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ABSTRACT:

Sex-Related Differences in Heart Rate Variability: A Preliminary Analysis

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Heart rate variability (HRV) is a non-invasive marker of autonomic nervous system regulation and cardiovascular adaptability [1,2]. Sex-related physiological differences have been reported to influence autonomic cardiac control [3], yet the quantitative characterization of these differences, particularly through nonlinear HRV metrics, remains an active area of research [4]. This study aims to evaluate potential differences in HRV dynamics between male and female subjects using 5-minute segments of long-term electrocardiographic recordings.

ECG signals were analyzed using HRVision system, a platform designed for HRV analysis across multiple domains. Fourteen representative records (9 female and 5 male subjects) were selected from the MIT-BIH Normal Sinus Rhythm Database [5]. Two stable five-minute segments were extracted from each recording to ensure stationarity of the RR interval series [6,7]. Time-domain metrics included mean heart rate, SDNN, RMSSD, and pNN50 [1,8]. Additionally, nonlinear indices derived from Poincaré plot analysis were evaluated, where SD1 reflects short-term vagal-regulated variability and SD2 represents longer-term variability related to overall autonomic balance [9].

Preliminary results revealed consistent differences between groups. Female subjects exhibited a higher mean heart rate (80.3 bpm) compared to males (67.4 bpm). Conversely, HRV magnitude was greater in male participants across multiple indices. Mean SDNN reached 83.4 ms in males versus 41.3 ms in females, while RMSSD averaged 42.4 ms and 28.8 ms, respectively. The parasympathetic-related index pNN50 also followed this trend, with mean values of 12.47% in males and 8.82% in females. Nonlinear descriptors showed similar behavior, with SD1 values of 30.0 ms in males and 20.4 ms in females, and SD2 values of 113.3 ms versus 54.6 ms, suggesting stronger vagally mediated and global variability in the male group [3].

Sex-related differences in HRV may be influenced by hormonal regulation, particularly the interaction between estrogen and progesterone levels, which modulate autonomic cardiovascular responses [10,11]. However, the hormonal phase of the female participants was not available in the database, preventing identification of follicular, ovulatory, or luteal stages. Therefore, hormonal variability may partially contribute to the observed differences. These findings support the presence of sex-dependent

autonomic regulation detectable through HRV analysis and highlight the need for further studies with controlled hormonal information.

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