Could physical activity be a valuable resource to lower stress in everyday life?

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Abstract

Background. Stress among students and young adults, is a well-documented issue. As a coping strategy, physical activity has been recognized to help with recovery from stress on the subsequent event. **Objective.** The primary aim of this study is to establish whether there exists an association between heart rate (HR)-based stress and self-reported physical activity, with a specific focus on exploring any potential recovery effect. **Methods.** To test these hypotheses a psychophysiological approach was chosen in the form of measurements based on self-reported physical activity with the measurement Experience Sampling Method (ESM) and heart rates (HR). The study involved 53 participants within the age range of 19 to 35 years. Over an 8-day period, participants completed an ESM study with 10 identical questionnaires per day. A time-lagged analysis was conducted to examine the relationship between stressful events and self-reported physical activity, with a focus on testing any recovery effect. **Results.** This resulted in a significant association between self-reported physical activity and subsequent subjective stressful events (p <0.001). Further, results indicated a significant recovery from HR-based stress considering self-reported physical activity after a stressful event (p< 0.001). **Discussion.** The results provide evidence supporting the hypothesis that physical activity contributes to stress recovery after encountering stress. The findings of this study are in line with previous studies indicating an association between physical activity and stressful events. Future research should place more emphasis on psychophysiological measuring methods and further investigate the impact of physical activity on recover stress after a stressful event.

Keywords: *daily stress, physical activity, young adults, experience sampling methodology (ESM), heart rate (HR), stress recovery*

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Introduction

Stress is known to be part of every young adult and student with the specific reasons for experiencing stress varying from one individual to another. This young generation encounter challenges of navigating adulthood amidst trying circumstances with the uncertainty brought about by recent global events intertwining with their daily stressors associated with academic pursuits or work obligations (American Psychological Association, 2020). Within this context, it becomes evident that the current young adult generation endures more stress with the average rating of 6.1 out of 10, surpassing that of preceding generations (Abrams, 2023). These young adults encounter not only elevated stress but also exhibit a heightened issues in decision-making, a contrast to the experiences of their predecessors. Experiencing this high-intensity and long-lasting stress has an impact on the body. The symptoms can reach from cardiovascular disease to a weakened immune system (Odual et al., 2022; American Psychological Association, 2022; Pervanidou & Chrousos, 2012) to physical pain, and dysfunctional lifestyle changes. Further, many studies urge their attention to the psychological aspect. Studies found stress to be causing problems like anxiety and depression (Pervanidou & Chrousos, 2012) Notably, a specific study unveiled the prevalence of psychological disorders among students being: depression (18.4%), anxiety (23.6%), and stress (34.5%), with 37.4% experiencing two or more psychological disorders (Ramón-Arbués et al., 2020). These statistics emphasize the critical need to thoroughly examine the factors that contribute to stress and to explore potential pathways towards recovery.

Stress Response and Measurement

The stress response, referred to as the body's fight-or-flight mode, is a natural mechanism that activates in times of emergencies, working to safeguard the organism (Hunter et al., 2009). Notably, stress presents itself uniquely in every individual, with a unique combination of physical, emotional, and behavioral responses (Jacoby et al., 2021). Consequently, identifying an individual's daily stress level can be a challenge. According to findings of Myin-Germeys et al. (2018), Experience Sampling Methodology (ESM) is a well-established sampling method for gathering naturalistic daily-life data which can provide accurate data about the participants life. By employing identical questionnaires multiple times, a day ESM provides a comprehensive overview of students' daily stressors. The ESM helps circumvent issues such as retrospective recall bias, resulting in fewer mistakes and distortions due to false memory (Myin-Germeys et al., 2018). Hence, the ESM allows the investigation of variations in daily stress levels and ascertains the contributing factors to stressful events (Myin-Germeys et al., 2018).

Stress can be reflected in bodily reactions, including higher cortisol and adrenaline rates as well as changes in cardiovascular functioning, leading to atypical fluctuations in a person's heart rate (Odual et al., 2022). Kim and colleagues (2018) conducted a literature review about the possibility of heart rate (HR) as a valid indicator of stress. Their findings demonstrated that while individuals experience psychological stress, their HR tends to fluctuate accordingly, confirming its suitability as a measure to indicate stress. This approach serves a highly functional purpose and provides valuable insights into social and biological matters (Myin-Germeys et al., 2018; De Calheiros Velozo et al., 2022). Further, the incorporation of innovative technologies, such as smartwatches, offers valuable means to assess individuals' heart rate fluctuation.

In order to enhance the value of stress assessment, a combination of ESM questionnaires and HR measures could result in more precise results about how stress is manifested. Blaauw et al. (2016) introduced the platform "Physiqual," which integrates Experience Sampling Methodology (ESM) and sensory data (HR) information, collected from wearables, into a unified format. Consequently, this novel method facilitates a more comprehensive and detailed perspective in the domain of psychophysiological research, allowing for new exploration with greater precision into stress and related phenomena. Still, according to our knowledge, no study has used a combination of ESM and sensory data to assess the daily stress recovery by physical activity in young adults and students.

Recovery from daily stressors

Recovery from stress is important to exit the fight-or-flight mode of the body. It can look very different for each student since recovery is an individual process (Lemaire & Wallace, 2010). According to Geurts & Sonnentag (2006), a successful recovery is attained when both psychological and physiological indicators return to their baseline levels before the onset of the stressor. This implies that the heart rate returns to normal as well as psychological states of anxiety or insomnia vanish. Ragsdale et al. (2011) propose that achieving recovery depends on tailoring helpful activities to the individually unique and appropriate level of effort required. Consequently, it becomes the individual's preference to determine the optimal level of effort a task should have to restore their baseline state.

While the occurrence of stressful events is unavoidable, building resilience can buffer stress and contribute to enhancing coping methods and skills to have better control over these situations (Guo & Liang, 2023). The research by Gerber and Pühse (2009) reveals that physical activity has a pivotal role in rapid stress buffering. Their study indicates that engaging in physical activity is associated with a reduced tendency to react negatively to stressful events, due to improved mood and an adaptation of the regulating process of the sympathetic nervous system. Meaning, with physical activity the body can regulate physiological reaction to a stressful event more effectively than without. Further, physical activity recovers the energy lost during stressful events and offers protection against further stress (Denovan & Macaskill, 2016). Thus, it prepares the individual for future events to buffers negative consequences caused by stress (Denovan & Macaskill, 2016). A more refined temporal perspective regarding the impact of physical activity is demonstrated in the study conducted by Putermann et al. (2017). Their findings indicate that individuals who engaged in physical activity throughout the day exhibited diminished negative stress reactivity on the same day. In summary, the effect of physical activity appears to endure throughout the entirety of the day.

In many cases going out for a walk is already helping with generating new energy for the mind and body (Weir, 2011). Szuhany and colleagues (2023) found strong evidence for physical activity being very effective in buffering stress-related symptoms like depression. Whether physical activity is being performed pre- or post-stressful event is irrelevant; a buffering effect is always found (Szuhany et al., 2013). Thus, their finding suggests that physical activity and investing time in sports help to recover from stress and improve mental well-being. Hence, being active in any way helps with easing the consequences of stress and protects the mind and body. Many other researchers have asked the same question and the findings show a positive correlation between physical activity (sports) and heightened stress recovery (Sharma et al., 2006; Weir, 2011; Odual et al., 2022). However, the variation in effectiveness altered. Some groups of participants showed higher effectiveness than others. These were the participants with severe symptoms of stress. For this group exercising was more helpful than for groups with moderate to mild symptoms. Nonetheless, exercising showed effectiveness in any group, indicating that this is a valuable coping method for any group.

The current study is aimed to investigate whether physical activity is effective in promoting subjective and physiological recovery from everyday stress. We will use ESM as a measurement and incorporate a combination of ESM with physiological measures of HR. Specifically, the hypotheses are,

1. a) Higher self-reported momentary physical activity has an effect on a subjective stressful event

   b) Higher self-reported momentary physical activity has an effect on the heart rate during a stressful event
2. a) Higher self-reported momentary physical activity is associated with subjective recovery from a stressful event

   b) Higher self-reported momentary physical activity is associated with more efficient heart rate recovery from a stressful event

Methods

Study Design

This study was part of a larger research purpose that gathered real-life data from young adults. To ensure the study's integrity, participants were thoughtfully excluded if they lacked fluency in Dutch or had health issues such as hormonal imbalances, cardiovascular disorders, or relevant allergies. The ESM method was selected for data collection due to its inherent suitability in capturing real-life data over an extended longitudinal period. Over the course of 8 days, we actively collected data through 10 semi-randomized "beeps" per day. These "beeps" were designed as identical questionnaires, aiming to understand the participants' experiences of stressful events and their level of physical activity. The central themes of these questionnaires revolved around participants' post-beep assessments of significant events preceding the last beep, as well as their level of engagement in physical activities. To gain a comprehensive understanding of participants' physiological responses, we recorded their HR five minutes prior to each "beep." Consequently, the participants' HR has been measured a total of ten times a day, with each measurement lasting five minutes.

Participants

The sample consisted of a total of 53 participants, ranging in age from 19 to 35. To recruit participants, a convenience sampling method was chosen, involving flyer distribution in a Belgium city named Leuven (e.g., university campus, library, train stations, etc.) and by postings on social media.

Materials

In this study, the participants were provided with a study smartphone, offering them a platform to receive the ESM questionnaires. To precisely measure their HR, they were equipped with sensor patches placed on their chests, enabling accurate assessment of HR variations directly from the participant's chest. Moreover, participants were instructed to remove the patches only when truly necessary (e.g., showering).

Procedure

Prior to commencing the study, ethical approval was granted by the esteemed Sociaal-Maatschappelijke Etische Commissie (SMEC) of KU Leuven. The data collection was conducted in 2019 from February to September. This long period is explained by the limited availability of study phones and chest patches for the participants. After the 8 study days were completed, the following participant received the equipment. This proceeded until the last person received the set in September.

Measures

Experience Sampling Method

In this study, participants were asked to answer the semi-randomized questionnaires, (“beeps”) digitally via MobileQ. MobileQ is an online web browser which allows researchers to generate EMS questionnaires for free. This program was installed in the form of an application on the study's mobile phone. With this tool, the questionnaires and cycles of “beeps” were programmed. One day ranged between 6:30 a.m. and 23:59 p.m. and was divided into ten-time blocks. The beeps were randomly scheduled within the blocks with a time span of 15- to 90 minutes in between two beeps; occasionally exceeding the 90 minutes. For each participant, the earliest and latest beep was personalized to their sleep-wake schedule to ensure their participation. If beeps were ignored multiple times, the researchers reminded the participant of their duty to complete the questionnaire.

Event-related stress

Event-related stress was defined as stress resulting from the most significant event experienced since the last beep. This question enabled us to ascertain whether participants encountered stress during that time period, with details of the event itself not being of primary concern. The subsequent beep provided insights into the participants’ stress levels following the occurrence of the subjective stress and whether the previous event remained relevant or had been resolved.

To operationalize stress, participants rated the most significant event since the last beep on a bipolar scale, ranging from -3 (very unpleasant event) to 3 (very pleasant event). Scores between 0 and 3 were considered positive, while values between -1 and -3 indicated the appearance of a stressor. The time point at which a stressor occurred was labelled “t_0,” representing the baseline (captured as *subjective_stress_baseline*). The following beep, referred to as "t_1" (named *subjective_stress_post*), provided information on the participant's stress levels after the occurrence of the stressor, which could have been characterized by improvement, aggravation, or a stagnant value.

Heart Rate

Daily-life electrocardiogram (ECG) measures were sampled at a frequency of 256Hz using wearable sensor patches attached to the participant's chest (Health Patch, IMEC, Belgium). These patches were previously validated and employed in previous studies like Smets et al. (2018). Mean HR measures were calculated in five-minute intervals immediately preceding each ESM beep. As mentioned above, the point of occurrence of an unpleasant event was designated as the baseline (t_0) indicating the emergence of a stressor (variable named *stress_HR_baseline*). The following ESM beep provided information on the participants' HR condition after a stressor event (t_1). This variable was named "*stress_HR_post*," capturing the post-stressor HR levels.

Association between stress and physical activity

For the first hypothesis, we examined the relationship between subjective stress and self-reported physical activity. To examine this relationship, we compared the scores after stressor occurrence (t_1) with the baseline time point, t_0. The timepoint t_1 was created by time-lagging the baseline measures of subjective stress and HR stress variables by one beep leading to the new variables *subjective_stress_post & HR_stress_post*. To avoid misinterpretations, we removed each participant's first beep, as the last beep of the prior day became the first beep of the subsequent day.

Stress-recovery

We removed the first beeps to account for the nighttime period when stressful events were less likely to occur as participants are asleep. The last beep of the day was deleted due to reasons mentioned above. To generate the recovery score from a stressful event, we calculated the difference between the time points t_0 and t_1. This calculation was performed for both stress data sets separately (ESM & HR), with both variables being time-lagged to generate t_1. The recovery score was then derived from the difference score between the variables at baseline and the subsequent beep (t_0-t_1). Consequently, we obtained the two recovery variables namely *subjective_stress_recovery* and *HR_stress_recovery*.

Physical Activity

To assess the participant's physical activity level, we utilized an ESM item that asked about their activity level before each beep. Respondents rated their physical activity on a 7-point Likert scale, ranging from 1 (not at all active) to 7 (very active). The resulting responses were coded into the continuous variable "phy_act," providing a quantitative measure of their level of physical activity.

Statistical Analysis

The data analysis was conducted in SPSS version 28 (IBM Corporation, 2019). To account for multiple data points from the same participants, we chose a long-format dataset, allowing for efficient correlation of variables. Given the demanding multilevel structure of our data, linear mixed models were employed to test our hypotheses. To account for potential biases from overly high or low scores, we included covariates in each model, representing the corresponding dependent variable at "basetime" (t_0). Statistically significant results were determined when the p-value was below .05. Concerning the first hypothesis, which examined the relationships between self-reported physical activity and subjective & HR stress, the linear mixed model incorporated the dependent variables (*subjective_stress_post & HR_stress_post*) and the predictor variable *phy_act*. Random intercepts were chosen, with the covariates representing the stress measures at (t_0).

Concerning the second hypothesis, which explored whether self-reported physical activity could lead to recovery from self-reported and HR stress, we modified the linear mixed model. The dependent variables were the participant's stress recovery scores (*subjective_stress_recovery & HR_stress_recovery*), while the predictor variable remained *phy_act*. The random intercept remained unchanged, and the covariates were similar to those used in the first hypothesis. Parameter estimates for fixed effects and tests for covariate parameters were used to test our linear mixed models.

Results

Sample Description

Considering the necessity for data exclusion of specific beep numbers in Hypothesis I (beep numbers 1) and Hypothesis II (beep numbers 1 & 10), some participants needed to be excluded from the study due to not enough datapoints. This resulted into the inclusion of 53 healthy participants, aged between 19 and 35 (M= 24.15, SD= 3.37). A significant majority of the participants identified as females (86.8%), while a smaller proportion comprised males (13.2%). Additionally, the prevailing demographic among the participants predominantly consisted of university students, with a relatively lower representation of working individuals (refer to Table 1 for detailed information). Additionally, the participants originated from various nationalities, with the majority being from Belgium (n= 46), while a few were of Dutch and Greek origin. For a comprehensive overview of the descriptive sample data, refer to Table 1.

The data collection process involved administering 10 questionnaires per day over an 8-day duration, resulting in the acquisition of a total of 4740 data points. This equates to 80 data points per participant. A comprehensive overview of the measurement frequencies can be found in Table 2, providing a detailed overview of the data distribution and its implications for the study's analysis and findings.

Table 1

Sample Characteristics (N = 53)

Characteristics	Categories	F	%
Gender	Female	46	86.8%
	Male	7	13.2%
Nationality	Belgian	46	86.9%
	Dutch	3	5.7%
	Greek	1	1.9%
Occupation	Student	31	58.5%
	Worker	21	39.6%

Table 2

Descriptive Statistics of the measurements

Measure	Range	Min.	Max.	*M*	*SD*
Event stress	5	-2	3	.93	1.34
Physical Activity	6	1	7	2.30	1.64
Heart Rate	232.73	0.0	232.73	82.78	18.82

Hypothesis I

The first part of this hypothesis investigated the potential association between stress and self-reported physical activity, particularly in the context of a subjective stressful event. To conduct this analysis, we utilized the participants' responses as variables (ESM data). As anticipated, the results derived from the linear mixed model revealed a significant effect of self-reported physical activity on the subjective stressful event ($p < 0.001$). This finding firmly establishes the existence of an association between self-reported physical activity and subjective stressful events, leading to the acceptance of this hypothesis. (Refer to Table 3 for detailed results)

In the second part of the first hypothesis, we explored the correlation between self-reported physical activity and the heart rate measured during a stressful event. In this particular investigation, we employed the psychophysiological collection method, utilizing ESM as a measure of self-reported physical activity and heart rate (HR) for stress assessment. In line with our initial predictions, the outcome revealed a significant association between physical activity and stress recovery ($p < 0.001$). Consequently, we can conclude that self-reported physical activity indeed has an influence on the heart rate measure of stress. Therefore, Hypothesis 1b stands validated and is accepted. (See Table 3 for comprehensive details of the result)

Table 3

Results of the Mixed Methods SPSS Output for Hypothesis I

		Std. Error	*df*	Estimate	*t*	*p*	Lower Bound	Upper Bound
Hypothesis I								
	ESM	0.03	168.51	0.64	18.51	<0.001	0.57	0.71
	Heart Rate	1.28	187.96	68.24	53.42	<0.001	65.72	70.76
Hypothesis II								
	ESM	0.04	151.82	-0.57	-15.90	<0.001	-0.62	-0.50
	Heart Rate	1.64	1841.03	-58.34	-35.49	<0.001	-61.56	-55.11

Note. This table demonstrates the significant results for the first and second hypotheses. Included is the continuous variable of physical activity.

Hypothesis II

For the second hypothesis, we based our assumption on the association between self-reported physical activity and subjective recovery following a stressful event. In our statistical analysis, we utilized the subjective recovery rates of participants (ESM) as the dependent variable. Results of the linear mixed model revealed a significant effect between self-reported physical activity and subjective recovery from stressful events ($p < 0.001$). Therefore, we can accept the first part of this hypothesis, as it suggests an existing association between these variables.

In the context of the second part of this hypothesis, we examined the relationship between self-reported physical activity and the heart rate measured during a stressful event. We successfully established statistical significance in this association. Notably, the fixed factor of physical activity showed a substantial impact on heart rate based stress recovery (p< 0.001). Additionally, the presence of negative values in the lower and upper bounds (as indicated in Table 3) confirms a negative relationship, indicating a recovery from stress based on heart rate. As a result, we can conclude that self-reported physical activity plays a pivotal role in reducing HR in stressful events.

Discussion

The aim of this study was to find out whether the stress induced by an event has a significant relationship with physical activity. Further, we investigated the possibility of physical activity being able to help with recovery from a stressful event. The findings from our investigation indicated that the utilization of self-reported physical activity demonstrated a statistically significant relationship with the measure of heart rate (HR) in terms of stress recovery also when relying on self-reported measures (ESM) alone.

The effect of physiological activity on stress recovery

Engaging in physical activities is believed to offer a buffering effect against self-reported stress. According to Gerstberger et al. (2023), involvement in physical activities resulted in both momentary stress reduction and a decrease in negative emotions. Our present study mirrors these outcomes, as we can indicate comparable results. Our findings of self-reported physical activity also revealed significant associations with self-reported stress suggesting that participants who engaged in physical activity experienced a buffering effect on their stress responses during subsequent situations. Thus, participants did not experience more stress than in the situation before. In Gerstberger and colleagues' investigation (2023), participants similarly exhibited reduced self-reported stress and a buffering effect after engaging in physical activity. This effect was momentary, indicating a current stress-buffering mechanism.

This could be also explained with the participants building a sort of resilience towards stress for the subsequent moment or the rest of the day (Puterman et al., 2017). In their study, Puterman and colleagues (2017) observe that participants who engage in physical activity experience reduced stress levels for the remainder of the day compared to their non-active counterparts. Similarly, Guo & Liang (2023) revealed that physical activity has a pivotal role in strengthening inner self-worth and external self-control. Their study indicated that engaging in physical activity was associated with a reduced tendency to react negatively to stressful events, due to improved confidence and social abilities. This could potentially explain the significant connections observed between self-reported stress and physical activity among participants in the present study. The rapid impact of physical activity on stress, as evidenced by both self-reported and heart rate measurements, suggests that participants may be cultivating a form of resilience through these quick-acting mechanisms. However, additional research in this direction is essential to ascertain whether the observed impact is due to buffering, resilience, or a combination of both effects.

The second hypotheses showed a significant relationship between self-reported physical activity via ESM and HR and self-reported stress. Notably, physical activity is recognized for its potential benefits on mental health and its capacity to regulate stress responses, including depression and anxiety (Hegberg & Tone, 2015). One study revealed the potential of physical activity to increase positive affect and thus recover from stress (Wichers et al., 2011). Within our study we found a significant connection between physical activity and stress levels post a stressful event. Particularly in the subsequent event after a stressor (approximately 90 minutes), the recuperation process and return to baseline stress levels appear to be facilitated by the involvement in physical activity. These results are supported by Wichers et al. (2011). They described the occurrence of a positive affect 180 minutes post engagement in physical activity which could explain the significant results in recovery from subjective stress.

Moreover, in accordance with the insights from Bernstein & McNally in 2018, the promotion of stress recovery through physical activity results in an enhancement of stress coping mechanisms. The heart rate data in our present study indicated strong resemblance to the patterns identified in their previous research. Specifically, we ascertain that the recovery rate based on HR was particularly notable among participants who engaged in heightened physical activity. This suggests that individuals who immersed themselves in substantial physical activity encountered an expedited recovery process following stressful events. Consequently, based on our results we could suggest that physical activity not only served as stress reduction but also contributes to an enhancement in emotional well-being, effectively transmuting adverse emotional states into positive ones.

Recovery from stress can be different for each person and is an individual process (Lemaire & Wallace, 2010). Stress can produce different symptoms which can be physical or psychological. In general, during a stressor occurrence, the HR is increasing meaning that recovery is indicated by the HR returning to pre-stressor baseline (Geurts & Sonnentag, 2006). Our results are in line with this assumption showing that the heart rate is sinking significantly when the participant was involved in self-reported physical activity. This is indicating that the participants' HR recovers to baseline prior to the stressor. To our knowledge, this present study is the first to investigate stress recovery by physical activity with the use of psychophysiological measures. We combined the ESM self-reported measure of physical activity with physiological HR measures of stress. As the results imply HR can variate during stress and is able to show valuable significant outcomes about HR stress recovery. It might be important to use this methodology of data collection in future research and develop it further.

Strengths and Limitations

The prominent strength of this study is the usage of psychophysiological data as a measurement. We combined participants' multiple days of self-reported physical activity (EMS) with the measure of stress by a physical measure (heart rate).

To our knowledge, we are the first study to utilise this method in modelling research on daily stress recovery. Particularly noteworthy is the ability to generate significant results comparable to the well-established ESM method which underscores its potential as a valuable and innovative form of data collection.

However, the present study also encountered a few limitations which should be considered since they might have influenced the results. Firstly, some beeps of participants (the first and last beep of the day) had to be deleted due to challenges encountered by the statistical platform SPSS which resulted from its inability to properly identify the proper categorisation of these beeps. Additionally, due to non-responses by participants more missing data was generated. Thus, in addition to the deleted beeps and missing data resulting from skipped questionnaires, it is essential to acknowledge the possibility of unresponsive bias occurring in this study. Unresponsive bias is the statistical pitfall of misleading results due to insufficient data points. Emphasizing that the responses of non-responding participants might have differed from those who responded more frequently. Resulting in the compromised generalizability of our findings. Secondly, the ESM item which conceptualised stress was solely based on one significant event. This might have led to an information bias due to missing information on the participant's overall stress level. We only gathered information on their stress after an event but not on whether they might be dealing with constant stress due to an upcoming event. Lastly, the HR of participants was only recorded five minutes before a beep. Meaning, that we had information on the participant's heart rate for only a limited amount of time. Hence, the variation in HR during the five minutes of measuring might be due to multiple factors. This could have caused a deviation from estimating daily stress and the true value of the participants' variation in HR, called estimation bias. Resulting in potentially ambiguous inferences and a lack of accurate generalisability of this study's results. A longer period of heart rate measurement could correct this limitation in the sense of having more stable measures of the participants' HR by reducing short-term fluctuations caused by diverse factors.

Further Research

This study used the psychophysiological method which indicated to be a valuable addition to the measure of stress. Its capacity to provide deeper insights into physiological stress recovery, in addition to subjective measures, underscores the importance of advancing and incorporating this approach more frequently in research designs. Examining the possibility of achieving similar significant outcomes through the utilization of diverse physiological-based measurement tools would be a compelling avenue for future research. One possible measure could be using step-counters for the measure of physical activity. Incorporating this measure could offer a unique perspective on daily physical activity when integrated with the ESM questionnaire. This combination has the potential to provide insights into physical movement patterns in relation to changes in physical heart rate.

Moreover, to enhance study refinement, additional stress operationalization items could be considered. An approach might involve transitioning from one specific event stress to a broader scope of ongoing stress experiences. Such an adjustment could shed light on the efficacy of physical activity in addressing spontaneous, recent, or chronic stress instances.

Lastly, expanding the sample to include a more diverse range of participants, could offer valuable insights into the potential benefits of physical activity for stress reduction across various age groups. Stress is a universal experience throughout life stages, making it compelling to explore how age might influence the preference for using physical activity as a stress management tool. This augmentation of the sample size could additionally unveil age-specific preferences and optimal engagement levels. To achieve this, a broader recruitment strategy involving not only the campus, but also city-wide dissemination of flyers could be implemented to maximize visibility and participation.

Conclusion

This study confirms the effectiveness of physical activity as a suitable coping mechanism for recovering from daily stress. Prior research has supported the significance of physical activity in stress reduction and resilience building. Notably, our study identified a significant association between self-reported physical activity and both subjective and heart rate-based stress responses among young adults, specifically in response to a stressful event. Notably, this study represents to our knowledge, a unique effort in investigating daily stress recovery through heart rate measurements, in conjunction with highly self-reported physical activity. As a result, it is important to go deeper into the field of psychophysiological research and develop this methodology further. Nevertheless, stress is a well-known problem with damaging effects on both mental and physical health. Given its prevalence in society, physical activity emerges as a viable solution to recover from daily stress burdens. Consequently, it is imperative to actively promote the incorporation of physical activity into the daily routines of individuals of all age groups.

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