

Desirée Fossum Hallerud
Mikaela Christine Elise Ellefsen

The effect of aerobic exercise on students´ perceived stress: a narrative literature review

Bacheloroppgave i Human Movement Science

Veileder: Karen Emilia Ekman

Mars 2024

Desirée Fossum Hallerud
Mikaela Christine Elise Ellefsen

The effect of aerobic exercise on students´ perceived stress: a narrative literature review

Bacheloroppgave i Human Movement Science
Veileder: Karen Emilia Ekman
Mars 2024

Norges teknisk-naturvitenskapelige universitet
Fakultet for medisin og helsevitenskap
Institutt for nevromedisin og bevegelsesvitenskap



Kunnskap for en bedre verden

Abstract

Background: This literature study investigates if aerobic exercise can have a positive effect on students' perceived stress. Students are a complex group, and are probably the driveforce for the future. Facing a high amount of stress is normal for students, and can affect their wellbeing. Aerobic exercise is a type of physical activity and previous research has posted the question about effects of aerobic exercise on students' stress levels. **Method:** We have investigated eight articles through a search on both Web of science and Scopus. The 8 articles did different trials to investigate aerobic exercises correlated to student stress levels. **Results:** Six out of eight articles show a positive effect of aerobic exercise on students' stress levels. One article had no significant interaction and one showed an increase in stress levels. **Conclusion:** Implementing aerobic exercise in daily life for students may have a positive effect for decreasing the amount of stress, but comparing the studies is difficult. We conclude that the stressed students may experience a decrease in stress by implementing aerobic exercise in their everyday life.

Abstrakt

Bakgrunn: Denne litteraturstudien undersøker om aerob trening kan ha en positiv effekt på studenters opplevde stress. Studenter er en kompleks gruppe i samfunnet, og de er trolig drivkraften for fremtiden. Studenter opplever ofte mye stress, noe som kan påvirke deres velvære. Aerob trening er en form for fysisk aktivitet, og tidligere forskning har stilt spørsmål rundt effekt av aerob trening for studenters stressnivå. **Metode:** Vi undersøkte åtte artikler gjennom søk på både Web of science og Scopus. De åtte brukte artiklene undersøkte om aerob trening har en positiv effekt på studenters stress. **Resultater:** Seks ut av åtte artikler viser til positiv effekt av aerob trening hos studenter som opplever stress. Én artikkel hadde ingen signifikant interaksjon, og én viste en økning i stressnivå. **Konklusjon:** Å implementere aerob trening i dagliglivet til studenter, kan ha en positiv effekt for å redusere mengden stress, men studiene vi har undersøkt er vanskelig å sammenligne. Vi konkluderer med at stressede studenter kan oppleve nedgang av stress ved å implementere aerob trening i hverdagen.

Keywords: Distress, Endurance training, Physical exercise, Undergraduate

Introduction

Students as a group in our society are highly complex and will potentially be the driving force for the future. There are countless types of students based on gender, physiology, psychology, and characteristics (Sialino et al., 2022), (Chandrachood, 2023). Students are a group that is facing a high amount of stress compared to the rest of the population, because of the high amount of pressure they experience through examinations, deadlines, and expectations of high academic performance (Stolarska et al., 2019), (Conley et al., 2013), (Herbert et al., 2020). Experiencing stress can be both positive and negative, where just a little bit of it helps us initiate chores, and too much can lead to physical and psychological exhaustion and health issues (World Health Organization, 2023).

Stress is a natural human response, which occurs when the body discovers a threatening situation where the optimal function may not be maintained. This response may occur within or outside the body. It is a complex phenomenon which affects both physiological and psychological systems, and which may affect every person differently (Del Giudice et al., 2018). Stress can be a risk factor that leads to negative well being and a number of health concerns, such as physical illness or mental disorders (Herbert et al., 2020). A consequence of this could be missing important lectures and education due to sick leave. “*Stress levels*” is a superior term which may include several definitions of stress. We have opted to focus on subjective feelings of stress by perceived stress. Whether stress could be affected by regular physical activity is discussed in earlier research (Gerber et al., 2014a), (von Haaren et al., 2016), but the results are inconsistent.

The World Health Organization (WHO) defines physical activity as “*any bodily movement produced by skeletal muscles that requires energy expenditure*” (World Health Organization, 2022). Aerobic exercise specifies as physical activity that makes the heart, lungs and muscles work, while you still are able to maintain the activity level over a longer time period (Weil, 2023). The benefits of aerobic exercise have been shown through several studies, with indicators that it can improve both mental and physical health (Herbert et al., 2020). Gerber and Pushe (Gerber and Pühse, 2009) argue that a possible explanation is that stress tolerance is strengthened by being physically active. On the other hand, it could be negative for students to include exercise in their schedule, as it may increase their stress levels due to increased pressure (Gerber et al., 2014a). We have chosen to focus on specifically aerobic exercise,

because it's the most available form of exercise for everyone due to the wide range of ways it can be performed. All kinds of people can find a way to participate because of this range, as aerobic exercise can be everything from walking, running and cycling, to team sports and dancing. WHO offers guidelines on how much aerobic exercise adults in the age between 18-64 years should implement in a week. The recommendation is 150-300 minutes moderate-intensity, or 75-150 minutes of vigorous-intensity aerobic exercise per week. By implementing these guidelines it may improve cognitive outcomes as well as your mental health (World Health Organization, 2022).

Whether aerobic exercise has a positive effect on students' perceived stress levels is still unclear in the literature. We aim to address the existing knowledge gap through a narrative literature study, where we will investigate the following issue: “the effect of aerobic exercise on perceived stress”. Analyzing the following articles, allows us to discuss the theme by examining strengths and weaknesses of the studies. Hopefully, we can provide a more certain answer to whether aerobic exercise does have an impact on students' stress levels at the end of our study.

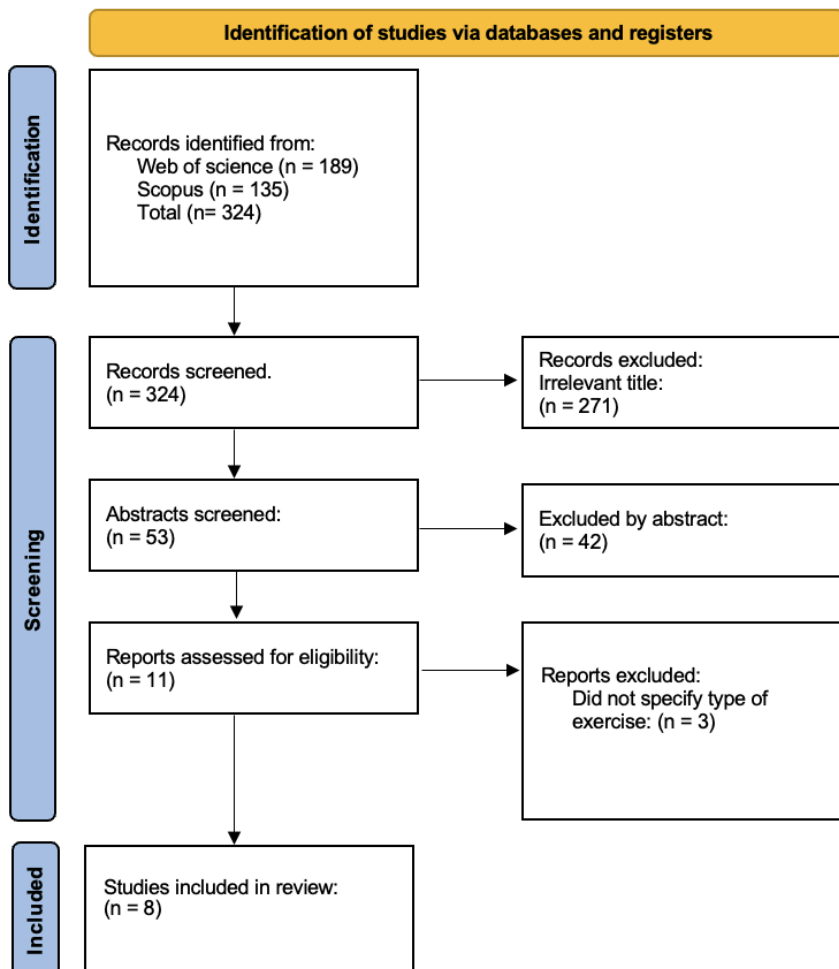
Method

This bachelor thesis is based on a systematic literature search. Web of Science and Scopus was used to find literature, and used the following search terms in both databases; ((student OR students OR "university students" OR undergraduate) AND ("endurance training" OR "aerobic training" OR "aerobic exercise") AND (depression OR sadness OR anxiety OR stress OR "stress levels")). After reading the topics on the findings we got from the search, we excluded 271 based on the title. We used our inclusion - and exclusion criterias to find relevant articles, and the screening process is presented in figure 1.

Table 1. Inclusion- and exclusion criterias for selection of articles.

| Inclusion criterias | Exclusion criterias |
|---------------------------------|--|
| Must be students | Children & elderly |
| Aerobic exercise | Does not specify aerobic exercise |
| Perceived stress | Duplicates |
| Language: english or norwegian | Other languages than english & norwegian |
| Published between 2010 and 2024 | Published before 2009 |
| Peer reviewed | Studies conducted on animals |
| Age: 18-30 | Younger than 18 & older than 30 |

Figure 1. Prisma flow chart (PRISMA, 2024)



Results

Eight studies were selected, using different study designs, which were one Randomized Controlled Trial (RCT), two experimental, two mixed method designs, one cross-sectional, one exploratory cross sectional study, and one quasi experimental study. All of the articles deal with how stress can be affected by aerobic exercise, but have used different interventions to investigate it. Six out of eight studies had an intervention, while two did not.

Table 2. Descriptive overview of the primary articles

| Article | Study design | Sample | Age (y/o) | Intervention | Measures | Main findings |
|------------------------------|--------------------|--|--|---|---|--|
| (von Haaren et al., 2015) | RCT | Total n= 61 Men n= 61 AET group: n= unspecified CG: n= unspecified | Average: 21.4 ±1.6 | 20-week aerobic running training course. | Electronic diaries using the software MyExperience movisens Edition. Baseline measures: beginning of the semester. (week 1) Post1: first academic examination (week 15) Post2: second academic examination (week 20) | Both groups increased perceived stress between baseline and post1. CG increases in stress from post1 to post2. The AET group showed less emotional stress than CG after the intervention. (p=<0.001) |
| (Chovanec and Groepel, 2020) | Experimental study | Total n= 52 Endurance: Total n=18 Women n=18 Resistance: Total n=21 Women n=21 CG: Total n=13 Women n=13 | Average: 21.02±1.65 Endurance : 21.22±0,39 Resistance: 21.24±0,42 CG: 20.38±0.27 | Two 8-week exercise programmes: 3x 60 min sessions per week. Stress test. | One-dimensional Perceived Stress Scale The Coping Orientation for Problem Experiences inventory | Significantly lower perceived stress in both training groups compared to CG; endurance; (p= 0,002), resistance: (p= <0,001) |

| | | | | | | |
|--------------------------|----------------------------|--|--|--|---|--|
| (Herbert et al., 2020) | Mixed-method design study. | Total n= 185 Laboratory study: Total n= 32 Women n= 30 Men n=2 Online study: Total n= 153 Women n=127 Men n=26 | Average: 22.54±2.93 | Laboratory pilot study: Laboratory aerobic exercise 2 times a week for two weeks. Online pilot study: Exercise videos two times a week for 6 weeks. | Stress and Coping Inventory. Measured before and after intervention. | Online laboratory study: Decreased stress between T1 and T2 (p= <0,001) in exercise group. Laboratory pilot study: No presented results on stress. |
| (Leuchter et al., 2022) | Cross-sectional study | Total n= 1,046 Women: n= ca. 50% Not specified: n= ca. 50% | 2013: Average: 25.6 2014: Average: 25.9 | No intervention. | The Perceived Stress Scale The International Physical Activity Questionnaire Different levels of exercise intensity. Data collected at not very stressful periods. | The progressive exercise intensity from moderate to high was linked to lower stress. (p=<0,001) Stress levels differ between levels of education. |
| (Stolarska et al., 2019) | Experimental study | Total n=240 Experimental group: Total n = 120 Women n=120 Control group: | 19 - 27 | Experimental group: 45-minute-long indoor aerobic training. CG: cognitive test | A pre and post-test that measured the mood before and after the training session. | Aerobic exercise may have a positive effect on stress. |

| | | | | | | |
|-----------------------------|-----------------------------------|--|----------------------------------|--|--|--|
| | | Total n = 120 Women n=120 | | | | |
| (Gerber et al., 2014a) | Exploratory Cross-sectional study | Total n= 451 undergraduate students Medical students: Total n=201 Women n=136 Men n=65 Exercise & health science students: Total n =250 Women n=144 Men n=106 | Average: 23.2 ± 2.4 | No intervention | Perceived Stress Scale. Office in Motion Questionnaire. | Significant effects: Perceived stress and dancing (p=0.001/p=0.0043) Perceived stress and ball sports (p = .0019/p = .0057) Perceived stress and weight lifting (p = .0043/p = .0083) No significant effect between aerobic exercise and stress. |
| (Hachenberger et al., 2023) | Mixed-method design study. | Total n=90 Women n=71 Men =17 Other n=2 Out of the 90 participants, 50 used accelerometry. | Average: 24.0 (SD 4.4) | No specific intervention. 10-day experience sampling. | Modified version of International Physical Activity Questionnaire. Accelerometer measures Questionnaires assessing stress experience | All subjective measured Physical activity showed a correlation with lowered stress during the day. Objectively measured physical activity showed lowered stress only with Low Physical Activity (LPA). |

| | | | | | | |
|-------------------------|--------------------------|--|--------------------------|--|--|--|
| (Johnston et al., 2021) | Quasi-experimental study | <p>Total n=291</p> <p>Team sport classes: Total n=138 women n=67 Men n=71</p> <p>Aerobic dance CG: Total n=153 Women n=153</p> | Average: 18.34 | <p>Team sport participation.</p> <p>Aerobic dance classes (CG)</p> <p>Questionnaires</p> | <p>Measure effectiveness of aerobic training compared to perceived stress in students.</p> | <p>Both groups scored moderate on the perceived stress test in both pre- and post-test.</p> <p>Significant increase in perceived stress in both groups from pre-test to post-test (p=0.035).</p> |
|-------------------------|--------------------------|--|--------------------------|--|--|--|

Von Haaren et al. (von Haaren et al., 2015) used a sample consisting of 61 inactive students in electrical engineering, all men, who completed a 20-week aerobic exercise program during the winter semester. They were randomly divided into an aerobic exercise training (AET) group and a control group (CG), and did not differ in characteristics. Perceived stress and emotional stress reactivity during two examination periods were investigated. All participants in both groups had an increase in perceived stress between baseline and post1. For the AET group, the perceived stress-levels were similar in both exam periods. The CG had an increase in perceived stress from post1 to post2. It was discovered that the AET group showed less emotional stress than the CG after 20 weeks of aerobic exercise ($p < 0.001$). The CG showed higher negative affect compared to baseline during the examinations, while the AET group had a decrease in negative affect from baseline to post1 and similar negative affect between baseline and post2. After the exercise intervention, the AET group showed less negative affect in the exam periods.

Chovanec and Gröpel (Chovanec and Groepel, 2020) investigated if aerobic exercise and resistance training in a eight-week period had an effect on perceived stress. The sample consisted of a total of 52 students, all women, with no significant difference in characteristics between the groups. They were randomly divided into three groups, where the endurance group had 18 participants, the resistance group had 21 participants, and the control group had 13 participants. Both of the intervention groups did three 60-minute long exercise sessions a week, for eight weeks, while the CG did nothing. A pre-test was carried out one week before the start of the intervention, and a post-test one week after the end of the intervention. These tests are the source of the collected data. The results from their study showed significant results in lowered perceived life stress both with aerobic exercise and resistance training (respectively $p = 0.002$ and $p < 0.001$) compared to the control group, with no significant difference between the two groups.

In the study conducted by Herbert et al. (Herbert et al., 2020), they did an online and a laboratory pilot study to investigate how aerobic exercise could affect students' mental health. A total of 185 university students participated in the study, where 157 of them were women, and 28 were men. Other characteristics are not mentioned in the article. The participants in both pilot studies were randomly allocated into either an exercise intervention group, an expressive writing group, or a control group. In the laboratory study the participants did two aerobic exercise sessions a week for two weeks, and in the online study the participants did

two aerobic exercise sessions a week for six weeks. The measures were done before and after the interventions. Among multiple things, they investigated how aerobic exercise could have an effect on perceived stress on students. Results from the online-study showed that short-term aerobic exercise could decrease perceived stress (exercise intervention group: $p < 0.001$). They saw an improvement in all groups, but it was particularly pronounced in the exercise intervention group, which overall reported less depressive symptoms between the pre- and posttest ($p < 0.005$). Furthermore, it was discovered that general exercise had a negative correlation with psychosomatic stress symptoms ($p < 0.01$). The laboratory study did not present any results regarding stress.

Leuchter et al. (Leuchter et al., 2022) investigated the subject from a bit different angle compared to the previous articles, and focused on how exercise intensity correlates with stress levels. It was not conducted an intervention, the participants simply just answered questionnaires. The study was carried out during the winter semester in 2013 and 2014. Data was collected at least two weeks away from exams for the first- and second year students, and in between blocks of clinical rotations for the third- and fourth year students. The sample consisted of 1,046 medical students, where students in year one to four of the education could participate. The article reports that approximately 50% of the participants were women, but does not specify what gender the rest of the sample are. Results from the study showed that higher exercise intensity led to lower probability for high stress levels and inverse, with a 30% decrease per intensity level ($p < 0.001$). When increasing the activity level from inactive to moderately active, the possibility for being in the group with lowest stress levels increased significantly. When comparing the sample to the age-adjusted national average, they found out that medical students were less likely to be physically active on HEPA-levels (health-enhancing physical activity (high intensity physical activity)) ($p < 0.001$). They also found that stress levels differed from what stage of their medical education they were in, peaking in the third year ($p < 0.001$).

Stolarska et al. (Stolarska et al., 2019) carried out a study to investigate the benefits of moderate-intensity exercise on students' mood. A sample of 240 women were divided into two groups; a training group and a control group. In the training group, the participants did a 45-minute long aerobic exercises session, while the control group performed cognitive tasks. The data was collected pre- and post sessions. All the participants were students aged between 18-27. Data was collected between April and June, during the second half of the

semester. Data based on students' stress responses, showed that there may be positive effects of aerobic exercise on stress.

By comparing aerobics, ball sports, dancing and weight lifting, Gerber et al. (Gerber et al., 2014a) investigated which of the mentioned activities is the best for stress management. An intervention was not conducted in this study, but the participants answered three different questionnaires who assessed the interaction between stress and different exercise activities. The timing of the study within the semester is unspecified. Gerber et al.'s sample consisted of 451 Swiss university students, where 201 of them were medical students (136 women and 65 men), and the rest were exercise and health sciences students (144 women and 106 men). It was found a significant effect between perceived stress and dancing ($p = .0011/p = .0043$), perceived stress and ball sports ($p = .0019/p = .0057$), and perceived stress and weight lifting ($p = .0043/p = .0083$). There was no significant interaction between perceived stress and aerobic exercise.

Hachenberger et al. (Hachenberger et al., 2023) investigated the associations between physical activity, stress experience and how it affects the wellbeing during an examination period. They did not have any specific intervention, thus data was collected both through questionnaires and accelerometry. A final sample consisted of 90 students (71 women, 17 males, two did not report gender), from Bielefeld university. All data was collected during the examination periods in February/March 2022 and July/August 2022. Each participant had a customized plan for the data collection, by answering a baseline questionnaire 11 days before their first exam. Experience sampling questionnaires started the following day with questions to answer in the morning and in the evening. Subjective measures of physical activity showed a correlation with less stress throughout the day for moderate-to-vigorous physical activity (MVPA) ($p < 0.001$), vigorous physical activity (VPA) ($p < 0.01$) and moderate physical activity (MPA) ($p < 0.01$). Objective measures showed a correlation with only accelerometer-low physical activity ACC-LPA ($p < 0.05$). The analysis revealed no interaction between subjective/objective measures and the period before the exam. They found that being active for an hour a day with ACC-LPA, rather than accelerometer moderate-to-vigorous physical activity (ACC-MVPA) was beneficial compared to being sedentary in the same period, but this result was not statistically significant ($p = 0.689$).

Johnston et al. (Johnston et al., 2021) hypothesized that participation in team sports could decrease students' levels of perceived stress. The participants were enrolled into two groups. The first group did team sports classes, which consisted of 138 participants (71 men and 67 women), and the other group was a comparison group who did aerobic dance (153 participants, all women). Their intervention lasted over 12 weeks, where the intervention group participated either in soccer or volleyball. All participants in both the intervention group and the CG were instructed to run 68 km during the period. A questionnaire was used to measure perceived stress, which were completed via online apps, and were to be answered within one week at pretest and post test. Both groups experienced an increase in their stress levels after the posttest was ended ($p=0.035$).

Discussion

All of the included articles researched whether exercise could have an effect on stress among students. Six out of the eight articles used in this literature study, found that aerobic exercise and exercise intensity may have a positive impact on students' stress, one found no effect, while the last study showed an increase in stress levels. We chose to include the two studies who focused on exercise intensity even if they did not specify aerobic exercise, because we interpret that the different intensities could go under the definition of aerobic exercise.

The six articles that found positive effects of aerobic exercise on stress show a lot of similarities, but also some differences. Von Haaren et al. (von Haaren et al., 2015) found evidence that aerobic exercise had a positive effect on perceived stress, and also led to reduced emotional reactions to stress. They indicated that lower negative affect meant decreased emotional stress reactivity, which they found in their AET group but not in the control group (von Haaren et al., 2015). One thing that can be considered as a limitation in their study, is that their sample is a bit unclear. They have written that there are 61 participants, but also that the sample is obtained from two phases which consists of 30 participants each. This does not align, as $30+30=60$, not 61. Additionally, the lack of information on how many participants that are in each group (AET and CG), is also considered a limitation. Chovanec and Gröpel (Chovanec and Groepel, 2020) found that both aerobic exercise and resistance training had a positive impact on perceived stress, which align with earlier research (Bretland and Thorsteinsson, 2015). Because their results showed no

difference between the two interventions, it is questionable if there is a difference in the effect aerobic- and resistance training will have on stress, and makes ground for further research.

Herbert et al. (Herbert et al., 2020) and Stolarska et al. (Stolarska et al., 2019) also found that aerobic exercise could reduce stress, but both had some results that are questionable.

Stolarska et al. does not give very specific results for stress but only mentions that it may be reduced by aerobic exercise, due to the way it affects mood. This is a big limitation which makes the article not very comparable to the others, based on their lacking results of stress.

Herbert et al. show significant results in their online study, however they did not report any results in relation to stress in their laboratory study. There are several different aspects in the laboratory study that are questionable, which will be discussed further down. Leuchter et al. (Leuchter et al., 2022) and Hachenberger et al. (Hachenberger et al., 2023) found that different exercise intensities had a positive effect on stress to different degrees. Both used questionnaires to collect data regarding subjective feelings around stress, while Hachenberger et al. also collected objective data using ambulatory measures. They found different results when measuring objective and subjective stress, which may support the complexity of stress (Del Giudice et al., 2018).

Gerber et al. (Gerber et al., 2014a) were the only ones who reported no significant interaction between perceived stress and aerobic exercise. Because of their big sample, we would assume that the results they found would be valid. On the other hand, they did not have an intervention, which could affect the results. The amount of physical activity between the two groups differed, and there were also reported differences on perceived stress between genders. Four types of activities were used, and aerobic exercise was one of the activities. We think that the three remaining activities (table 2) should undergo aerobic training as well, according to how aerobic exercises are defined in the introduction. There are also similarities in the study conducted by Johnston et al. (Johnston et al., 2021), where they use exercises that we would categorize as aerobic exercise in both the intervention group and the control group (see table 2).

Johnston et al. (Johnston et al., 2021) stood out as the only study who found results that aerobic exercise increased the stress levels. The results in both of their groups were quite similar. As they reported in their own discussion, their study has some limitations. They also mention that the participants in the intervention group never were in either the lowest or

highest area on the stress scale, which may indicate that team sports can help not to be overwhelmed by stress. It also indicates that exercise may not be enough to zero out their stress entirely (Johnston et al., 2021).

There are several different interventions that are used in the different articles, with varied strengths and weaknesses. First, having a longer intervention such as Chovanec and Gröpel (Chovanec and Groepel, 2020), will probably be advantageous because the results will be more pronounced. In comparison, a shorter intervention, for example the 2-week long one that Herbert et al. (Herbert et al., 2020) used in their laboratory study, could be problematic. According to Chovanec and Gröpel (Chovanec and Groepel, 2020), it takes longer than eight weeks to see the effects of exercise as a coping strategy. Thus, an intervention in a two week period might not be long enough to show valid results. On the other hand, having a too long intervention could be challenging due to the lack of motivation in the participants, and a bigger chance for them to drop out of the study. A possible solution to motivate the participants could be giving them a reward when completing the study. Gerber et al. (Gerber et al., 2014a) was one of the studies that undertook this, as they gave all the participants that completed the study extra credit points. Stolarska et al. (Stolarska et al., 2019) used a 45-minute long intervention, which seems quite short if we compare it to some of the other studies. Still, the intervention matches their studies' purpose, because they investigated the acute effect of physical activity on stress, and not long-term as for example, von Haaren et al. (von Haaren et al., 2015). Not having an intervention at all and relying only on questionnaires, as Lechter et al. (Leuchter et al., 2022) and Gerber et al. (Gerber et al., 2014a), could be a limitation, which will be discussed further down.

Another factor that needs to be taken into consideration is the time period the study is conducted in. Testing students' perceived stress should be carried out when the students are the most stressed, which is most likely in the exam period (Wunsch et al., 2017). Therefore, testing outside this time period may not give the most realistic results regarding students' stress. Gerber et al. (Gerber et al., 2014a) did not mention when the measurements were taken, and Leuchter et al. (Leuchter et al., 2022) got their measurements in periods that were not very stressful, which both can be seen as a limitation. In contrast, von Haaren et al. (von Haaren et al., 2015) compared the beginning and ending of their students' semester and therefore the result may be more valid. By using different time periods to collect data, the

results might not be very comparable, which may be another limitation for the validity of our conclusion.

One reason for the varying results could be that several of the studies are conducted on specific groups of students. Some examples of different groups may be gender or degree programs. When it comes to gender, it could be both the distribution of genders within the study, and between studies that affect the results. Gerber et al. (Gerber et al., 2014a) was one of the articles that used mixed genders in both the intervention group and the control group. They discovered no significant interaction based on their result (table 2). Gerber et al. also reported that there was a gender difference in reported perceived stress in both groups. Using mixed genders could be a great way to test a wider spectrum of students, but it can be problematic if the gender distribution is uneven. As mentioned in the introduction, students go under a wide spectrum of genders, and there might be differences between them that may affect the result. Also, a skewed selection of genders in the sample could result in representing one gender more than others, as for example for Herbert et al. (Herbert et al., 2020). Using only one gender in a study is safer due to the certainty that the participants all represent one group. This can also be problematic for the same reason, as it does not give any information regarding other groups. It is well known that there exist more genders than only two at this day, therefore it is important to specify all genders that are represented. Leuchter et al. (Leuchter et al., 2022) do not mention what gender approximately half of their sample consists of. Other than that, all of the articles only investigated women and men.

In addition to the group of genders, people who choose different degree programs might differ in personal characteristics. Therefore, conducting a study on only one degree program as for example Leuchter et al. (Leuchter et al., 2022) and von Haaren et al. (von Haaren et al., 2015) did, may not show reliable results for a wider population. These characteristics might also have an importance for how they perceive and cope with stress (Garces-Arilla et al., 2023), which could make the results differ a lot between degree programs. Because of these different samples, it is unknown whether Leuchter et al. (Leuchter et al., 2022) and von Haaren et al. (von Haaren et al., 2015) would have found the same effects if they did the same study on other groups of people. The students in the Exercise and health science degree program in Gerber et al. (Gerber et al., 2014a) reported more activity, compared to the medical students. This may show that the students in this degree program are more active which must be taken into consideration by comparing to a possibly less active group.

Nevertheless, it is still possible that the discovered effects could occur in other groups as well.

Another reason that the results vary may be the different study designs that are used. Leuchter et al. (Leuchter et al., 2022) and Gerber et al. (Gerber et al., 2014a) are two of the studies who did not have an intervention, and their results rely exclusively on questionnaires. Leuchter et al. discovered a link between high intensity training and lower stress levels, in contrast to Gerber et al. who did not receive a significant result through their questionnaire (table 2). This indicates that results from questionnaires may be scattered. Collecting data from only surveys may be challenging (Johnston et al., 2021) due to several reasons. First, inserting the wrong information in a questionnaire may be likely to happen. This may occur because of for example misinterpretation, lack of motivation to answer correctly, fear of privacy intrusion, or participants answering based on what they think is most socially acceptable. Second, getting the right participants, and enough of them, might be challenging. A lot of potential attendees may not attend because they don't feel like using time and/or energy on a survey. The people who do attend a questionnaire-study, may have a lot of the same characteristics and personality traits, which makes the sample not representable for everyone. Third, surveys often are superficial and do not go in depth within their subject, due to the challenges listed above. This makes it hard to investigate responses, feelings and other factors that may be important to get precise results.

A third reason for the varying results might be the size of the sample that is used. It is well known that a bigger sample often makes a more precise result that is closer to the reality. Despite this circumstance, a too big sample may result in a waste of resources (Hamasaki et al., 2013). Six of the articles included in this text have a sample that includes over a 100 participants, which makes the results they present reliable. The two remaining had a sample who consisted of under a 100 (table 2), which might make the results a bit less reliable than if the sample was bigger. That is because critical details or effects might not be discovered (Hamasaki et al., 2013). That being said, it is not a matter of course that the results are wrong, but it is important to be aware of that when interpreting the results.

Recent studies have reported that physical activity can be an effective way of reducing stress in students, both acute and long term, and that physical exercise can be an effective method to cope with stress in stressful periods (Childs and de Wit, 2014). The results from our study

overall supports this, as most of the articles did find a significant positive effect of aerobic exercise on stress (von Haaren et al., 2015), (Chovanec and Groepel, 2020), (Herbert et al., 2020), (Leuchter et al., 2022), (Hachenberger et al., 2023). The short intervention from Stolarska et al. (Stolarska et al., 2019) which lasted for only 45 minutes, concerns the acute effect of aerobic exercise on stress. As their results were positive, it corresponds with Childs and de Wit's (Childs and de Wit, 2014) findings, indicating that exercise causes individuals to be more resistant to acute stress. Magalhaes (Magalhaes, 2016) has reported evidence that aerobic exercise only has a small effect on lowered perceived stress, which does not entirely correspond with our findings, except from Stolarska et al. (Stolarska et al., 2019) who only found that there might be a connection.

Earlier research also appraise the effect of exercise intensity on stress. For example (Gerber et al., 2014b) found that vigorous intensity exercise was an effective way to reduce stress. In the study done by Leuchter et al. (Leuchter et al., 2022), they found some of the same effects, as they reported progressively lowered stress as the exercise intensity increased. Hachenberger et al. (Hachenberger et al., 2023) on the other hand, found that all subjective measured exercise intensities led to a reduction in stress, while the intensities that were objective measured only showed an effect of low intensity exercise. This contradicts the results from Gerber et al. (Gerber et al., 2014b), which underscores the need for additional research in this field. We also find it important to do more research regarding how different types of physical activity can influence perceived stress, and how several different genders respond to aerobic exercise regarding stress.

Conclusion

The findings we have presented in this literature review illustrates how students' stress perception could be influenced by being physically active, and contributes to the understanding of the continuous stress exposure they experience. We have found significant evidence that aerobic exercise can be used as an effective method to deal with rising stress levels during stressful periods. Thus, we conclude that aerobic exercise does have a positive impact on perceived stress, but still needs more research. We also conclude that stress cannot be completely zeroed out by aerobic exercise. With our findings as background, we suggest that students implement regular aerobic exercise in their everyday schedule, to be more

resistant to stress when that occurs. We also suggest that it would be effective to implement physical activity in the educational lap, and to offer courses in universities which gives students necessary knowledge about the advantages and importance of being active.

References

- Bretland, R.J., Thorsteinsson, E.B., 2015. Reducing workplace burnout: The relative benefits of cardiovascular and resistance exercise. *PeerJ San Franc. CA* 3, e891–e891. <https://doi.org/10.7717/peerj.891>
- Chandrachood, M., 2023. Dealing with different types of students: Teachers' blind spot. *GAIMS J. Med. Sci.* 3, i–iv. <https://doi.org/10.5281/zenodo.7728012>
- Childs, E., de Wit, H., 2014. Regular exercise is associated with emotional resilience to acute stress in healthy adults. *Front. Physiol.* 5, 161–161. <https://doi.org/10.3389/fphys.2014.00161>
- Chovanec, L., Groepel, P., 2020. Effects of 8-week endurance and resistance training programmes on cardiovascular stress responses, life stress and coping. *J. SPORTS Sci.* 38, 1699–1707. <https://doi.org/10.1080/02640414.2020.1756672>
- Conley, ColleenS., Durlak, JosephA., Dickson, DanielA., 2013. An Evaluative Review of Outcome Research on Universal Mental Health Promotion and Prevention Programs for Higher Education Students. *J. Am. Coll. Health* 61, 286–301. <https://doi.org/10.1080/07448481.2013.802237>
- Del Giudice, M., Buck, C.L., Chaby, L.E., Gormally, B.M., Taff, C.C., Thawley, C.J., Vitousek, M.N., Wada, H., 2018. What Is Stress? A Systems Perspective. *Integr. Comp. Biol.* <https://doi.org/10.1093/icb/icy114>
- Garces-Arilla, S., Fidalgo, C., Mendez-Lopez, M., Osmá, J., Peiro, T., Salvador, A., Hidalgo, V., 2023. Female students' personality and stress response to an academic examination. *Anxiety Stress Coping* 1–13. <https://doi.org/10.1080/10615806.2023.2264208>
- Gerber, M., Brand, S., Elliot, C., Holsboer-Trachsler, E., Pühse, U., 2014a. Aerobic Exercise, Ball Sports, Dancing, and Weight Lifting as Moderators of the Relationship between Stress and Depressive Symptoms: An Exploratory Cross-Sectional Study with Swiss University Students. *Percept. Mot. Skills* 119, 679–697. <https://doi.org/10.2466/06.PMS.119c26z4>
- Gerber, M., Brand, S., Herrmann, C., Colledge, F., Holsboer-Trachsler, E., Pühse, U., 2014b. Increased objectively assessed vigorous-intensity exercise is associated with reduced stress, increased mental health and good objective and subjective sleep in young adults. *Physiol. Behav.* 135, 17–24. <https://doi.org/10.1016/j.physbeh.2014.05.047>

- Gerber, M., Pühse, U., 2009. Review Article: Do exercise and fitness protect against stress-induced health complaints? A review of the literature. *Scand. J. Public Health* 37, 801–819. <https://doi.org/10.1177/1403494809350522>
- Hachenberger, J., Teuber, Z., Li, Y.-M., Abkai, L., Wild, E., Lemola, S., 2023. Investigating associations between physical activity, stress experience, and affective wellbeing during an examination period using experience sampling and accelerometry. *Sci. Rep.* 13, 8808. <https://doi.org/10.1038/s41598-023-35987-8>
- Hamasaki, T., Sugimoto, T., Evans, S., Sozu, T., 2013. Sample size determination for clinical trials with co-primary outcomes: exponential event times. *Pharm. Stat.* 12, 28–34. <https://doi.org/10.1002/pst.1545>
- Herbert, C., Meixner, F., Wiebking, C., Gilg, V., 2020. Regular Physical Activity, Short-Term Exercise, Mental Health, and Well-Being Among University Students: The Results of an Online and a Laboratory Study. *Front. Psychol.* 11, 509. <https://doi.org/10.3389/fpsyg.2020.00509>
- Johnston, S.A., Roskowski, C., He, Z., Kong, L., Chen, W., 2021. Effects of team sports on anxiety, depression, perceived stress, and sleep quality in college students. *J. Am. Coll. Health* 69, 791–797. <https://doi.org/10.1080/07448481.2019.1707836>
- Leuchter, R.K., Stuber, M.L., McDonald, A.L., Croymans, D.M., 2022. Relationship between exercise intensity and stress levels among US medical students. *Med. Educ. ONLINE* 27, 2027651. <https://doi.org/10.1080/10872981.2022.2027651>
- Magalhaes, M., 2016. The effect of various physical exercise modes on perceived psychological stress. *South Afr. J. Sports Med.* 26, 104-. <https://doi.org/10.17159/2413-3108/2014/v26i4a501>
- PRISMA, 2024. PRISMA [WWW Document]. [Httpprisma-Statementorg](http://www.prisma-statement.org). URL <http://www.prisma-statement.org/PRISMAStatement/FlowDiagram> (accessed 1.29.24).
- Sialino, L.D., Picavet, H.S.J., Wijnhoven, H.A.H., Loyen, A., Verschuren, W.M.M., Visser, M., Schaap, L.S., Van Oostrom, S.H., 2022. Exploring the difference between men and women in physical functioning: How do sociodemographic, lifestyle- and health-related determinants contribute? *BMC Geriatr.* 22, 610. <https://doi.org/10.1186/s12877-022-03216-y>
- Stolarska, B., Stolarski, M., Matthews, G., 2019. A Comparison of the Effects of 45-minute Aerobic Training and Cognitive Task Solving on Transient Mood States in a Female Student Sample. *Appl. Psychol. Health Well-Being* 11, 499–521.

<https://doi.org/10.1111/aphw.12165>

von Haaren, B., Haertel, S., Stumpp, J., Hey, S., Ebner-Priemer, U., 2015. Reduced emotional stress reactivity to a real-life academic examination stressor in students participating in a 20-week aerobic exercise training: A randomised controlled trial using Ambulatory Assessment. *Psychol. SPORT Exerc.* 20, 67–75.

<https://doi.org/10.1016/j.psychsport.2015.04.004>

von Haaren, B., Ottenbacher, J., Muenz, J., Neumann, R., Boes, K., Ebner-Priemer, U., 2016. Does a 20-week aerobic exercise training programme increase our capabilities to buffer real-life stressors? A randomized, controlled trial using ambulatory assessment. *Eur. J. Appl. Physiol.* 116, 383–394. <https://doi.org/10.1007/s00421-015-3284-8>

Weil, R., 2023. Aerobic Exercise [WWW Document]. *MedicineNet*. URL

https://www.medicinenet.com/aerobic_exercise/article.htm (accessed 2.6.24).

World Health Organization, 2023. Stress [WWW Document]. <https://www.who.int/>. URL

<https://www.who.int/news-room/questions-and-answers/item/stress> (accessed 2.5.24).

World Health Organization, 2022. Physical activity [WWW Document].

<https://www.who.int/>. URL

<https://www.who.int/news-room/fact-sheets/detail/physical-activity> (accessed 2.5.24).

Wunsch, K., Kasten, N., Fuchs, R., 2017. The effect of physical activity on sleep quality, well-being, and affect in academic stress periods. *Nat. Sci. SLEEP* 9, 117–125.

<https://doi.org/10.2147/NSS.S132078>

