dHealth 2023
B. Pfeifer et al. (Eds.)

doi:10.3233/SHTI230024

Handheld Device Measures Cardiovascular Effects of Cognitive and Physical Stress

Martin BACHLER[a,b], Lena KUMMER[b], Alina SEHNERT[c], Siegfried WASSERTHEURER[a], Eugenijus KANIUSAS[b], Walter SEHNERT[c], Thomas MENDGEN[c], Bernhard HAMETNER[a,b] and Christopher MAYER[a,b,1]
[a] *AIT Austrian Institute of Technology, Vienna, Austria*
[b] *Institute of Biomedical Electronics, TU Wien, Vienna, Austria*
[c] *Institute for Clinical Research Sehnert, Dortmund, Germany*

Abstract. Stress is an increasing burden for our society and related to cardiovascular (CV) parameters and diseases. Effects of mental or physical stress were observed in CV parameters during task completion and recovery. These effects were measured using a novel handheld device, which can be incorporated in mHealth solutions.

Keywords. Cognitive task, physical task, pulse arrival time, blood pressure

1. Introduction

Stress is an increasing burden for our society, and it is directly linked to various diseases, e.g., cardiovascular (CV) diseases [1]. Associations between different stressors and blood pressure and other CV parameters are known. However, the effects of cognitive or physical stress on CV parameters have been mostly studied in healthy populations [2]. Thus, we investigated the effects of cognitive and physical stress in treated hypertensive patients with a new handheld device.

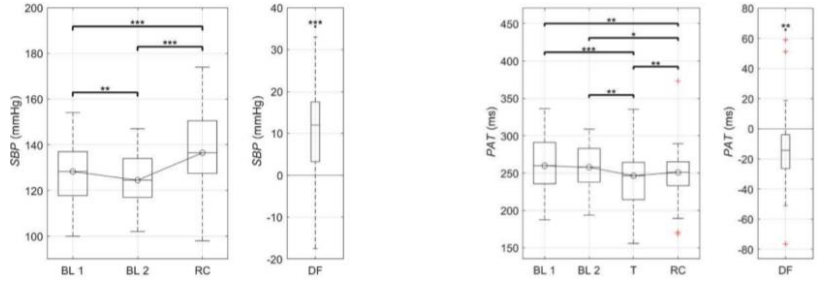
2. Methods

This study included 52 patients with treated arterial hypertension who gave informed consent [3]. The study protocol was approved by the ethics committee. Patients were randomized to either cognitive (i.e., a modified DemTect test [3]) or alternatively physical stress (i.e., climbing staircases). Systolic (SBP) and diastolic (DBP) blood pressure was measured three times at baseline and after recovery. Pulse arrival time (PAT) was measured using the handheld smartPWA device (details: [4]) using a single lead electrocardiogram (ECG) and finger photoplethysmogram (PPG) at baseline, during the tasks and at recovery for five minutes. For comparisons, either a two-sample t-test or a Wilcoxon rank sum test was used, as appropriate. Significance was assumed at 5% level and Bonferroni correction was used to correct for multiple testing.

[1] Corresponding Author: Christopher C. Mayer, AIT Austrian Institute of Technology, Vienna, Austria, E-Mail: christopher.mayer@ait.ac.at

3. Results and Discussion

Fifty-two subjects (21 female/31 male; self-identified) with a mean age of 64.6 (SD 8.2) years were assigned to the physical (N=24) or cognitive (N=28) test. Mean SBP was 129.0 (SD 14.5) mmHg and DBP 78.6 (SD 10.5) mmHg. In Figure 1 shows the changes from baseline (BL1 and BL2) to the task (T) performance (i.e., not stratified for mental or cognitive task) and to the recovery phase (RC) for SBP and PAT, respectively. Changes from baseline to task and recovery were more pronounced in the physical activity group for SBP and PAT (data not shown).



(a) SBP (b) PAT

Figure 1. Boxplots of SBP (a) and PAT (b) at both baselines (BL1, BL2), during both tasks (T) – not for SBP – and at the end (RC). Single boxplot difference (DF) of BL1 to RC. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results of this study show as expected that PAT decreased with increasing SBP from baseline to recovery. Furthermore, PAT increased after task completion, but did not reach the starting value. Since an increase in BP leads to an increase in vascular tone, and thus to an increased Youngs modulus of the arterial wall, pulse wave velocity increases, and thus PAT shortens [5]. Overall, the physical task elicited greater CV changes than the cognitive task. Results are explorative and warrant more research related to acute stress effects by different stressors and the consequences of stress reduction. The used handheld device can be incorporated in mHealth solutions and may be able to substitute conventional blood pressure measurement in therapy in the future.

Acknowledgment

Study was funded by the State of Lower Austria: digiPIT/WST3-F-5030665/010-2021.

References

[1] F. Vancheri, G. Longo, E. Vancheri, M.Y. Henein. Mental Stress and Cardiovascular Health-Part I, *J Clin Med*. 11(12):3353,2022.

[2] R.D. Lipman, P. Grossman, S.E. Bridges, J.W. Hamner, J.A. Taylor. Mental stress response, arterial stiffness, and baroreflex sensitivity in healthy aging. *J Gerontol A Biol Sci Med Sci*. 57(7):B279-84,2002.

[3] L. Kummer. Cardiovascular parameters during mental and physical stress in hypertensive patients. Master Thesis, TU Wien, 2022. https://doi.org/10.34726/hss.2022.95961

[4] T. Mengden, M. Bachler, W. Sehnert, P. Marschall, S. Wassertheurer. Device-guided slow breathing with direct biofeedback of pulse wave velocity – acute effects on pulse arrival time and self-measured blood pressure, *Blood Press Monit* 28(1):52-58,2023.

[5] J.Y.A. Foo, S.L. Chu. Pulse transit time as an indirect marker for variations in cardiovascular related reactivity. *Technol. Heal. Care*, 14(2):97-108,2006.