

Summary

In modern society we face multiple day-to-day challenges such as being in traffic, meeting deadlines, and organizing child care, all of which cause considerable stress. Prolonged stress exposure is associated with cardiovascular disease (Dimsdale, 2008), depression, anxiety, back pain, poor immune system, obesity and metabolic syndrome (Chrousos, 2009; Tamashiro, Sakai, Shively, Karatsoreos, & Reagan, 2011). Due to the health-enhancing effects of regular exercise on blood pressure, hemodynamic activity, neuroendocrine, inflammatory and hemostatic responses, it is suggested that regular exercise buffers the deleterious effects of psychological stressors by reduced physiological and emotional stress reactivity (Hamer, 2012). However, previous studies only partly support the assumption that regular exercise can reduce physiological and emotional stress reactivity (Crews, & Landers, 1987; Forcier et al., 2006; Jackson, & Dishman, 2006). Most of these previous studies used between-subject designs and artificial stressors, and did not consider the habitual physical activity level of participants. The few studies that used real-life stressors demonstrated encouraging results, but were all cross-sectional. No study investigated the effects of regular exercise on both, emotional and physiological stress reactivity using a real-life stressor and a randomized, controlled trial. Thus, the current thesis investigated the effects of a 20-week aerobic exercise training (AET) on physiological and emotional responses to real-life stress using a randomized, controlled trial and an inactive sample. To assess participants' physiological and psychological responses during every-day life, ambulatory assessment was used.

Sixty-one inactive male students were randomized to either AET or a control group. Participants of the AET group completed a supervised individually tailored 20-week AET to improve aerobic capacity ($VO_2\text{max}$). An effective AET intervention (significantly enhanced $VO_2\text{max}$) was presumed for the hypothesized effects of the intervention on real-life stress. Thus, as a manipulation check to assess aerobic capacity, $VO_2\text{max}$ was determined via cardiopulmonary exercise testing pre- and post-intervention. To examine physiological and emotional reactivity to real-life stress, two specific real-life assessment periods were chosen. The pre-intervention assessment was set to the beginning of the semester and the post-intervention assessment was set to a real-life stressful episode (academic examinations). During both periods participants completed two days of measurement. We assessed physiological responses continuously using an ambulatory ECG monitor with an integrated accelerometer to assess physical activity. In addition, participants completed electronic diary entries of perceived stress, mood and context information repeatedly every two hours.

Chapter 1 gives a general introduction on the scope of the present thesis, outlines the structure of the thesis and displays how the different chapters contribute to the whole concept of the thesis. Furthermore, the chapter provides the theoretical background and closes with the study design.

Chapter 2 The activity-affect association in inactive people

Insights into the association between physical activity/exercise and affect are important for the analysis of the effects of regular exercise on emotional stress responses. Previous studies included active and inactive people, but they do not necessarily exhibit the same affective reactions to physical activity and exercise. Thus, in *Chapter 2* we analyzed whether the *feel-better effect* of unstructured physical activity observed in previous studies can be confirmed during every-day life in sedentary people. Using the baseline data (no intervention) of the first year of data collection ($N = 30$), we assessed the association between unstructured physical activity and subjective ratings of the three basic mood dimensions, energetic arousal, valence and calmness. Therefore the mean activity intensity was calculated over the last 15 min and related to the subsequent diary prompt. Within-subject correlations revealed non-significant associations between physical activity and affect. Due to the high variability in within-subject correlations, we conclude that not all inactive people show the same affective reactions to physical activity in every-day life. Thus, the general assumption of a *feel better effect* of physical activity might not be suitable for this target group.

Chapter 3 Regular exercise and emotional stress reactivity

Chapter 3 reports on the effects of the randomized, controlled trial on emotional responses to real-life stress in 61 male inactive students. We investigated whether a preventive 20-week AET can reduce emotional reactivity to real-life stress. Therefore we analyzed whether the interaction between the factor “group” (AET versus control group) and the factor “perceived stress” (subjective diary ratings) predicted the level of negative affect. Using multilevel models we calculated emotional stress reactivity separately for baseline (pre-intervention) and stressful episode (academic examinations). The results of the cardiopulmonary exercise tests revealed a significant VO_2max improvement in the AET group compared to the control group, $F(1, 56) = 55.3$; $p < .001$; $\eta^2 = .51$. Furthermore, after participating in the 20-week AET, the experimental group exhibited lower emotional stress reactivity compared with their control counterparts ($\beta = -0.18$, $t = -3.55$, $p < .001$) during the real-life stressful episode. Thus, AET appears to be a promising strategy against the negative health effects of accumulated negative affect.

Chapter 4 Regular exercise and physiological stress reactivity

Chapter 4 reports on the effects of the randomized, controlled trial on physiological stress responses during real-life stress. We hypothesized that a 20-week AET does reduce physiological stress reactivity to real-life stress in sedentary students. Therefore we analyzed heart rate variability (LF/HF, RMSSD) based on the two days of ambulatory ECG recordings during baseline and stressful episode, and controlled for physical activity and perceived stress. Multilevel analyses revealed that the AET group showed significantly decreased LF/HF ($p = .011$) and increased RMSSD ($p = .021$) to real-life stress compared to the control group. Using a longitudinal design and a real-

life stressor, we could demonstrate that exercise appears to buffer the deleterious effects of stress on the autonomic nervous system.

Chapter 5 closes with the general conclusions: In summary, the present thesis provides empirical support that regular exercise can lead to improved emotional and physiological responses during real-life stress. Thus, regular exercise appears to be a promising strategy against the negative health effects of accumulated emotional and physiological stress reactivity in every-day life of sedentary people.