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Understanding the relationship between perceived stress, academic motivation, and physical activity in college students during the coronavirus pandemic

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The coronavirus pandemic has influenced the lives of many people. We analyzed the effects of physical activity and stress on students' motivation during the pandemic. Participants were 254 university students who reported their academic motivation, physical activity, general stress, the coronavirus pandemic strain, and their coronavirus stress. Women reported higher levels of coronavirus stress, general stress, and motivation. The coronavirus stress was predicted by the strain of the coronavirus pandemic but not by physical activity. General stress and gender predicted mastery goals, and performance goals were predicted by general stress. Physical activity was not related to students' motivation during the pandemic. Higher levels of general stress were associated with higher academic motivation. Negative emotions like stress could have enhanced students' motivation during uncertain times of the pandemic. Moreover, a moderate stress level could be favorable for academic dedication and achievement.

KEYWORDS

coronavirus pandemic, stress, motivation, physical activity, students, gender differences

Introduction

The coronavirus pandemic has changed the lives of almost every person and influenced their subjective wellbeing at some point (Zacher and Rudolph, 2021). What is not known until now and should be investigated in this study is whether students' perceived stress during the coronavirus pandemic is related to their academic motivation. This should be true for higher education students because universities have been closed for a long time. Furthermore, the possible protective role of physical activity should be included.

Wellbeing and stress during the coronavirus pandemic

Among others, general life satisfaction and gratitude could predict personal wellbeing during the coronavirus pandemic (Büssing et al., 2020). Whereas life satisfaction did not change in the early beginning of the pandemic from December 2019 to March 2020 in a German sample, it decreased in a later phase between March and May 2020. In Canadian participants, physical activity decreased during the pandemic while their self-perceived psychological stress increased significantly (Marashi et al., 2021). A decline in physical activity (six months before and during the pandemic) is related to generalized anxiety disorder and depression symptoms. Hence, people who worked out less due to the pandemic reported higher anxiety and more depression symptoms (Marashi et al., 2021). In the social-cognitive theory framework, it is pronounced that self-efficacy and goals are related to physical activity (Young et al., 2014). However, the negative relation to physical activity seemed plausible because low self-efficacy is associated with both depressive (Sawatzky et al., 2012) and anxiety symptoms (Goldin et al., 2009).

Furthermore, in a German sample, a higher difference between sports and physical activity before and during the pandemic was related to lower wellbeing in university students (Pietsch et al., 2022). In an intervention study, a group of Iranian students received two sessions of physical training per week for three months during the first year of the pandemic, and the control group received no training (Dana et al., 2021). While intrinsic motivation before the intervention did not differ between groups, in the posttest, the intervention group reported significantly more intrinsic motivation than the control group. In Canadian participants, a decrease in physical activity (due to the pandemic) was related to higher work stress (Woodruff et al., 2021). Silva et al. (2020) also found higher stress levels for inactive participants during quarantine than for those who were active. Forte et al. (2021) investigated the pandemic strain during the first wave of corona in Portugal and found a decrease in physical activity. Hence, people who did not have the opportunity to engage in physical activities during the pandemic as much as they did before seem less healthy, more stressed, and less motivated. Because regulations on lockdowns or the closure of sports facilities changed quickly during this pandemic period, we decided to ask participants to report their physical activity during the last week.

The coronavirus pandemic has also significantly affected students in higher education. Universities were mainly closed, and distance teaching had been installed. As a consequence, 86.8% of students reported that the pandemic had impacted their studies substantially, and 65.3% indicate low or very low wellbeing (Dodd et al., 2021).

The number of studies focusing on students' wellbeing during the coronavirus pandemic is growing. Husky et al. (2020) demonstrated that two-thirds of students reported an increase in anxiety during confinement as well as moderate-to-severe levels of stress. In another study from France, the prevalence of severely perceived stress was 22%. The presence of someone hospitalized for COVID-19 in one's household and being female were the main predictors of perceived stress (Bourion-Bédès et al., 2021). A cross-sectional survey with data collected before and at three stages during the pandemic revealed that anxiety and depression increased from 2017 to the pandemic stages and during these stages from April 2020 to April 2021 (Zurlo et al., 2021). The pandemic affected not only domestic students enrolled in their own country but also international students, such as international students in the UK (Al-Oraibi et al., 2022). A qualitative exploration revealed the need for practical, social, and emotional support during self-isolation, and students reported increased stress and anxiety.

There is evidence that the wellbeing of students during the coronavirus pandemic is related to their physical activity: Wilson et al. (2021) reported a significant decline in physical activity and increased stress during the coronavirus pandemic in students from a University in the United States. Furthermore, in a study with students from the United States, the total minutes of physical activity was also related to positive affect (measured with the positive and negative affect scale) before and during the stay-at-home orders. This relation was neither moderated by stressful life events (Maher et al., 2021) nor by sleep quality, food insecurity, and demographic factors.

Stress among students influenced their wellbeing even before the corona pandemic began. A systematic review showed that stress and quality of life were negatively associated (Ribeiro et al., 2018). Strain as a consequence of stress is associated with anxiety, depression, somatization, burnout, and physiological health problems in police officers (Gächter et al., 2011). Furthermore, perceived stress and strain are closely related to each other (e.g., Layne et al., 2004). Therefore, the relationship between stress and strain during the pandemic should be investigated in more detail.

In Italian students, coronavirus-related stress increased during the pandemic from April 2020 to April 2021 (Zurlo et al., 2021). Stress was related to anxiety, depression, and other aspects of psychological health in Italian university students (Zurlo et al., 2021, 2022) and depression in Chinese medical students (Liu et al., 2021) during the pandemic.

An interesting question is whether the pandemic and the decline in wellbeing also affected students' academic motivation. The answer to this question might be crucial because it has been stated in several meta-analyses (e.g., Möller et al., 2009) that students' motivational beliefs are related to their academic achievement.

The relationship between academic motivation and perceived stress

Regarding academic motivation, a social-cognitive approach emphasizes students' belief in actual events and the role of achievement context. According to Steinmayr et al. (2019), a variety of motivation constructs can be organized into the category of expectancy components and the class of value components. In line with the social-cognitive perspective, students' motivation is relatively situation-specific. Next, a more traditional personality model of motivation, the theory of achievement motivation, exists (McClelland et al., 1953), where motivation is seen as a more stable concept. Two achievement motives are *hope for success* and *fear of failure*. These achievement motives were also considered in the achievement goal theory. First, there was a differentiation between *mastery goals* (focusing on intrinsic values associated with learning) and *performance goals* by doing better than others (Ames, 1992). Moreover, mastery and performance goals could be split into approach and avoidance according to the valence of the goals (Elliot and McGregor, 2001).

The results of studies that have investigated the relationship between perceived stress and academic motivation are inconsistent; for example, in the study of Liu (2015): The perceived stress in grade 10 in high school negatively predicted intrinsic motivation and positively predicted amotivation in grade 12. In another study, a path analysis demonstrated that stress, motivation, and academic performance were sequentially associated (Park et al., 2012). Consequently, one implication was that stress is negatively associated with motivation in students from a university, in this case, medical students from Korea. The results of a study with nursing students from China also showed negative relations between stress and motivation (Wang et al., 2019), on the one hand. On the other hand, academic stress and motivation were not associated in undergraduate students from the United States and other countries (Karaman and Watson, 2017), and Struthers et al. (2000) even showed that stress positively predicted motivation in Canadian college students. Ramaprabou and Dash (2018) found high levels of achievement motivation for students with moderate stress and less motivation for students with slight stress and with high-stress levels. Hence, an optimal moderate stress level seems beneficial for high academic motivation.

The relationship between academic motivation and perceived stress during the coronavirus pandemic

During the corona pandemic, the results of correlations between academic motivation and perceived stress and gender differences in both variables are inconsistent. In Malaysian

undergraduate students, no significant correlations between perceived stress and academic motivation during the pandemic appeared (Ahmad et al., 2021). Academic stress and motivation were not associated in Philippine senior high school students (Tus, 2020). On the other hand, Tefiki (2021) found negative correlations between perceived stress and the motivation to learn online in European high school students during the first year of the pandemic, and a study with nursing students from Turkey showed negative relations between stress and motivation (Ardic et al., 2022).

Regarding gender differences in perceived stress during the pandemic, most studies found higher levels in women than men (Silva et al., 2020; Aslan and Pekince, 2021; Bourion-Bédès et al., 2021; García-Fernández et al., 2021; Tefiki, 2021). In Malaysian undergraduate students, no gender differences appeared (Ahmad et al., 2021). In Polish students, women reported lower quality of life during the pandemic but only in students at a technical university and not in social science, medicine, and dentistry (Trzcionka et al., 2022). Investigating gender differences in the pandemic strain, higher levels of nervousness, sadness, and preoccupation for women were found in Portuguese participants while men reported higher levels of calm and relaxation (Forte et al., 2021).

For gender differences in motivation, most studies found higher levels of motivation in women or girls than in men or boys: Women reported higher scores of amotivation, extrinsic, and intrinsic motivation than men (Hakan and Münire, 2014), and girls showed higher levels of mastery goals throughout middle school than boys (Theis and Fischer, 2017). During the coronavirus pandemic, no gender differences in the motivation to learn online were found (Tefiki, 2021), while women reported higher academic motivation than men (Ahmad et al., 2021).

The goal of the study

Even though there is a lot of research investigating the relationship between perceived stress during the coronavirus pandemic and wellbeing, few studies have investigated the relationship between perceived stress during the pandemic and academic motivation in higher education and no study has focused on the association between academic motivation and the coronavirus stress in academic context (and not the general stress during the pandemic). So far, studies have shown, on the one hand, that students at universities suffer from the coronavirus pandemic from stress (Zurlo et al., 2021, 2022). On the other hand, it was found that reduced physical activity can predict the stress levels in the coronavirus pandemic of university students (Moriarty et al., 2021). Furthermore, stress seemed negatively related to most scales of academic motivation (Park et al., 2012).

Academic motivation can be associated with perceived general stress (e.g., Struthers et al., 2000) or specifically to

the stress due to the pandemic. The specific stress due to the pandemic in academic context has been investigated regarding its effects on anxiety, depression, and other aspects of psychological health in Italian university students (Zurlo et al., 2021, 2022). To the best of our knowledge, no study has yet investigated the relationship between the specific coronavirus stress in students and their academic motivation. To fill this gap, we wanted to analyze the influence of perceived general stress on the one hand and the coronavirus stress in academic contexts on the other hand on students' academic motivation. Furthermore, we included the extent of strain students felt due to the pandemic because our questionnaire regarding coronavirus stress refers to the stress perceived in academic context. The coronavirus strain refers to the overall strain due to the coronavirus pandemic. With this approach, we wanted to cover the influences of general stress (e.g., time pressure), the coronavirus stress in academic contexts (e.g., reduced contact to professors), and the coronavirus strain (e.g., social isolation).

According to this, the following hypotheses could be formulated:

1. The Perceived Coronavirus Stress Is Predicted by Physical Activity (Woodruff et al., 2021), Gender (Silva et al., 2020; Aslan and Pekince, 2021; Bourion-Bédès et al., 2021; García-Fernández et al., 2021; Tefiki, 2021), and Strain (Layne et al., 2004) of the Coronavirus Pandemic in University Students.
2. It Is Assumed That Academic Motivation Is Predicted by the Perceived Coronavirus Stress and Its Related Factors: Gender (Theis and Fischer, 2017; Ahmad et al., 2021), Physical Activity (Dana et al., 2021), Perceived General Stress (Tefiki, 2021; Ardiç et al., 2022), the Strain of the Coronavirus Pandemic, Including two Possible Interactions Between Gender and Perceived Coronavirus Stress (see Bourion-Bédès et al., 2021), Physical Activity and Perceived Coronavirus Stress.

Methods

Participants

In this study, 254 students participated, 152 female students ($M = 21.27$, $SD = 2.66$) and 102 male students ($M = 22.16$, $SD = 2.39$) from two Universities in Germany. Nineteen already had a COVID infection, 148 students reported that a family member or a close friend suffered from an infection, and 85 were already vaccinated. Assuming a small-to-moderate effect size of $f^2 = 0.10$ in multiple regression analyses for the criterion academic motivation including seven predictors (gender, physical activity, coronavirus stress, strain of the coronavirus pandemic, perceived stress, and two possible two-way interactions) with a power of 0.95 at an alpha level of 0.05, a sample size of $n = 226$ must be recruited.

The study was conducted according to the Declaration of Helsinki. All participants were informed of the goal, the study's anonymity, and the data storage's anonymity. Furthermore, information was provided on the right to refuse to participate in the study or to withdraw consent to participate at any time without reprisal. All participants gave their informed consent before inclusion in the study in the online survey. The study was preregistered at <https://osf.io/mfwhz>. Data are available at <https://mfr.osf.io/render?url=https%3A%2F%2Fosf.io%2F26qy3%2Fdownload>.

Material

Demographic questionnaire

In this demographic questionnaire, the following questions were asked: age, gender; Have you had a Covid-infection (yes, no)? Did one or more of your family members or close friends suffer from Covid (yes, no)? Have you already had a vaccination (yes, no)? How strained are you through the Coronavirus-Pandemic in your life in general (1 = not at all to 5 = very much)? Have you or one of your household members been hospitalized during the Coronavirus-Pandemic?

Motivation

Achievement Goal Questionnaire-Revised (AGQ, Elliot and McGregor, 2001). A German version of the AGQ with six mastery goal items (e.g., "My aim is to completely master the material presented in this class") and six performance goal items ("My aim is to avoid doing worse than other students") was used. The answer format was a seven-point Likert scale ranging from 1 = not true to 7 = exactly true. Mastery goals and performance goals showed good internal consistencies (Cronbach's alpha > 0.80) (Elliot and McGregor, 2001). The present study revealed Cronbach's alpha = 0.80 for the total scale and 0.88 (performance goals) and 0.67 (mastery goals) for the subscales.

Stress during the coronavirus pandemic

COVID-19 Student Stress Questionnaire (CSSQ, Zurlo et al., 2020). The CSSQ is a seven-item stress questionnaire for students in the coronavirus pandemic. One example item is as follows: "How do you perceive your academic studying experience during this period of the COVID-19 Pandemic?". Participants must answer each item on a five-point Likert scale from 1 = not at all stressful to 5 = extremely stressful. The questionnaire revealed a satisfactory internal consistency (Cronbach's alpha = 0.71) in the Italian version. For the German version, the questionnaire was forward- and backward-translated. A mean score between 1 and 5 could be obtained. According to the categorization of Bourion-Bédès et al. (2021), this score can be differentiated into three groups: 1–2.33

indicate low stress, 2.33–3.67 moderate stress, and 3.67–5 high stress. After eliminating two items because of low inter-item correlations, Cronbach's alpha was .69 for the global scale.

Perceived Stress Questionnaire (PSQ, Levenstein et al., 1993; German version: Fliege et al., 2001). Perceived stress is measured with 20 items answered on a four-point Likert scale ranging from 1 = rarely to 4 = usually. An example item is "You feel rushed." Internal consistency Cronbach's alpha (0.85) of the German version (Fliege et al., 2001) and test–retest reliability (0.82) of the original version (Levenstein et al., 1993), as well as the validity of both versions, were proved. A score between 20 and 80 could be reached. A mean score between 1 and 4 could be achieved. According to Bourion-Bédès et al. (2021), this score can be differentiated into three groups: 1–2 indicate low stress, 2–3 moderate stress, and 3–4 high stress. In the present study, Cronbach's alpha for the scale was 0.93.

Physical activity

International Physical Activity Questionnaire Short Form (Craig et al., 2017). The IPAQ is a questionnaire for the registration of physical activity in the last 7 days. It includes seven items, how many days in intensive, moderate, and walking they have spent and how many hours and minutes they have experienced with the specific intensity. The overall activity was measured in MET-minutes per week by the sum of the Total MET-minutes/week = Mod (METs * min * days) + Vig (METs * min * days) with moderate intensity = 4.0 METs and vigorous intensity = 8.0 METs.

Procedure

An email with the study's link was sent out. The online questionnaire was implemented using SoSci Survey (Leiner, 2019) and made available to the participants (www.sosicisurvey.de). First, all participants gave informed consent and reported their gender and age. Afterward, they answered the questions concerning the coronavirus pandemic (e.g., the strain of the coronavirus pandemic), and they filled out the PSQ (Fliege et al., 2001), AGQ (Elliot and McGregor, 2001), IPAQ-SF, and the CSSQ (Zurlo et al., 2020). They were then thanked for their participation. Data collection took place from 18 May to 23 May 2021.

Statistical analysis

First, it was analyzed with correlation analyses and independent *t*-tests whether the perceived general stress and the perceived coronavirus stress are correlated and whether gender differences in the study variables appear. Those first analyses were in addition to the analyses described in the preregistration.

Second and in line with the formulated hypotheses, hierarchical regression analysis with the criterion "perceived coronavirus stress" and the possible predictors: gender and strain of the coronavirus pandemic have been calculated. Different from the preregistration, physical activity was not added as a predictor because the correlation with coronavirus stress was very low. After this, hierarchical regression analyses with the criterion "academic motivation" for both dependent variables "mastery goal" and "performance goal" and the possible predictors (coronavirus stress, gender, perceived stress), including a possible interaction (gender and perceived coronavirus stress), has been calculated. Because of very low correlations between performance and mastery goals, respectively, with physical activity and strain of the coronavirus pandemic, these variables were not added as predictors (different from preregistration).

Results

Correlations and gender differences

First, correlations between all study variables are displayed in Table 1. The coronavirus stress is related to perceived stress, mastery goals, and the strain due to the pandemic. Perceived stress is related to performance and mastery goals and strain. For physical activity, no significant correlations appeared with coronavirus stress and with performance and mastery goals.

Gender differences for the perceived coronavirus stress, general perceived stress, performance, and mastery goals are displayed in Table 2. Women showed higher values in the perceived coronavirus stress and the perceived general stress. Gender differences also appeared in academic motivation. Women reported higher values in performance and mastery goals.

The perceived general stress and the specific coronavirus stress were highly correlated [$r(254) = 0.462, p < .001$]. The mean coronavirus stress was moderate with $M = 3.45, SD = 0.79$, the perceived general stress was also moderate ($M = 2.52, SD = 0.58$). There were no differences in both types of stress between (a) students who had a family member or close friend who underwent a coronavirus infection and (b) those students who were already vaccinated or not (all $p_s > 0.7$).

Prediction of the perceived coronavirus stress

A hierarchical regression analysis was calculated with coronavirus stress as a criterion. As predictors, gender was added in the first step because gender differences were significant for coronavirus stress. In the second step, only the strain of the coronavirus pandemic was added as a predictor. Both variables explained 35.1% ($R = 0.593$) of the variance [$F(2, 251)$].

TABLE 1 Correlations of the study variables.

	CS	PS	Performance goal	Mastery goal	Strain
PS	0.462***				
Performance goal	0.083	0.220***			
Mastery goal	0.186**	0.313***	0.216***		
Strain	0.590***	0.494***	0.049	0.111	
PA	0.030	0.018	-0.037	0.004	0.008

** $p < 0.01$, *** $p < 0.001$. CS, coronavirus stress; PA, physical activity; PS, perceived general stress; Strain, strain of the coronavirus pandemic.

TABLE 2 Means, standard deviations, and results of *t*-tests for gender differences.

	Men: <i>M</i> (SD)	Women: <i>M</i> (SD)	<i>t</i> (df)	<i>p</i>	<i>d</i>
CV	3.30 (0.82)	3.45 (0.75)	2.412 (252)	0.017	0.304
PS	2.35 (0.57)	2.64 (0.57)	3.960 (252)	<0.001	0.499
Performance goals	3.34 (1.29)	3.90 (1.41)	3.219 (252)	0.001	0.406
Mastery goals	4.75 (0.97)	5.38 (0.81)	5.500 (190.200)	<0.001	0.798

CS, coronavirus stress; PS, perceived general stress.

= 67.904, $p < 0.001$]. Gender significantly predicts the perceived coronavirus stress but is fully mediated by the coronavirus pandemic's strain (see Table 3).

Prediction of the academic motivation

The prediction of academic motivation was analyzed for performance and mastery goals separately. Hierarchical regression analyses were calculated, with performance and mastery goals as criteria. Because gender differences were significant, gender was added as a predictor in the first step. The perceived coronavirus stress, the perceived general stress, and the interaction of gender and coronavirus stress were added as predictors in a second step.

For performance goals, the regression analysis showed that 7.2% ($R = 0.268$) of the variance is explained by the four predictors [$F_{(4, 249)} = 4.825$, $p < 0.001$, see Table 4]. Gender predicts performance goals but is then fully mediated by the perceived general stress.

For mastery goals, the regression analysis showed that 17.6% ($R = 0.420$) of the variance is explained by the four predictors [$F_{(4, 249)} = 13.335$, $p < 0.001$, see Table 5]. Gender predicts mastery goals and is then partially mediated by the perceived general stress.

Discussion

In the first hypothesis, we assumed that gender, physical activity, and the coronavirus strain predicted the coronavirus stress. Our results only partly support this. First, gender

predicted the coronavirus stress. Then, the strain fully mediated gender differences. Contrary to our assumptions, physical activity could not be included in the analysis because of very low correlations. Furthermore, hypothesis 2 regarding the prediction of academic motivation is also only partly supported by our results: Academic motivation is predicted by gender. However, this relation is fully mediated by the perceived general stress for the performance goals and partially mediated by the perceived stress for mastery goals. This supports our hypothesis. Contrary to our assumptions, the perceived coronavirus stress and its interaction with gender were no significant predictors of academic motivation. Furthermore, we did not include the coronavirus pandemic's strain and physical activity. This contradicts our assumptions. Performance goals were associated with the perceived general stress but not to the coronavirus stress. Mastery goals were positively correlated with the perceived stress and the coronavirus stress. Regression analyses showed that the perceived general stress was a significant predictor while the coronavirus stress was not. Moreover, gender differences in coronavirus stress, general perceived stress, and performance and mastery goals were found.

Prediction of the coronavirus stress

Our results show that the subjective measurement of the coronavirus pandemic's strain predicted the perceived coronavirus stress. This is in line with other studies showing that strain and stress were closely associated before the pandemic (e.g., Layne et al., 2004). During the pandemic, no study has yet investigated the relationship between students' strain due to the

TABLE 3 Prediction of the coronavirus stress.

Variable	B	95% CI for B		SE B	β	R ²	ΔR^2
		LL	UL				
Step 1						0.023*	0.023*
Constant	3.786	3.494	4.078	0.148			
Gender	-0.241	-0.437	-0.044	0.100	-0.150*		
Step 2						0.351***	0.329***
Constant	1.965	1.582	2.374	0.201			
Gender	-0.087	-0.250	0.076	0.083	-0.054		
Strain	0.455	0.376	0.535	0.040	0.581***		

Strain, strain of the coronavirus pandemic. * $p < 0.05$, *** $p < 0.001$.

TABLE 4 Prediction of performance goals.

Variable	B	95% CI for B		SE B	β	R ²	ΔR^2
		LL	UL				
Step 1						0.039**	0.039**
Constant	4.463	3.954	4.973	0.259			
Gender	-0.561	-0.904	-0.218	0.174	-0.199**		
Step 2						0.072***	0.032*
Constant	3.033	0.620	5.446	1.225			
Gender	-0.250	-1.762	1.261	0.768	-0.089		
CS	-0.059	-0.300	0.181	0.122	-0.034		
PS	0.467	0.139	0.794	0.166	0.197**		
Gender * CS	0.028	-0.188	0.243	0.109	0.069		

CS, coronavirus stress; PS, perceived general stress. ** $p < 0.01$, *** $p < 0.001$.

pandemic and their coronavirus stress in academic context. The general strain due to the pandemic seems to add to students' stress. Efforts should be made to reduce these strains for students so that they are not additionally burdened, for example, by social isolation. When these strains cannot be avoided, students could be better instructed in how to deal with stressful and burdensome situations. Moreover, gender as a predictor of coronavirus stress was fully mediated by the strain of the coronavirus pandemic. However, there are significant gender differences in this specific type of stress. Significant gender differences are in line with other studies (Silva et al., 2020; Aslan and Pekince, 2021; Bourion-Bédès et al., 2021; García-Fernández et al., 2021; Tefiki, 2021), for example, the study of Bourion-Bédès et al. (2021) who demonstrated that women suffer more from the pandemic than men. Both studies differ in several aspects, such as the country (France vs. Germany) and the time of the investigation (first coronavirus pandemic wave in the study of Bourion-Bédès vs. third wave in the present study). However, gender differences (higher stress for women than men) appeared in both studies. This is also in line with a study by García-Fernández et al. (2021), who showed that men experienced less stress than women during the first wave of

the coronavirus pandemic in Spain. In their study, a marginally significant interaction between gender and co-existence (living alone vs. with other people) appeared. The difference in stress between men and women living alone was more than twice that between those who did not live alone. Higher stress on female nurses compared to male nurses during the first coronavirus pandemic wave could also be supported in a study with nursing students in Turkey (Aslan and Pekince, 2021). The higher perceived general stress of women compared to men is well known and may be attributed to the gender difference in worry disposition (Schulz et al., 2002).

Prediction of academic motivation

Academic motivation is predicted by gender, but this is fully or partly mediated by perceived stress. All other predictors did not explain any incremental variance, and the significant predictors accounted only for a small percentage of variance. Little is known about possible gender differences in academic motivation during the pandemic (Ahmad et al., 2021; Tefiki, 2021). In a study with Turkish university students conducted

TABLE 5 Prediction of mastery goals.

Variable	B	95% CI for B		SE B	β	R ²	ΔR^2
		LL	UL				
Step 1						0.114***	0.114***
Constant	6.025	5.696	6.353	0.167			
Gender	-0.640	-0.861	-0.419	0.112	-0.338***		
Step 2						0.176***	0.062***
Constant	5.599	4.073	7.125	0.775			
Gender	-1.080	-2.036	-0.124	0.485	-0.570*		
CS	0.057	-0.095	0.209	0.077	0.048		
PS	0.361	0.154	0.568	0.105	0.227***		
Gender * CS	-0.081	-0.218	0.055	0.069	-0.302		

CS, coronavirus stress; PS, perceived general stress. * $p < 0.05$, *** $p < 0.001$.

before the pandemic, men showed higher extrinsic motivation than women (Hakan and Münire, 2014). Still, performance and mastery goals were not investigated. In a study with high school students of 17 years (study 1) and 14 years (study 2), girls demonstrated higher mastery goals in German and English, whereas boys revealed higher mastery goals in math and physics. Regarding performance goals, boys showed higher values in the approach dimension in math, physics, history, and chemistry and higher performance-avoidance goals in math and physics (Wirthwein and Steinmayr, 2020). In another study, girls showed higher mastery goals than boys in middle school. There were no significant differences between genders concerning performance goals at the beginning of middle school. Still, performance goals stabilized in girls after Grade 7, whereas there was a decline in boys during this period (Theis and Fischer, 2017). However, to our knowledge, no study has investigated possible gender differences in academic motivation during the pandemic besides the school context. Our study adds to this missing research: Female university students demonstrate higher academic motivation measured with performance and mastery goals than male university students.

Investigating the predictors of academic motivation in more detail, it was evident in the present study that not gender but perceived stress is the relevant variable in explaining academic motivation in a way that perceived stress predicted academic motivation positively: The higher the perceived stress, the higher the academic motivation. Comparable results were found by Ramaprabou and Dash (2018), showing that achievement motivation was highest in students with a moderate stress level compared to a slight or high one. Struthers et al. (2000) found that stress positively predicted motivation in Canadian college students, and Park et al. (2012) reported that the academic motivation scale “extrinsic identified regulation” was positively related to stress in Korean medicine students. Furthermore, interpersonal stress was positively associated with academic motivation in Mexican-origin college students but only under

the condition of a positive sibling relationship (Jones et al., 2022). In Nigerian students, intrinsic motivation and academic stress were also positively related (Muza and Muhammad, 2020). At first glance, this seemed astonishing because a lot is known about the downside of stress, for example, that students under stress perform worse (Gustems-Carnicer et al., 2019). However, negative emotions or stress can also have enhancing effects. Strack et al. (2017) demonstrated that anxiety motivation, which means the tendency to use anxiety as a source of motivation, mediated the relationship between trait anxiety and academic achievement: People who were aware of their anxiety could use this to boost their motivation and performance. The anxiety control theory predicts that anxiety is associated with directing more effort to the task (Eysenck et al., 2007). The same could have happened with the perceived stress during the coronavirus pandemic: The uncertainty leads to focus on academic motivation for not losing touch with the academic claim. The coronavirus might trigger the awareness of feelings: Because no one had experienced a pandemic before, students were aware of their anxiety and stress and used this to motivate themselves. Different correlations found in the present study support this assumption: higher levels of coronavirus stress are associated with higher mastery goals. Students who experienced more stress due to the pandemic were more motivated to focus on intrinsic values associated with learning. On the contrary, the pandemic’s stress was not associated with performance goals. Hence, the perceived stress due to the pandemic did not motivate students to do better compared to others. For performance goals, significant correlations were found only with perceived general stress but not with the pandemic’s stress. Hence, when it comes to doing better than others, the general stress is important, but the isolation from other students or professors or the online learning is not. A possible reason could be that students cannot compare their performance to others because of times of isolation. Mastery goals were significantly correlated with the general stress and the pandemic’s stress. Focusing on intrinsic

values associated with learning seems to be more important when the stress due to online learning and isolation from the campus becomes more apparent.

Besides that, a moderate level of stress could help students become more responsible, set their goals, and go after them. In contrast, very little stress could lead to easiness or even carelessness which could be associated with less motivation and willpower to achieve a goal. Moreover, stress and motivation could be closely interlinked and mutually dependent. Students who are highly motivated and fear not getting good grades could be more stressed than unmotivated students who do not care about good grades. However, more studies must follow to support this assumption, for example, while investigating anxiety motivation.

The role of physical activity

In none of the measurements presented here, physical activity plays an important role. Physical activity did not correlate with coronavirus stress or academic motivation. This result contradicts our hypotheses. However, in the study of Maher et al. (2021), a positive relationship between the amount of physical activity and positive affect has been demonstrated. Whereas the measurement of positive effect seemed to be concentrated on short-term emotions, the concept of stress is outlasting. The results of the study presented here are also in contrast to the study of Silva et al. (2020), where physical inactivity is associated with increased stress in Brazilian during the coronavirus pandemic. One reason for the different results might be the time of the investigations. In the third wave, participants might have figured out a lot of methods to stay more active, and physical inactivity is not that relevant anymore to cope with the experienced stress. Another reason could be our measurement of physical activity: Participants were asked to report their activities during the past week. While Maher et al. (2021) used the exact measurement we used at two time points before and at the beginning of the pandemic, Silva et al. (2020) asked their participants in May 2020 to report their physical activity before and during the pandemic.

Limitations

First, the time our participants were surveyed could have influenced the results. Students might have gotten used to the situation after more than 1 year of restrictions. Second, our stress measurements were correlated, and general stress better explained students' motivation than the specific stress during the coronavirus pandemic. Higher education students might be able to cope with the situation better than younger adolescents or less educated people. The academic context with digital learning possibilities might have been good enough so that the pandemic

has not affected students' academic motivation as much as more personal traits like their wellbeing or contentment. Third, other variables could have influenced students' motivation that we did not survey. Furthermore, Cronbach's alpha for mastery goals and the coronavirus stress was below 0.7, which is questionable.

Conclusion

Our results provide clear evidence that the perceived stress in the coronavirus pandemic is positively related to academic motivation in German University students. This study adds to the literature that a specific amount of stress might be favorable for motivational factors. Furthermore, gender differences were found in students' motivation, perceived coronavirus stress, and perceived general stress. The study has two important implications: The first is to acknowledge that the coronavirus pandemic also had some positive effects besides all negative ones. The second one is that gender should be an essential differential factor in all stress and academic motivation studies during the coronavirus pandemic.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: <https://mfr.osf.io/render?url=https%3A%2F%2Fosf.io%2F26qy3%2Fdownload>.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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