. In contrast, health-impeding behaviors (HIB), such as smoking and alcohol consumption, have a negative effect on health (Inchley et al., 2018). Some work also demonstrated that HIB had a more significant (negative) impact on health than HPB (Holt-Lunstad et al., 2010; Holt-Lunstad & Smith, 2012). We assume in a third hypothesis that HPB (nutrition and exercise) are negatively correlated to PHC in adolescents (Hypothesis 3.1, H3.1) and that HIB (smoking and alcohol) are positively correlated to PHC in adolescents (Hypothesis 3.2, H3.2).

The Additional Value of Emotions

There is a recent trend for examining emotions when it comes to predicting physical health (Faller & Lang, 2019; Lazarus, 1993; Salovey et al., 2000; Schubert, 2015; Stock & Badura, 1995), partly because of the heterogeneous nature of stress findings (e.g., Steptoe & Vögele, 1986). There are several findings that emotions are even more important to physical health than other psychological factors (e.g., personality; Badenes et al., 2016). Emotions are a crucial signal to the organism, indicating the meaning of situations and thoughts and thus whether action is needed or not (Izard, 2009; Pinel et al., 2019). Many studies have shown that emotions trigger various mechanisms at the physical level depending on their function (for a summary, see Pinel et al., 2019). The influence of emotions on physical health has been confirmed in experimental studies (Rein et al., 1995; Sinha et al., 1992). When emotions are experienced as negative in the long term, they trigger unfavorable biological mechanisms and promote long-term physical damage (Faller & Lang, 2019; Henry, 1989, 1992; Schubert, 2015). These connections in adolescence have rarely been investigated, although the few studies which have been conducted returned promising data (e.g., Badenes et al., 2016; Kröner-Herwig et al., 2008). The benefit of the present study lies primarily in the intention to address this sample. The fourth hypothesis thus assumes that the tendency toward negative emotions (anger, sadness, fear) is positively related to PHC (Hypothesis 4.1, H4.1) and that this relationship is the strongest in comparison to the other psychological factors (stress and social support; Hypothesis 4.2, H4.2).

Furthermore, we compare the influence of psychological and behavioral factors. While studies examining health behaviors alone found stable effects between health behaviors and PHC (Braverman et al., 2017), the influence of health behaviors was smaller than expected in studies when psychological variables were also used to predict physical health (Holt-Lunstad et al., 2010; Holt-Lunstad & Smith, 2012; Mikolajczak et al., 2015; Niles & O'Donovan, 2019). Thus, anxiety and depression are good predictors of physical health comparing to health behaviors, in some cases with larger effects (Niles & O'Donovan, 2019). We aim to examine whether psychological factors (stress, social support, emotion) or health behaviors (healthy eating, physical activity, alcohol, and smoking) are better at predicting PHC in adolescents (Research Question 1, RQ1).

A particular focus will be on the investigation of specific emotions. Researchers argue that different qualities of emotion affect other parts of the body (Henry, 1989, 1992; Izard, 2009), which has been suggested in past studies. For predicting adolescent headaches, anxiety was shown to be more predictive than anger (OR = 1.36, OR = 1.16; Kröner-Herwig et al., 2008), which Niles and O'Donovan (2019) confirmed in their analyses for general physical illness in young people. We want to distinguish three qualities of negative emotions: anger, sadness, and fear, and test their

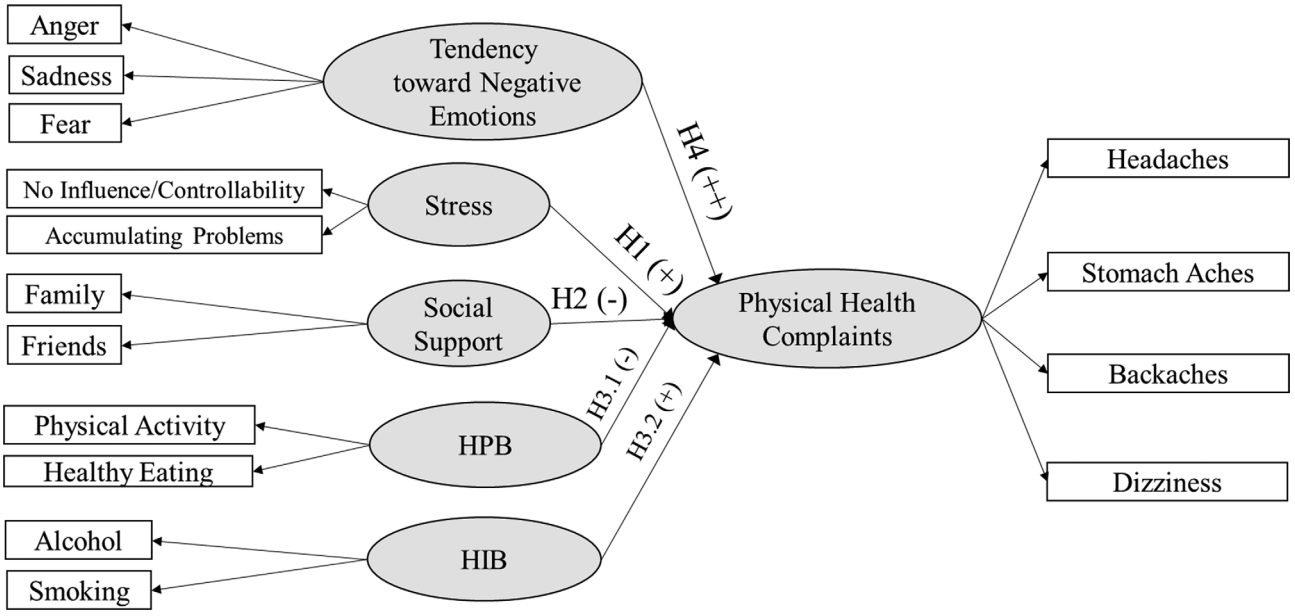

Figure 1. Structural equation model: Prediction of physical health complaints through psychological and behavioral factors to test H1–H4.

effects explorative for predicting specific PHC (Research Question 2, RQ2).

Aim of the Present Study

The present study aims to enable the prediction of PHC in adolescents. We will distinguish between psychological (tendency toward negative emotions, stress, and social support) and behavioral factors (healthy eating, physical activity, alcohol, and smoking). Two models were computed. In the first model (structural equation model, Figure 1), Hypotheses 1–4 were tested. We also test whether psychological or behavioral factors have higher correlates with PHC (RQ1).

The second model (path model, Figure 2) examines in more detail which emotion has the most significant effect on PHC in people between 11 and 15 years old (RQ2). We focus on negative emotions, more precisely anger, sadness, and fear, within the last 6 months.

Method

The data were taken from Health Behavior in School-aged Children (HBSC) conducted in Brandenburg, Germany, in 2018 (John & Bilz, 2020). The HBSC study is an international school-based cross-sectional survey conducted closely with the World Health Organization (WHO). The HBSC study aims to capture the health and health behavior of adolescents in grades five, seven, and nine. In 2018, the German federal state of Brandenburg participated in the HBSC study for the first time, with its representative sample.

Implementation of the Study

The data used are taken from the Brandenburg HBSC survey, which took place between April and November 2018. The Brandenburg University of Technology Cottbus-Senftenberg (BTU), in cooperation with the Federal Ministry of Education, Youth and Sport of Brandenburg; the Federal Ministry of Social Affairs, Health, Integration and Consumer Protection of Brandenburg; and the health insurance company AOK Nordost carried out the survey. The implementation of the study was approved by the Ministry of Education, Youth and Sport of the State of Brandenburg (registration number 07/2018). The ethics commission of the BTU Cottbus-Senftenberg confirmed the study (file number: EK2018-6). The pupil's participation was voluntary but could only be approved with both their consent and that of a parent.

The sample design (stratified cluster sample) was based on the research protocol of the international HBSC consortium (Inchley et al., 2018). The aim was to achieve a number of n = 1,200 pupils per grade (5, 7, 9) based on the internationally recommended sample size (Inchley et al., 2018). The drawing of the samples was carried out at the school level with Probability Proportional to Size Design (PPS Design; Yates & Grundy, 1953). This approach ensures that the pupil's probability of being drawn is not affected by school size. It is estimated that N = 63,000 pupils currently

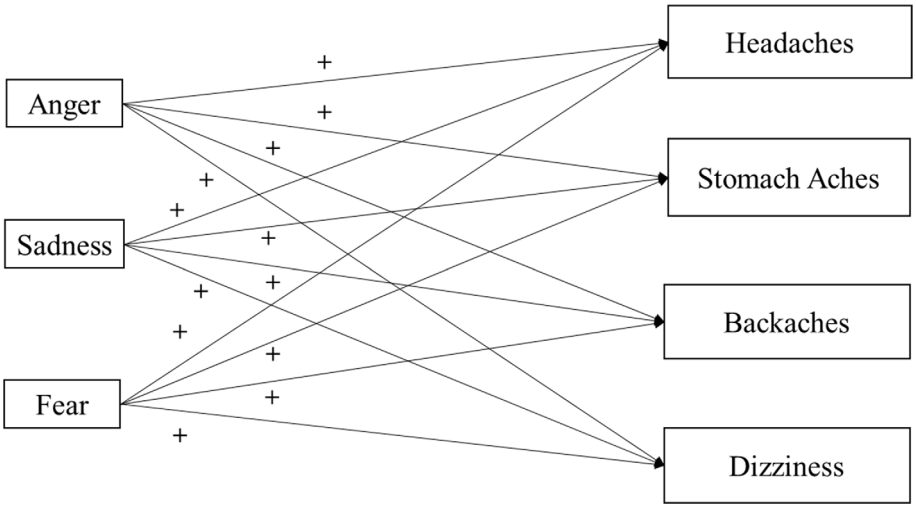

Figure 2. Path model: Prediction of physical health complaints through anger, sadness, fear.

attend the 5th, 7th, or 9th grade in Brandenburg. The sample was drawn based on two stratification characteristics: school (primary school, secondary school, comprehensive school, attended high school, special school) and grade (5, 7, 9).

The schools (k = 158) were randomly selected and contacted, with a projected rejection rate of 20% at pupil level and 40% at school level. Each school was sent a letter inviting them to participate and informing them about the content and organization of the study. After the school agreed to participate, the material was sent to their internal contact person. They were then given the task of handing over the material to the teachers, who distributed the questionnaires to their classes. After being filled in by the pupil, each questionnaire was enveloped, and were mailed to the BTU project staff.

Sample Description

Of the schools contacted, k = 55 schools with 217 classes and N = 3,068 pupils ultimately participated in the study. The response rate at the school level was 34.8% and 66.1% at the pupil level. The participating schools were spread over 18 different districts of Brandenburg. The gender ratio was fairly balanced, with n = 1,584 girls (51.6%) and n = 1,471 boys (47.9%). Another n = 13 people did not indicate their gender; the reasons for this remain unknown. The pupils were between 8 and 17 years old; overall, the mean age of the sample was M = 13.05 (SD = 1.77). The pupils attended various types of schools: primary school (n = 838; 27.3%), secondary school (n = 783; 25.5%), comprehensive school (n = 268; 8.7%), special school (n = 165; 5.4%), and the highest proportion attended high school (n = 1,014; 33.1%).

Operationalization of the Constructs in the Questionnaire

The questionnaire comprised 33 pages and thus provided very comprehensive data. The questionnaire consisted of several parts: the internationally used main questionnaire, the national setting of priorities, and the extension for the state of Brandenburg. Topics covered were health, family situation, violence and bullying, attitudes toward specific groups of people, media use, and, only in 9th grade, experience with sex and drugs. Answering the questions took about 60 min on average. The paper-pencil questionnaire was answered anonymously within the respective school.

Collection of Sociodemographic Data

Sociodemographic data were collected, to determine gender, age, and type of school. Gender was determined by a binary question ("Are you a boy or a girl?"). The pupils were then asked for their date of birth. Age was determined by the difference between the date of birth and the date of the survey in the schools. The type of school and the respective district were documented externally rather than individually recorded by the respondents for economic reasons.

Measurement of Perceived Stress

For measuring perceived stress, the Shortened Perceived Stress Scale (PSS-4; Cohen et al., 1983) is widely accepted and was therefore used in this study. It was translated into German by Klein and colleagues (2016). The shortened version is based on the four items that correlate most closely with the overall scale. In the questionnaire, subjects are asked how often in the last month they felt unable to control the course of important things or unable to cope with increasing difficulties. The answers range from 1 (= *never*)

to 5 (= *very often*). The scale has shown satisfactory internal consistencies in recent works, α = 0.72 to α = 0.84 (Cohen et al., 1983; Glasscock et al., 2013). In past studies (Cohen et al., 1983; Sood et al., 2013), good values have been shown in convergent validity about other inventories (e.g., psychological distress, r = .28). In addition, the scale has been validated qualitatively and quantitatively on 14- and 15-year olds (Glasscock et al., 2013). The internal consistency cannot be confirmed in the present study (α = .47). Using the two negatively formulated items increased the Cronbach's α = .64, only these will be used in this study to measure stress.

Measurement of Social Support

In this study, social support was subdivided into social support from family and social support from friends and was applied from the Multidimensional Scale of Perceived Social Support (MSPSS; Zimet et al., 1990). The scale for recording social support from people other than friends and family (significant others) was not used here. The internal reliability in recent works (Zimet et al., 1990) is very good, with α = .90 (family) and α = .91 (friends), which can be confirmed in the present study (family, α = .91, and friends, α = .88). In past studies the convergent validity of these scales was confirmed with medium to high correlations and the scale for family and friends inter-correlates highly, with r = .44 (Zimet et al., 1990). The scales are often used for young people because of their brevity and comprehensibility (Inchley et al., 2018). Eight items are measured, which can be answered from 1 (= *very strongly disagree*) to 7 (= *very strongly agree*). The items ascertain whether the person feels supported and whether they have someone among their family or friends to approach with problems. The items are all positively formulated. Four items for social support from family and four items for social support from friends can be combined into mean scores.

Measurement of the Tendency Toward Specific Emotion

The Strengths and Difficulties Questionnaire (SDQ) has been often used in various countries to diagnose mental health problems in adolescents (e.g., Goodman & Goodman, 2009). Furthermore, it has been translated into German and validated on German samples (Lohbeck et al., 2015). We took two items from the subscale for emotional problem areas to examine sadness and fear and one item from the subscale for externalizing behavioral problems to measure anger. The wording of the items was: "I get very angry and often lose my temper" (anger), "I am often unhappy, down-hearted or tearful" (sadness), and "I have many fears, I am easily scared" (fear). The remaining items on the subscale for emotional problems (e.g., the tendency toward worry and nervousness/clinginess) were not selected because we do not regard them as emotions in the narrower sense. All statements refer to the past 6 months. The items are answered in three degrees: 1 (= *not true*), 2 (= *somewhat true*), and 3 (= *certainly true*). We assume that a high value reflects the person's tendency to have experienced that emotion more often. The internal consistency in the present study is α = .67 and is satisfactory considering the low number of items.

Measurement of Health-Promoting and Health-Impeding Behaviors

Two types of behaviors are distinguished: HPB, including healthy eating and physical activity, and HIB, including the consumption of alcohol and cigarettes (Inchley et al., 2018). Healthy eating was assessed with the Food Frequency Questionnaire used in HBSC studies (Inchley et al., 2018). It was operationalized by the frequency of eating fruit and vegetables within a week. The subjects gave their answers on a 7-point scale, from 1 (= *never*) to 7 (= *several times a day*). The item should serve as an indicator of general healthy eating, even if it does not reflect all healthy diets. Physical activity was measured by the frequency of exercise (at least 60 min of physically strenuous activity) per week (Prochaska et al., 2001). The measure is based on the WHO's recommendation of one hour of physical activity per day for young people under 18. The response could range from 0 (= *on zero days*) to 7 (= *on seven days*). The scale is of high quality (Liu et al., 2010): the intraclass correlation is r = .82, and the validity with objective measurements of motion (Computer Science and Applications Accelerometer) is r = .37. HIB was measured by alcohol and smoking in the last 30 days (Inchley et al., 2018). Both items were recorded by a question about how many days the person had drunk alcohol or smoked cigarettes. The pupils answered on a 7-point scale, from 1 (= *never*) to 7 (= *30 days or more*).

Measurement of PHC

PHC has been recorded in HBSC studies since 1986 using the HBSC Symptom Checklist, covering eight types of complaints (Inchley et al., 2018). A two-factor solution has proven to be optimal for an overall factor, whereby a distinction is made between psychological symptoms, such as depression and physical symptoms, such as backaches (Haugland & Wold, 2001; Torsheim & Wold, 2001). It has been shown that the scale can be used flexibly and that analyses at an item level are also meaningful (Ravens-Sieberer et al., 2008; Torsheim & Wold, 2001). In the present study, the focus will be exclusively on *physical* health complaints to avoid confounding effects with the SDQ items. PHC includes headaches, stomach aches, backaches, and dizziness. Symptoms were rated for frequency over the last 6 months, from 1 (= *daily*) to 5 (= *never*). As with general

Table 1. Descriptive statistics of all variables

	M	*SD*	Min	Max	Time
Anger	1.52	0.65	1 (*low*)	3 (*high*)	Last 6 months
Sadness	1.43	0.65	1 (*low*)	3 (*high*)	Last 6 months
Fear	1.42	0.62	1 (*low*)	3 (*high*)	Last 6 months
Stress	2.66	0.67	1 (*never*)	5 (*very often*)	Last month
Social support from family	5.85	1.49	1 (*low*)	7 (*high*)	In general
Social support from friends	5.59	1.47	1 (*low*)	7 (*high*)	In general
Healthy eating	4.75	1.49	1 (*never*)	7 (*several times a day*)	Typical week
Physical activity	2.92	1.48	0 (*never*)	7 (*on 7 days*)	Typical week
Alcohol	1.37	0.89	1 (*never*)	7 (*30 days or more*)	Last month
Smoking	1.26	1.07	1 (*never*)	7 (*30 days or more*)	Last month
Headaches	3.81	1.21	1 (*never*)	5 (*daily*)	Last 6 months
Stomach aches	4.05	1.07	1 (*never*)	5 (*daily*)	Last 6 months
Backaches	4.00	1.24	1 (*never*)	5 (*daily*)	Last 6 months
Dizziness	4.27	1.10	1 (*never*)	5 (*daily*)	Last 6 months

Notes. *M* = Mean; *SD* = Standard Deviation; Min and Max = Range of possible answers, and their descriptions; Time = The period of time included in the question.

health, the values have been inverted: the higher the score is, the more often the person has experienced PHC. The retest reliability turned out to be satisfactory at $r = .79$, and the content validity was confirmed by interviews with adolescents (Haugland & Wold, 2001). In the present study, the internal consistency was satisfactory with $\alpha = .68$.

Statistical Analysis

To test the hypotheses, two models were established: a structural equation model to measure the proportion of various psychological and behavioral variables on PHC (H1–H4 and RQ1) and a path model to test the associations between specific emotions and PHC (RQ2). Along with the suggestions of Leys and colleagues (2019) for dealing with outliers, we deleted only a few values ($n < 10$). For the estimation of parameters, the maximum-likelihood method was used. While missing values in the structural equation model were estimated through FIML (full information maximum likelihood; final $N = 3{,}068$), the missing data in the path model were deleted listwise via Mplus (final $N = 3{,}046$). We assume that the listwise deletion of $n = 24$ cases did not significantly affect the results, as the values were not systematically missing and less than 5% of the data were involved. Besides the structural model, the measurement models were tested by confirmatory factor analysis. The factor loadings (λ is good from .50; Hoyle, 2012) are the correlation of the variable and the factor, and the squared load is the amount of the total variance of the variable due to the factor (Hair et al., 2018). The path model only shows manifest variables, which allows a more specific examination of individual constructs (RQ2). We indicated three different types of fit indices because they can be affected by model complexity or sample size (Kline, 2015). By stating the normalized χ^2-value (relation between the χ^2-test and the degrees of freedom), the absolute fit can be determined. A value below three is considered as an acceptable model fit (Kline, 2015). Second, we specified the value of the Bentler Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI), which can be evaluated as good with > .95 (Hu & Bentler, 1998). In addition, absolute indices were used to investigate the accuracy of fit: the standardized mean square root residual (SRMR) and the mean square root error of the approximation (RMSEA), which is sensitive to model complexity and satisfactory up to a value of 0.05 (Hoyle, 2012; Hu & Bentler, 1998; Kline, 2015). In both models, standardized beta coefficients are used to compare the relationship between distinct variables to a criterion. To test the effects for difference (H4.2 and RQ1), in addition to the *p*-value, Williams' *t* will be presented (Williams, 1959), which allows the comparison of regression coefficients in dependent samples (same criterion PHC).

Results

Descriptive Analyses

Table 1 shows the descriptive characteristics of the variables used. Regarding emotions, anger was felt most frequently in the last 6 months, sadness and fear a little less. Emotions and stress are in the middle range of the answer rating scale. The adolescents felt socially supported, a little more by their family than friends. In a typical week, pupils ate fruits and vegetables more frequently than they

Table 2. Correlations of the latent variables

	1	2	3	4	5	6
1. Tendency to negative emotion	–	.45**	−.19**	−.07**	.11**	.35**
2. Stress		–	−.23**	−.04	.21**	.36**
3. Social support			–	.16**	−.10**	−.19**
4. HPB				–	−.05*	−.01
5. HIB					–	.21**
6. PHC						–

Notes. N = 3,068. Pearson correlation (r). Generation of latent variables via principal component analysis in SPSS; Tendency to negative emotions: anger, sadness, fear in the last 6 months; Social support: social support from family, and friends; Health-Promoting Behavior (HPB): Healthy Eating/Physical Activity; Health-Impeding Behavior (HIB): Alcohol/smoking; Physical Health Complaints (PHC): headaches, stomach aches, backaches, dizziness. **p < .001; *p < .01.

did physical exercise. Alcohol and cigarettes were rarely consumed, although alcohol was used a little more frequently. The table also shows that PHC was experienced above the theoretical average of the answer rating scale, while dizziness was the most common and headaches the least common of PHC over the last 6 months.

Testing the Hypotheses With the Models

The first goal of the present study was to predict PHC through psychological (emotions, stress, and social support) and behavioral (healthy eating, physical exercise, alcohol, and smoking) factors. Table 2 provides the correlations between the six latent variables (tendency toward negative emotion, stress, social support, HPB, HIB, and PHC) extracted as principal components in SPSS. The highest correlation was found between the tendency toward negative emotions and stress (r = .45). All other predictors correlated rather low to medium-high (r = −.07 to r = −.23). There were mixed correlations with PHC: the highest with emotions (r = .35) or stress (r = .36), small to medium with social support (r = −.19) and HIB (r = .21), and not at all with HPB (r = −.01).

Prerequisites to Test Hypotheses 1–4

The structural equation model can be seen in Figure 3. The fit indices for the model were very good, with CFI = .967 and TLI = .954, and with SRMR = .026 and RMSEA = .031. The χ^2-value was 299.763. Considering the degrees of freedom (df = 75), the normalized χ^2-value (= 3.98) is unsatisfactory, although the value tends to be biased by large samples. The results from the measurement models (Figure 3) varied: for the emotions, only sadness seemed to clear up more than 50% of the latent variable; fear and anger somewhat less. The results were similar for stress and social support, with the two items revealing distinct amounts of variance. Nutrition clarified the HPB-variable better than exercise. HIB showed similarly high factor loadings of the two variables and is therefore satisfactory. The explained variance for PHC fell into the middle range, with the lowest variance in explanation for backaches (20%), and the highest for headaches and dizziness (46%). As the structural model showed, 65% of the variance of PHC could be explained by the predictors, which could be considered as high.

Psychological, Behavioral Factors and Physical Health Complaints

To evaluate the hypotheses (H1–H4), the coefficients presented along the paths can be used (Figure 3). It can be seen that stress and PHC (H1) were positively associated with β = .17 (SE(β) = .05, 95% CI for β [.08, .27]). The association of social support with PHC (H2) was weaker (β = −.08, SE(β) = .03, 95% CI for β [−.15, −.02]), but still significant and negative. Hypotheses 1 and 2 can be confirmed, although only with small effects. There was also a negative connection between HPB and PHC (β = −.06, SE(β) = .03, 95% CI for β [−.14, .00]) and a positive connection between HIB and PHC (β = .16, SE(β) = .03, 95% CI for β [.11, .22]). Accordingly, we can also confirm Hypotheses 3.1 and 3.2. The tendency toward negative emotions had a significant and positive link with PHC (β = .35, SE(β) = .05, 95% CI for β [.26, .45]). While Hypothesis 4.1 can thus be confirmed, the psychological effects should be compared to test Hypothesis 4.2. The tendency toward negative emotions proved to be the strongest predictor of PHC and is significantly different from the other psychological factors (stress, t(3,065) = 4.90, p < .001; social support, t(3,065) = −23.86, p < .001). RQ1 dealt with the comparison between the psychological and behavioral factors for predicting PHC. The mean value of the amounts was calculated (mean β for psychological effects = .20, mean β for behavioral effects = .12). Psychological factors explained PHC better than behavioral factors, t(3,065) = 2.1687, p = .030.

Prerequisites for Testing the Specific Effect of Emotions

The second model was used to examine to what extent specific emotions predict specific PHC (RQ2). Examination

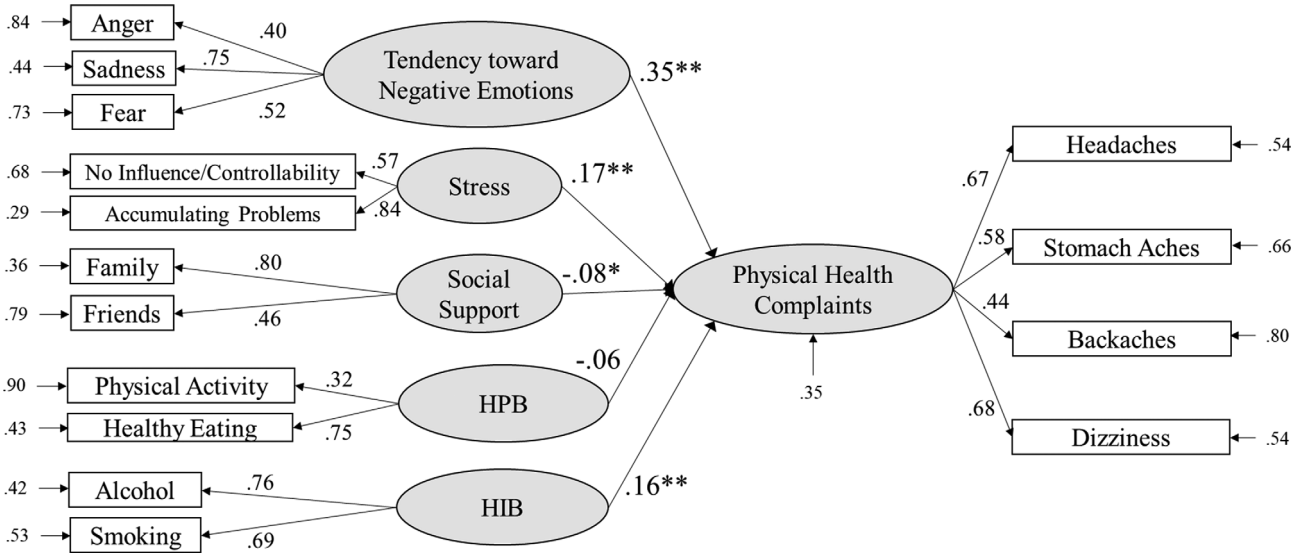

Figure 3. Results of the structural equation model: prediction of physical health complaints trough psychological and behavioral factors. Psychological factors (tendency toward negative emotions, stress, and social support) and behavioral factors (HPB and HIB) on physical health complaints; *N* = 3,068; Standardized beta along the paths; $^{**}p < .001$, $^{*}p < .01$.

of the correlations revealed small to medium Pearson coefficients between emotions and PHC. All correlations were significant with $p < .001$. On average, sadness showed the highest correlation with PHC ($r = .15$ to $r = .29$). Small to medium effects were seen between fear and stomach aches ($r = .20$), dizziness ($r = .20$) and headaches ($r = .18$). The correlation between fear and backaches was almost zero. Consistent but small correlations between anger and PHC were found ($r = .12$ to $r = .14$). The path model can be seen in Figure 4. We decided on a parsimonious model and therefore eliminated four paths. The differences of the coefficients between the initial and the modified models were minor (results from χ^2-difference-test, $p = .004$). The results from the χ^2-test were unsatisfactory ($\chi^2 = 15.642$, $df = 4$, $p = .004$). However, the other fit indices were very good (CFI = .995, TLI = .976, SRMR = .015, RMSEA = .031). Through the emotions, far less variance in PHC could be explained than in the structural equation model. All these values were small (3% to 9%).

Specific Emotions and Specific Physical Health Complaints

Sadness had on average the strongest associations with all PHC: the most with dizziness (β = .25, 95% CI for β [.21, .28]), slightly less with headaches (β = .20, 95% CI for β [.17, .24]) and stomach aches (β = .19, 95% CI for β [.15, .23]), and the least with backaches (β = .13, 95% CI for β [.09, .16]). Anger had only a small relation to backaches (β = .07, 95% CI for β [.03, .10]) and was statistically significant. Fear showed a small link with stomach aches (β = .13, 95% CI for β [.09, .16]), headaches (β = .10, 95% CI for β [.06, .13]) and dizziness (β = .10, 95% CI for β [.07, .14]). On average, sadness shows the highest effects on PHC (on average β = .19), followed by fear (on average β = .11), and finally anger, although the effects are largely not significant.

Discussion

Interpretation of the Results

The present study aimed to examine the association between psychological factors and PHC, using two models. The hypotheses and their evaluation are shown in Table 3. In the first model, the predictors were compared to each other for their association level with PHC. The link between stress and PHC was positive and significant (β = .17). This means that adolescents who felt more stress also reported more PHC. The first hypothesis was therefore confirmed. When testing the second hypothesis, in which we assumed that social support had a negative association with PHC, a weaker relationship was revealed (β = −.08). Thus, the results of earlier studies, which pointed to the decisive role of stress or social support on physical health (Hostinar et al., 2014; Miller et al., 2011; Torsheim & Wold, 2001), could not be fully confirmed.

Furthermore, HPB was not related to the occurrence of PHC (H3.1). HIB was among the expectations positively related to PHC (β = .16; H3.2). According to this, it made no difference to adolescents whether they exercised or

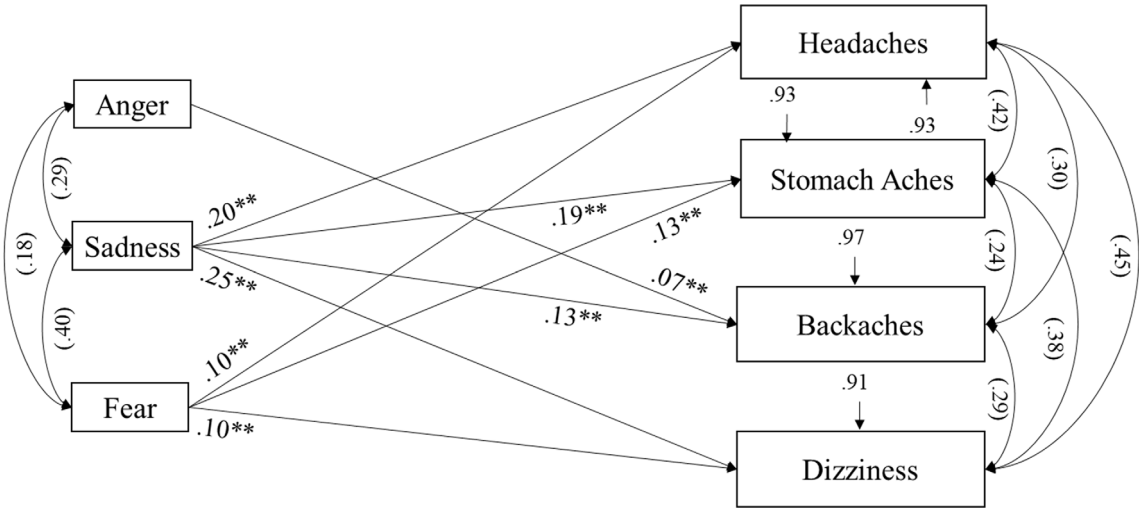

Figure 4. Results of the path model: Prediction of physical health complaints trough anger, sadness, fear. *N* = 3,046, parsimonious model. Standardized beta along the paths. $^{**}p < .001$, $^{*}p < .01$.

Table 3. Hypotheses in summarize

Hypothesis	Result	Conclusion
H1: Stress and PHC in adolescents are positively related.	β = .17**	Confirmed
H2: Social support and PHC in adolescents are negatively related.	β = −.08*	Confirmed
H3.1: HPB (diet and exercise) are negatively related to PHC in adolescents.	β = −.06	Not confirmed
H3.2: HIB (alcohol and smoking) and PHC in adolescents are positively related.	β = .16**	Confirmed
H4.1: The tendency toward negative emotions is positively related to PHC in adolescents.	β = .35**	Confirmed
H4.2: Tendency toward negative emotions is the strongest psychological predictor of PHC (compared to other psychological predictors).		Confirmed
RQ1: Are psychological or behavioral factors better suited to predict PHC in adolescents?		Psychological factors showed higher average effects on PHC than behavioral factors.
RQ2: Which of the emotions has the strongest connection with which of the PHC?		Sadness showed the highest effects on PHC.

Notes. H = Hypothesis; RQ = Research Question; PHC = Physical Health Complaints; HPB = Health-Promoting Behavior; HIB = Health-Impeding Behavior. $^{**}p < .001$; $^{*}p < .01$.

had a healthy diet, but it did make a difference whether they drank alcohol or smoked cigarettes.

Tendencies toward negative emotions had the highest association with PHC (β = .35; H4.1). The greater the tendency toward negative emotions, the less healthy the adolescent felt regardless of the situation. This effect was significantly dissimilar from the other psychological factors (stress, social support; H4.2). Although the effect of negative emotions on physical health has already been found in experimental (e.g., Rein et al., 1995) and longitudinal studies (e.g., Niles & O'Donovan, 2019), it represents new knowledge for adolescence and in comparison with other psychological factors. In another question (RQ1), we found that psychological factors were, on average better at predicting PHC than behavioral factors. This finding overlaps with those of Mikolajczak and colleagues (2015), Niles and O'Donovan (2019), and with the inferences from Holt-Lunstad and colleagues' meta-analyses (Holt-Lunstad et al., 2010; Holt-Lunstad & Smith, 2012): while health-impeding behaviors have a similarly high association with PHC as psychological factors, the association of health-promoting behaviors is vanishingly small.

In a second model, the relation of specific emotions to PHC was investigated in more detail (RQ2). Following the biological emotion-stress model of Henry (1992), we assumed that specific emotions could trigger distinct aspects of PHC. Different large effects of emotions on specific PHC were shown, although the associations remained relatively small. PHC had the highest association with sadness (on average β = .19). Although the smallest associations were found between anger and PHC, it tended to be related to backaches (β = .07). Anger could affect health mainly through its suppression instead of its expression (Mund & Mitte, 2012). Fear was more likely to be associated with

stomach aches (β = .13). However, this might have been related to digestive processes that could not be regulated in the permanent state of fear (Niles & O'Donovan, 2019; Pinel et al., 2019).

Critical Reflections of the Present Study

In the present study, one point of criticism is the cross-sectional research design. We cannot infer the direction of the association with only one measurement point. Accordingly, it could also be that PHC triggers stress and negative emotions. To exclude this argument, we referred to longitudinal and experimental studies that support the direction we assumed in our study (Danner et al., 2001; Kao et al., 2005; Niles & O'Donovan, 2019; Rein et al., 1995).

Almost all coefficients proved to be relatively low, especially the effects of emotions on PHC in model 2 (Figure 4). We critically note that the sample size is responsible for the significance of the small effects. Some authors urge caution for retrospective surveys (e.g., Conner & Feldmann Barrett, 2012). They state a difference between momentary and retrospective surveys, assuming two different types: the "experiencing" and the "remembering" self. As the remembering self seems to be more important for long-term planning and decision making, there are weaker relationships with bodily processes than with the experiencing self. A further explanation of the small effects lies in the changing format of the response criteria or the length of the examination. For example, it remains unknown how much the duration of written surveys affected the answers (Shaw et al., 2018). Another question concerns whether adolescents can assess how well they have felt in recent months, as even adults sometimes have difficulties identifying and reporting concrete emotional states (Pandey & Choubey, 2010).

Problems With the Survey of Social Support and Stress

Social support had a weak relationship to PHC. This suggests that social support, by itself, is not linked to PHC when adjusted for the other variables (stress, emotions, and behavior). This variable may be more suitable as a moderator variable between emotion and PHC, as Chen et al. (2017) have already suggested. There were also some problems with the stress variable regarding internal consistency. Even after excluding two items, the Cronbach's α was only mediocre. Future studies should check this and record the stress variable in more detail than it was done in the present study.

Problems With the Health Behavior Survey

Since various associations with health in adolescence were found between HPB and HIB, their separation seems advisable for future studies. A further factor analysis was carried out to check whether more than just the two variables used reflected health-related behaviors (dental hygiene, unhealthy diet, drug use, sexual contraception). This revealed more factors than two, which would have made our model overly complex. In addition, the results of health-promoting behaviors could have been distorted by the response options (frequency from 1 hr daily and upwards). All persons who exercise less than one hour daily are not taken into account, although this presumably already has positive effects on health. Future studies should address the operationalization of health behaviors. For this, we recommend a more detailed and specific assessment of behaviors in adolescents. Another reason for the weak associations could be attributed to social desirability: if the adolescents expected negative consequences from their answers, these could thus be biased. This should always be considered when surveying young people.

Problems With the Emotion Survey

There are several arguments for why the relationship between emotions and PHC was so weak (see Model 2). It might be due to the specific target group: if the emotions do not last long enough and have not yet stabilized, changes in PHC cannot be mapped in adolescents. Some studies showed the tendency of emotions to work in the body over very long periods, becoming especially visible in adulthood and, for example, influencing longevity (Danner et al., 2001; Veenhoven, 2008).

A further point of criticism lies in the measurement of emotions. The formulation of the items in the SDQ does not appear to be optimal for depicting emotions, as several facets are always queried in one question (e.g., anger measured by feeling angry and often losing one's temper). Future studies should record emotions through another instrument (e.g., PANAS; Watson et al., 1988). Unfortunately, no positive emotions were recorded in the present survey. Due to its positive effect on health, positive emotions may be particularly important for disease prevention (Kao et al., 2005; Veenhoven, 2008) and should thus be part of future studies.

It might be possible to map stronger relationships with PHC by constructs close to emotions (Franken, 2004; Mikolajczak et al., 2015; Pandey & Choubey, 2010), such as emotional awareness (Badenes et al., 2016; Veiga et al., 2019), emotion regulation (Appelhans & Luecken, 2006), emotional suppression (Mund & Mitte, 2012), or emotional competencies (Franken, 2004; Mikolajczak et al., 2015). As Franken (2004) discussed in her dissertation, it seems less about a specific emotion but more about dealing with it. This should be further investigated in longitudinal studies, especially in adolescents.

Problems With the Physical Health Complaint Survey

Measuring PHC can sometimes be very complex (Pinel et al., 2019; Van der Linde et al., 2013). As mentioned above, PHC usually becomes apparent only after some time. Because PHC increase in adulthood, the associations with psychological burdens are more likely to be mapped in adults. In adolescents, other symptoms than those examined here should be considered, such as skin problems, allergies, and colds or inflammation. In addition, self-reports of PHC often have an increased risk of bias (Van der Linde et al., 2013). This is where the person's perception and ability to reflect may contribute to whether they can assess their well-being correctly and to which circumstances they attribute their health situation (Haugland & Wold, 2001). In addition to self-reports, future studies should assess complaints using objective measurement methods.

Practical Implications

When looking at the link between psychological factors and PHC, the focus on adolescents is particularly worthwhile.

Studies have shown that adolescents' behaviors become entrenched in adulthood (Kinnunen et al., 2010). For example, health behaviors exhibited in adolescence (e.g., smoking) or certain behaviors in dealing with negative emotions (e.g., aggression) are still observed in adulthood. In addition, adolescents seem to be more easily accessible than adults are and are generally receptive to interventions (Beelmann & Lösel, 2006; Stice et al., 2009; Webster-Stratton, 2000). If we provide preventive programs for adolescents, we can expect success for physical health as well as life satisfaction and longevity (Danner et al., 2001; Kao et al., 2005).

PHC prevention programs continue to focus on promoting healthy behaviors, identifying needs based on membership in a risk group (e.g., social background), or observed risk behaviors (e.g., excessive alcohol consumption; Moffitt, 2006). As the present study showed, programs that train the handling of negative emotions would be more suitable for preventing PHC. Guidelines for promoting emotional-social competencies could be consulted (Webster-Stratton, 2000). Some programs have proven to be effective in adolescents, such as those aimed at strengthening emotional-social skills (d = 0.78; Beelmann & Lösel, 2006) or reducing aggression (d = 0.44; Stice et al., 2009), although we can only guess whether or not this has long-term beneficial effects on physical health (Veenhoven, 2008).

Outlook

This study aimed to compare psychological factors and predict PHC in adolescents. Attention was given to a new construct: the tendency toward negative emotions, along with well-proven constructs such as stress, social support, and health behavior. For further research, it is worthwhile focusing on emotions, although the handling of negative emotions is particularly suitable for preventing physical disease (Veenhoven, 2008). Emotions and PHC should be specifically captured since various emotions can have diverse effects on specific PHC (Faller & Lang, 2019; Henry, 1992; Izard, 2009). If possible, stress should also be considered in a more differentiated manner than it was done in this study. For future studies, it is advisable to examine the relationships between psychological factors and health in a longitudinal design to clarify the direction of the influence. It should also be further investigated how significant the differences are between self-assessment and objective assessment of PHC. Research on adolescents has proved worthwhile, even if the effects were not as great as in adulthood. Future studies should focus on adolescents in the context of prevention and intervention.

References

Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review of General Psychology, 10*(3), 229–240. https://doi.org/10.1037/1089-2680.10.3.229

Badenes, L. V., Prado-Gascó, V., & Barrón, R. G. (2016). Emotion awareness, mood and personality as predictors of somatic complaints in children and adults. *Psicothema, 28*(4), 383–388. https://doi.org/10.7334/psicothema2015.265

Beelmann, A., & Lösel, F. (2006). Child social skills training in developmental crime prevention. *Psicothema, 18*(3), 603–610.

Bilz, L., Sudeck, G., Bucksch, J., Klocke, A., Kolip, P., Melzer, W., Ravens-Sieberer, U., & Richter, M. (2016). *Schule und Gesundheit: Ergebnisse des WHO-Jugendgesundheitssurvey „Health Behaviour in School-aged Children"* [School and health: Results of the WHO Youth Health Survey]. Beltz/Juventa.

Braverman, M. T., Stawski, R. S., Samdal, O., & Aarø, L. E. (2017). Daily smoking and subjective health complaints in adolescence. *Nicotine and Tobacco Research, 19*(1), 102–110. https://doi.org/10.1093/ntr/ntw133

Chen, E., Brody, G. H., & Miller, G. E. (2017). Childhood close family relationships and health. *American Psychologist, 72*(6), 555–566. https://doi.org/10.1037/amp0000067

Cohen, S. (2004). Social relationships and health. *American Psychologist, 59*(8), 676–684. https://doi.org/10.1037/0003-066X.59.8.676

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*(4), 385–396. https://doi.org/10.2307/2136404

Conner, T. S., & Feldmann Barrett, L. (2012). Trends in ambulatory self-report: The role of momentary experience in psychosomatic medicine. *Psychosomatic Medicine, 74*(4), 327–337. https://doi.org/10.1097/PSY.0b013e3182546f18

Danner, D. D., Snowdon, D. A., & Friesen, W. V. (2001). Positive emotions in early life and longevity. *Journal of Personality and Social Psychology, 80*(5), 804–813. https://doi.org/10.1037/0022-3514.80.5.804

Eminson, M. (2007). Medically unexplained symptoms in children and adolescents. *Clinical Psychology Review, 27*(7), 855–871. https://doi.org/10.1016/j.cpr.2007.07.007

Faller, H., & Lang, H. (2019). *Medizinische Psychologie und Soziologie* [Medical psychology and sociology]. Springer.

Franken, U. (2004). *Emotionale Kompetenz: Eine Basis für Gesundheit und Gesundheitsförderung* (Doctoral dissertation) [Emotional Competence: A Base for Health and Health Promotion]. University of Bielefeld Archive. https://pub.uni-bielefeld.de/record/2303721

Glasscock, D. J., Andersen, J. H., Labriola, M., Rasmussen, K., & Hansen, C. D. (2013). Can negative life events and coping style help explain socioeconomic differences in perceived stress among adolescents? *BMC Public Health, 2*(13), 532–544. https://doi.org/10.1186/1471-2458-13-532

Goodman, A., & Goodman, R. (2009). Strengths and Difficulties Questionnaire as a dimensional measure of child mental health. *Journal of the American Academy of Child and Adolescent Psychiatry, 48*(4), 400–403. https://doi.org/10.1097/CHI.0b013e3181985068

Gross, J. T., & Cassidy, J. (2019). Expressive suppression of negative emotions in children and adolescents: Theory, data, and a guide for future research. *Developmental Psychology, 55*(9), 1938–1950. https://doi.org/10.1037/dev0000722

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2018). *Multivariate data analysis*. Cengage Learning.

Haugland, S., & Wold, B. (2001). Subjective health complaints in adolescence – reliability and validity of survey methods. *Journal of Adolescence, 24*(5), 611–624. https://doi.org/10.1006/jado.2000.0393

Henry, J. P. (1989). The arousal of emotions: Hormones, behavior, and health. *Advances, 6*(2), 59–62.

Henry, J. P. (1992). Biological basis of the stress response. *Integrative Physiological and Behavioral Science, 27*(1), 66–83. https://doi.org/10.1007/BF02691093

Holt-Lunstad, J., & Smith, T. B. (2012). Social relationships and mortality. *Social and Personality Psychology Compass, 6*(1), 41–53. https://doi.org/10.1111/j.1751-9004.2011.00406.x

Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine, 7*(7), 1–20. https://doi.org/10.1371/journal.pmed.1000316

Hostinar, C. E., Sullivan, R. M., & Gunnar, M. R. (2014). Psychobiological mechanisms underlying the social buffering of the hypothalamic-pituitary-adrenocortical axis. *Psychological Bulletin, 140*(1), 256–282. https://doi.org/10.1037/a0032671

Hoyle, R. H. (2012). *Handbook of structural equation modeling*. Guilford Press.

Hu, L.-T., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3*(4), 424–453. https://doi.org/10.1037/1082-989X.3.4.424

Inchley, J., Currie, D., Cosma, A., Piper, A., & Spanou, G. (2018). *Health Behaviour in School-Aged Children (HBSC) study protocol: Background, methodology and mandatory items for the 2017/18 survey*. World Health Organization.

Izard, C. E. (2009). Emotion theory and research: Highlights, unanswered questions, and emerging issues. *Annual Review of Psychology, 60*(1), 1–25. https://doi.org/10.1146/annurev.psych.60.110707.163539

John, N., & Bilz, L. (2020). *Kinder- und Jugendgesundheit in Brandenburg: Ergebnisse der HBSC-Gesundheitsstudie 2018 im Auftrag der WHO* [Child and adolescent health in Brandenburg: Results from the 2018 HBSC Health Survey commissioned by WHO]. Pabst Science.

Jovic-Vranes, A. S., Vranes, B., Marinkovic, J., & Cucic, V. (2005). Adolescent substance abuse, the importance of family, school and peers. *International Journal of Public Health, 50*(2), 119–124. https://doi.org/10.1007/s00038-004-4014

Kao, S., Lai, K. L., Lin, H. C., Lee, H. S., & Wen, H. C. (2005). WHOQOL-BREF as predictors of mortality. *Quality of Life Research, 14*(6), 1443–1454. https://doi.org/10.1007/s11136-004-7709-9

Kinnunen, P., Laukkanen, E., & Kylmä, J. (2010). Associations between psychosomatic symptoms in adolescence and mental health symptoms in early adulthood. *International Journal of Nursing Practice, 16*(1), 43–50. https://doi.org/10.1111/j.1440-172X.2009.01782.x

Klein, E. M., Brähler, E., Dreier, M., Reinecke, L., Müller, K. W., Schmutzer, G., Wölfling, K., & Beutel, M. E. (2016). The German version of the Perceived Stress Scale. *BMC Psychiatry, 16*, 159–168. https://doi.org/10.1186/s12888-016-0875-9

Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford Press.

Kröner-Herwig, B., Morris, L., & Heinrich, M. (2008). Biopsychosocial correlates of headache: What predicts pediatric headache occurrence? *headache, 48*(4), 529–544. https://doi.org/10.1111/j.1526-4610.2007.00945.x

Lazarus, R. S. (1993). From psychological stress to the emotions. *Annual Review of Psychology, 44*(1), 1–22. https://doi.org/10.1146/annurev.ps.44.020193.000245

Lazarus, R. S., & Folkman, S. (1987). Transactional theory and research on emotions and coping. *European Journal of Personality, 1*(3), 141–169. https://doi.org/10.1002/per.2410010304

Leys, C., Delacre, M., Mora, Y. L., Lakens, D., & Ley, C. (2019). How to classify, detect, and manage univariate and multivariate outliers, with emphasis on pre-registration. *International Review of Social Psychology, 32*(1), 1–10. https://doi.org/10.5334/irsp.289

Liu, Y., Wang, M., Tynjälä, J., Lv, Y., Villberg, J., Zhang, Z., & Kannas, L. (2010). Test-retest reliability of selected items of HBSC Survey Questionnaire in Beijing, China. *BMC Medical Research Methodology, 10*, 1–9. https://doi.org/10.1186/1471-2288-10-73

Lohbeck, A., Schultheiß, J., Petermann, F., & Petermann, U. (2015). Die deutsche Selbstbeurteilungsversion des "Strengths and Difficulties Questionnaire" [The German Self-Assessment version of the SDQ]. *Diagnostica, 61*(4), 222–235. https://doi.org/10.1026/0012-1924/a000153

McEwen, B. S. (2008). Central effects of stress hormones in health and disease. *European Journal of Pharmacology, 583*(2–3), 174–185. https://doi.org/10.1016/j.ejphar.2007.11.071

Mikolajczak, M., Avalosse, H., Vancorenland, S., Verniest, R., Callens, M., van Broeck, N., Fantini-Hauwel, C., & Mierop, A. (2015). A nationally representative study of emotional competence and health. *Emotion, 15*(5), 653–667. https://doi.org/10.1037/emo0000034

Miller, G. E., Chen, E., & Parker, K. J. (2011). Psychological stress in childhood and susceptibility to the chronic diseases of aging. *Psychological Bulletin, 137*(6), 959–997. https://doi.org/10.1037/a0024768

Moffitt, T. E. (2006). Life course persistent versus adolescence limited antisocial behavior. In D. Cicchetti & D. J. Cohen (Eds.), *Handbook of developmental psychopathology* (pp. 570–588). Wiley.

Mund, M., & Mitte, K. (2012). The costs of repression: A meta-analysis on the relation between repressive coping and somatic diseases. *Health Psychology, 31*(5), 640–649. https://doi.org/10.1037/a0026257

Niles, A. N., & O'Donovan, A. (2019). Comparing anxiety and depression to obesity and smoking as predictors of major medical illnesses and somatic symptoms. *Health Psychology, 38*(2), 172–181. https://doi.org/10.1037/hea0000707

Pandey, R., & Choubey, A. K. (2010). Emotion and health: An overview. *Journal of Projective Psychology and Mental Health, 17*(2), 135–152.

Pinel, J. P., Barnes, S. J., & Pauli, P. (2019). *Biopsychologie* [Biological psychology]. Pearson.

Prochaska, J. J., Sallis, J. F., & Long, B. (2001). A physical activity screening measure for use with adolescents in primary care. *Archives of Pediatrics and Adolescent Medicine, 155*(5), 554–559. https://doi.org/10.1001/archpedi.155.5.554

Ravens-Sieberer, U., Erhart, M., Torsheim, T., Hetland, J., Freeman, J., Danielson, M., & Thomas, C., The HBSC Positive Health Group. (2008). An international scoring system for self-reported health complaints in adolescents. *European Journal of Public Health, 18*(3), 294–299. https://doi.org/10.1093/eurpub/ckn001

Rein, G., Atkinson, M., & McCraty, R. (1995). The physiological and psychological effects of compassion and anger. *Journal of Advancement in Medicine, 8*(2), 87–105.

Salovey, P., Rothman, A. J., Detweiler, J. B., & Steward, W. T. (2000). Emotional states and physical health. *The American Psychologist, 55*(1), 110–121. https://doi.org/10.1037/0003-066x.55.1.110

Schubert, C. (2015). *Psychoneuroimmunologie und Psychotherapie* [Psychoneuroimmunology and psychotherapy]. Schattauer.

Shaw, T., Runions, K. C., Johnston, R. S., & Cross, D. (2018). Does the risk outweigh the benefits? Adolescent responses to completing health surveys. *Journal of Research on Adolescence, 28*(2), 412–426. https://doi.org/10.1111/jora.12343

Sinha, R., Lovallo, W. R., & Parsons, O. A. (1992). Cardiovascular differentiation of emotions. *Psychosomatic Medicine, 54*(4), 422–435. https://doi.org/10.1097/00006842-199207000-00005

Sood, S., Bakhshi, A., & Devi, P. (2013). An assessment of perceived stress, resilience and mental health of adolescents living in border areas. *International Journal of Scientific and Research Publications, 3*(1), 1–4. https://doi.org/10.1.1.299.3385

Steptoe, A., & Vögele, C. (1986). Are stress responses influenced by cognitive appraisal? An experimental comparison of coping strategies. *British Journal of Psychology, 77*(2), 243–255. https://doi.org/10.1111/j.2044-8295.1986.tb01999.x

Stice, E., Shaw, H., Bohon, C., Marti, C. N., & Rohde, P. (2009). A meta-analytic review of depression prevention in programs for children and adolescents. *Journal of Consulting and Clinical Psychology, 77*(3), 486–503. https://doi.org/10.1037/a0015168

Stock, C., & Badura, B. (1995). Fördern positive Gefühle die physische Gesundheit? [Do positive emotions promote physical health?] *Zeitschrift für Gesundheitswissenschaften, 3*(1), 74–89. https://doi.org/10.1007/BF02959947

Torsheim, B., & Wold, T. (2001). School-related stress, social support, and somatic complaints. *Journal of Adolescence Research, 16*(3), 293–303. https://doi.org/10.1177/0743558401163003

Van der Linde, R. M., Mavaddat, N., Luben, R., Brayne, C., Simmons, R. K., & Khaw, K. T. (2013). Self-rated health and cardiovascular disease incidence. *PLoS One, 8*(6), 1–8. https://doi.org/10.1371/jour-nal.pone.0103509

Veenhoven, R. (2008). Healthy happiness: Effects of happiness on physical health and the consequences for preventive health care. *Journal of Happiness Studies, 9*(3), 449–469. https://doi.org/10.1007/s10902-006-9042-1

Veiga, G., Oosterveld, P., Fernandes, J., & Rieffe, C. (2019). Validation of the Portuguese emotion awareness questionnaire for children and adolescents. *European Journal of Developmental Psychology, 16*(2), 215–224. https://doi.org/10.1080/17405629.2017.1344124

Watson, D., Clark, L. A., & Teilegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS Scales. *Journal of Personality & Social Psychology, 54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

Webster-Stratton, C. H. (2000). *How to promote children's social and emotional competence*. Paul Chapman.

Williams, E. J. (1959). The comparison of regression variables. *Journal of the Royal Statistical Society: Series B, 21*(2), 396–399. https://doi.org/10.1111/j.2517-6161.1959.tb00346.x

Yates, F., & Grundy, P. M. (1953). Selection without replacement from within strata with probability proportional to size. *Journal of the Royal Statistical Society, 15*(2), 253–261. https://doi.org/10.2307/2983772

Zimet, G. D., Powell, S. S., Farley, G. K., Werkman, S., & Berkoff, K. A. (1990). Psychometric properties of the Multidimensional Scale of Perceived Social Support. *Journal of Personality Assessment, 55*, 610–617. https://doi.org/10.1023/A:1005109522457

History
Received May 26, 2020
Revision received April 29, 2021
Accepted April 30, 2021
Published online February 16, 2022

Publication Ethics
The implementation of the study was approved by the Ministry of Education, Youth and Sport of the State of Brandenburg (registration number 07/2018). The ethics commission of the BTU Cottbus-Senftenberg confirmed the study (file number: EK2018-6). The participation of the pupils was voluntary but could only be approved with both their own consent and that of a parent.

Funding
This work has been supported by the Brandenburg Ministry of Education, Youth and Sport; the Brandenburg Ministry of Social Affairs, Health, Integration and Consumer Protection; and AOK Nordost to Ludwig Bilz. Open access publication enabled by Chemnitz University of Technology.

Avelina Lovis-Schmidt
Department of Psychology
Chemnitz University of Technology
Wilhelm-Raabe-Str. 43
09107 Chemnitz
Germany
avelina-lovis.schmidt@psychologie.tu-chemnitz.de