Mgr Iwona Walecka

Summary in English

Validity and usefulness of the EliteHRV application with a chest strap in measuring heart rate variability in pediatric cardiac patients

Patients with congenital heart disease/defects (CHD) frequently exhibit disturbances in the autonomic nervous system (ANS) function. One of the key non-invasive methods for assessing ANS activity is heart rate variability (HRV) analysis. HRV is a comprehensive evaluation of oscillations in the intervals between consecutive heartbeats, more precisely - in the intervals between R points in the QRS complex. High HRV is associated with better stress tolerance, enhanced regenerative processes, a more favorable mental and physical health profile, and a lower risk of cardiovascular events and mortality.

Despite growing interest in HRV in both population-based and clinical studies, its application in pediatric cardiology practice, especially in the context of CHD, remains limited. The gold standard for recording RR intervals (RRi) used in HRV analysis is electrocardiography (ECG), which ensures high precision and reliability of measurements. In recent decades, there has been increasing interest in alternative methods of RRi recording and HRV measurement, such as heart rate monitors (HRM) and mobile applications. For any new device to be implemented in clinical practice, validation against the gold standard is essential. HRM devices integrated with mobile apps or smartwatches have already been validated against ECG in populations of healthy and obese children.

The doctoral dissertation consists of three stages, each with specific objectives:

I. **Stage**: Evaluation of the agreement and reliability of short-term RRi measurements obtained using the Elite HRV application paired with the Polar H10 chest strap, compared to ECG for HRV analysis in pediatric cardiology patients at rest.

II. **Stage**: A systematic review of English-language literature on heart rate asymmetry (HRA) in children.

III. **Stage**:

   a. Assessment of the agreement of short-term RRi recordings obtained via the Elite HRV app and Polar H10 chest strap for HRA analysis, compared to ECG, based on 5-minute stationary recordings in pediatric cardiology patients.

b. Analysis of the relationship between age, sex, and detailed clinical diagnosis and the differences in HRA parameters obtained using the Elite HRV application paired with the Polar H10 chest strap versus standard ECG recordings.

In **Stage I**, data from 114 children (58 boys and 56 girls, aged 3–17 years) were analyzed. In a hospital setting, simultaneous RRi measurements were taken in a supine position using the Elite HRV app with the Polar H10 chest strap and a 12-lead ECG. Short-term HRV parameters (5 minutes) were calculated using the free version of Kubios software. Agreement was assessed using intraclass correlation coefficients (ICC), Bland-Altman analysis, and effect sizes. A high level of agreement was observed between the results obtained from the two tools, with differences falling within the respective confidence intervals. Additionally, the study highlighted the need to validate HRV measurement accuracy for other nonlinear parameters, such as heart rate asymmetry and symbolic dynamics, in pediatric cardiology patients.

Therefore, **Stage II** involved a systematic literature review focusing on one group of nonlinear parameters—heart rate asymmetry (HRA) in children. HRA is defined as the imbalance between heart rate decelerations and accelerations, which significantly influences HRV. It has been shown that HRA indices provide additional diagnostic information in adults, but their application in children remains limited. The review was conducted according to PRISMA guidelines, analyzing publications from 2000 to 2025 identified across five databases. Of the 16 identified studies, 4 full-text articles met the inclusion criteria and were included in the analysis. HRA is considered a potential tool for identifying neurocardiological dysregulation and serving as a prognostic indicator for future adverse cardiovascular events in children.

Stage III focused on analyzing HRA in pediatric cardiac patients. To date, no studies have assessed resting HRA in this patient group using mobile devices. HRA analysis based on data from mobile devices may be more susceptible to signal disturbances than HRV analysis, as HRA is characterized by greater sensitivity to microfluctuations in the signal. The aim was to evaluate the agreement of HRA parameters calculated from short-term (5-minute) RRi recorded via HRM and ECG under stationary conditions. Additionally, the relationship between age, sex, and clinical diagnosis and the discrepancies in HRA parameters obtained using both methods was analyzed in pediatric cardiac patients.

Based on the conducted research, it has been determined that the Elite HRV application, in combination with the Polar H10 chest strap, is a reliable tool for short-term HRV analysis in pediatric cardiology patients. The Polar H10 together with Elite HRV can also be used for daily monitoring of RR intervals, serving to assess selected HRA parameters in pediatric cardiology

patients under resting conditions. Discrepancies between RR interval measurements taken with the Polar H10 and ECG recordings mainly concern patients with cardiac arrhythmias. Further research is necessary to understand the mechanisms and clinical significance of HRA in the pediatric population.