Wearable-Derived Long-Term Heart Rate Variability Predicts Major Adverse Cardiovascular Events in Middle Aged Individuals Without Previous Cardiovascular Disease

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Wearable devices enable continuous heart rate (HR) monitoring at scale, which, with a predicted strong increase in cardiovascular chronic conditions, may provide new opportunities for population-based preventative strategies. However, it is unclear how long-term HR recorded with wearable devices can be harnessed to predict cardiovascular (CV) disease, especially in view of a lower accuracy and temporal resolution compared to clinical ECGs. We hypothesized that robust HRV estimator can identify individuals at higher risk of major adverse CV events (MACE) in the general population. In the National Survey of Health and Development (NSHD), the Actiheart monitor was used to measure 30-second averaged HR in 1,880 participants aged 60-64 (53.2% female) for up to 5 days. In total, 418 participants were excluded because of >25% missing HR samples, or recordings lasting less than 36 hours, or prevalent cardiovascular disease, and survival analysis included the remaining 1,462 participants. The median absolute deviation of 5-min averaged HR (MAD_{AHR}) and the median absolute deviation of 30-sec averaged successive HR differences (MAD_{SDHR}) were used as robust estimates of the established metrics SDANN and SDSD, respectively. After a median follow-up of 11.3 years, n=136 (9.3%) MACE occurred. MAD_{AHR} and MAD_{SDHR} were associated with MACE, with MAD_{AHR} showing hazard ratio (95% confidence interval) equal to 1.33 (1.10-1.62, p<0.01) for 1 SD decrease, and the binary variable MAD_{SDHR} ≤1 bpm showing hazard ratio equal to 2.15 (1.39-3.32, p<0.01) after adjusting for average heart rate, sex, body-mass index, hypertension, diabetes, and beta-blockers. This study demonstrates for the first time that wearable derived long-term HRV can predict CV events in individuals without previous CV disease.

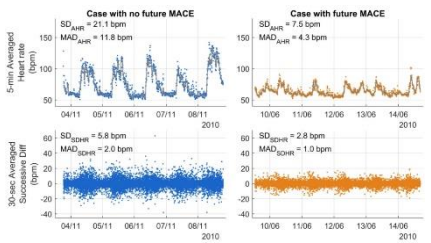

Figure 1. Example of HR monitored over 5 days in a participant who will (right) and will not (left) develop MACE.