ORIGINAL ARTICLE

# HEART RATE VARIABILITY: COMPARISON OF 24 HOURS WITH 72 HOURS HOLTER MONITORING IN HEALTHY ADULTS

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**Background:** Heart rate variability represents oscillations in intervals between heart beats that is characterised as variable RR intervals on standard ECG. It provides information about autonomic as well as non-autonomic regulatory mechanisms in health and disease states. Reduced heart rate variability is considered a non-invasive marker of autonomic dysfunction that can predict wide range of cardio-pulmonary disorders leading to sudden cardiac death. The objective of this study was to compare heart rate variability recorded from 24 hours with that recorded from 72 hours of holter monitoring in healthy adults. **Methods:** Thirty-seven healthy voluntary adults were selected and holter monitored for 72 hours using Reynolds medical holter monitors 'life card CF'. Statistical time domain parameters, i.e., SDNN, SDANN and RMSSD were calculated from 24 hours and 72 hours ambulatory ECG recordings. The data were analysed using SPSS-21. Paired sample *t*-test was used to compare the mean values of heart rate variability parameters. **Results:** Mean values of SDNN, SDANN and RMSSD from 24 hours holter monitoring were 141.62 ms, 125.16 ms, and 28.40 ms and those recorded from 72 hours of holter monitoring were 136.94 ms, 122.37 ms, and 26.46 ms respectively. Differences between none of the variables from the two recordings were statistically significant ($p>0.05$) **Conclusion:** Increase in duration of holter monitoring has no advantage on time domain parameters of heart rate variability in healthy individuals.

**Keywords:** heart rate variability, ambulatory ECG recording, holter monitoring, arrhythmias

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## INTRODUCTION

In a healthy individual, autonomic nervous system is the key regulator of heart rate.[1] Continuous and reciprocal changes in parasympathetic and sympathetic nervous system during normal day and night cycle lead to fluctuations around mean heart rate.[2] The rate and depth of breathing, mental or physical activities and different phases of sleep result in rhythmic undulations in the frequency of impulse conduction along the vagus nerves, leading to substantial variations in RR intervals known as sinus arrhythmia or heart rate variability.[3] Heart rate variability (HRV) thus corresponds to oscillations in intervals between heart beats, represented as variable RR intervals on standard ECG.[4] Heart rate variability, i.e., beat-to-beat variation in either heart rate or the duration of the R–R interval has become an important risk assessment tool for sudden cardiac death due to tachyarrhythmias. It provides a non-invasive means of quantifying cardiac autonomic activity. In the general population reduced RR variability is associated with less favourable health, increased mortality and the risk of cardiac events.[5] It is associated with a poor prognosis for a wide range of clinical conditions, on the other hand, vigorous periodic changes in R–R interval during routine daily activities are often considered as a symbol of health.[6,7]

In a healthy individual heart rate variability represents sympatho-vagal balance with vagal preponderance. Sympatho-vagal imbalance due to decreased vagal and reciprocally increased sympathetic activity leads to reduced heart rate variability.[8] The disturbances in autonomic system dynamics play an important role in a wide range of cardiopulmonary and non-cardiac disorders. There is significant evidence suggesting enhanced sympathetic and reduced parasympathetic activity leading to fatal ventricular arrhythmias and sudden cardiac death.[9,10] Although various non-invasive quantitative markers of autonomic activity have been developed for risk stratification, nevertheless, it has always been a challenge to identify population who are at high risk of sudden arrhythmic death. Among the different techniques, heart rate variability has emerged as an effective method to assess the sympatho-vagal balance at sinoatrial level.[11] It is a cost-effective, widely available, non-invasive marker for assessing cardiac autonomic imbalance and for predicting cardiovascular events, especially sustained ventricular arrhythmias and sudden cardiac death.[12]

Routinely, 24 hours ambulatory holter ECG recordings are used in cardiology clinics to record heart rate variability.[5] With the advancements in digital recording techniques, it has now become possible to get prolonged ambulatory ECG recordings and monitor HRV indices for extended time period even up to seven days.[13] This has opened new horizons in cardiac electrophysiology to determine the appropriate length of time for which heart rate variability should be monitored. Researchers have used different recordings ranging from few hours to days in their studies.[14]

However, the diagnostic advantage of prolonged holter monitoring on heart rate variability in normal healthy individuals has not yet been studied. Therefore, whether holter monitoring for duration greater than 24 hours will yield better results, remains unanswered.

We planned this study to assess the advantage of prolonged holter monitoring on heart rate variability in normal healthy adults. This study will provide an insight in determining the optimal length of holter monitoring to measure heart rate variability.

## MATERIAL AND METHODS

It was a cross sectional comparative study conducted at Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi (AFIC/NIHD) and Army Medical College, Rawalpindi from August 2006 to February 2007. A formal approval was obtained from Medical Ethics Committee of Army Medical College, Rawalpindi followed by written and informed consents from the healthy volunteers under study. Thirty-seven healthy individuals of 15 to 38 years of age with no known cardiovascular problem were included. A 12-lead ECG was recorded followed by exercise tolerance test. Diabetes mellitus was ruled out by checking blood glucose levels.

The volunteers were then subjected to holter ambulatory ECG recording for 72 hours using Reynolds, Life Card CF, holter monitors. The time domain analysis of heart rate variability was carried out form 72 hours and 24 hours holter recordings separately. The digital ECG data were analysed using Pathfinder 700 series software. Out of three channels recorded, the one which displayed best ECG recording and with least artefacts was selected. The whole data were edited manually with extreme care using visual checks and manual correction of all QRS complexes. All the erroneous beats were identified and edited from data. After editing, the holter ECG data were analysed for time domain indices of HRV. SDNN (Standard deviation of all NN intervals), SDANN (Standard deviation of the averages of NN intervals in all 5 minutes segments of the entire recording) and RMSSD (The square root of the mean of sum of the squares of differences between adjacent NN intervals) were calculated from 24 and 72 hours of holter ECG recordings.

Statistical analysis was done using SPSS-21. Paired sample *t*-test was used to compare HRV indices recorded from 24 and 72 hours and $p \leq 0.05$ was considered significant.

## RESULTS

The mean age of patients was 25.72±5.44 years and male to female ratio was 1.6:1. The mean values of heart rate variability indices, SDNN, SDANN and RMSSD, recorded from 24-hours and 72-hours holter monitoring are shown in Table-1. Difference between none of the variables from the two recordings was statistically significant ($p>0.05$).

**Table-1: Comparison of HRV from 24-hour holter monitoring with that recorded for 72 hours**

| HRV indices | Duration of holter monitoring | | *p* |
|---|---|---|---|
| | 24 hours | 72 hours | |
| SDNN (ms) | 126.62±20.64 | 134.00±17.89 | 0.303 |
| SDANN (ms) | 121.83±17.98 | 127.35±14.68 | 0.182 |
| RMSSD (ms) | 27.05±7.07 | 26.59±7.08 | 0.761 |

## DISCUSSION

Our study revealed that there was no statistically significant difference between HRV indices in healthy individuals when 24 hours holter recordings were compared with those recorded for 72 hours. Ramaekers *et al* studied the HRV in normal healthy volunteers during the day and night separately and did not document any change in HRV indices during 24 hours.[15] Likewise, Qui *et al* studied the effect of sympatho-vagal influence on HRV. They evaluated effect of gender on both, time and frequency domain parameters. They concluded that HRV was affected by the increased sympathetic neural responses and was not affected by the duration ofmonitoring.[16] Marina *et al* analysed Heart Rate Variability in a large sample of active young subjects including athletes, using time and frequency domain methods. HRV was recorded for 30 minutes duration. Significant differences were found for most parameters between athletes and active subjects for both males and females but not between genders. Their study clearly demonstrated the fact that HRV depended upon the physical activity and not on the duration of monitoring.[17] Results of our study were concordant with the findings of above mentioned studies showing no effect of long term holter recording on HRV indices.

A logical explanation of the fact that there is no difference between holter recordings of 24 hours and longer duration for heart rate variability is the physiological mechanism of beat to beat variability. Autonomic nervous system is the main regulator of cardiac autonomic activity.[18] Sympathetic nervous system increases heart rate whereas parasympathetic or the vagal stimulation decreases it. Under resting conditions, vagal tone prevails and variations in heart rate are largely dependent on vagal modulation.[9] Variations in firing rate from central and peripheral oscillators during day and night with various physical and mental activities control rhythmic fluctuations in efferent neural discharge which manifest as heart rate variability on ECG. During 24 hours any unusual variations in heart rate including day/night cycle are averaged out and an overall uniform heart rate variability is achieved.[19] Over the last decade researchers have been trying to evaluate HRV indices for various time intervals in health and diseased states.

Goya-Esteban *et al* evaluated various time and frequency domain variables of HRV. They compared heart rate variability indices recorded from 24 hours with those recorded from 7 days.[14] Results of their study for time domain parameters of heart rate variability were similar to ours, illustrating no significant difference between 7 days and 24 hours recording. Similarly in another study Costa *et al* compared short and long term holter ECG recordings for heart rate variability using maximum 24 hours recordings.[20] Their results were in contradiction to our findings reporting that duration of holter monitoring significantly affects heart rate variability. The physiologic basis of the conflicting results is that, a substantial part of the long term heart rate variability is contributed by the day and night differences. Heart rate variability determined from holter ECG recordings obtained during day time and night would yield significantly different results. To obtain uniformity in long term time domain heart rate variability, at least 18 hours of holter monitoring that includes part of day and night should be carried out.[21] Studies mentioned above including ours provide an insight about the probable mechanism for no difference between heart rate variability recorded from 24 hours and that recorded form longer holter monitoring. One day night cycle is essential and enough to get maximum possible and attainable variability in heart rate. Holter monitoring beyond 24 hours cannot add any further variability to the already achieved heart rate variability.[22]

## CONCLUSION

Heart rate variability recorded from 24 hours holter monitoring provides maximum possible information and longer recordings are not required. This information will not only provide relief to the patients but will also remove extra and unnecessary burden from healthcare facilities.

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