

## Chapter 60

# Wavelet Packet Analysis of ECG Signals to Understand the Effect of Cannabis Abuse on Cardiac Electrophysiology of Indian Women Working in Paddy Fields

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## ABSTRACT

*This chapter is aimed at identifying the variation in the cardiac electrophysiology due to the abuse of the cannabis products (bhang) in a non-invasive manner. ECG signals were acquired from 25 Indian women working in the paddy fields. Amongst them, 10 women regularly abused bhang and the rest 15 women never abused bhang. The ECG signals were preprocessed and subjected to wavelet packet decomposition (WPD) up to the level 3 using db04 wavelet. Ninety-six statistical features were extracted from the wavelet packet coefficients and analyzed using linear and non-linear statistical methods. The*

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*results suggested a variation in the cardiac electrophysiology due to the abuse of bhang. Artificial neural networks (ANNs), namely, radial basis function (RBF) and multilayer perceptron (MLP) were able to classify the ECG signals with an accuracy of  $\geq 95\%$ . This supported the hypothesis that abuse of bhang may alter the cardiac electrophysiology. The results of the study may be used to increase awareness among people to avoid the abuse of cannabis products.*

## **INTRODUCTION**

The abuse of *Cannabis sativa* based products for recreational purposes is common across the globe (Bachs & Mørland, 2001). Although severe restrictions have been imposed by the Government of India (GoI) on many of the cannabis products such as Marijuana, and Hashish, the restrictions on bhang (a recreational product made from the leaves of cannabis plant) is not so strong. It is widely abused by the common people (especially in villages) due to its low cost. Further, it is also used to make drinks by people belonging to Hindu religion during certain carnivals (Nayak et al., 2016). However, some recent studies have reported the onset of cardiovascular diseases in the people abusing cannabis, which may even lead to mortality (Menahem, 2013). Although the effect of cannabis products on human health has been much reviewed, not much work was found to analyze the effect of cannabis on the cardiac electrophysiology (Nayak et al., 2016). The physiology of the heart can be non-invasively analyzed using ECG signal analysis (Opie, 2004). Feature extraction is one of the important steps in the analysis of the ECG signals. The features should be extracted in such a way that they can contain the essential information about the original data in a reduced dimension. Thus, the features can be used, instead of the original signal, for performing desired signal processing operations. In some cases, the features have been reported to provide better interpretation than the original signals (Guyon & Elisseeff, 2006; Li & Zhou, 2016). In recent years, wavelet-based feature extraction methods such as discrete wavelet transform (DWT) and its recent extension WPD are gaining popularity among the researchers for the extraction of features from the ECG signals (Gokhale & Khanduja, 2010; Mahapatra, Mohanta, Mohanty, kumar Nayak, & kumar Behari, 2016; Rai, Trivedi, & Shukla, 2013). Amongst them, WPD has been reported to be superior as it decomposes not only the approximation coefficients (AC) but also the detailed coefficients (DCs) in contrast to the DWT, which decomposes only the ACs. As a result, both the DCs and the ACs can be used to extract features to provide more information (Li & Zhou, 2016). Numerous methods have been proposed for the classification of the ECG signals such as Fuzzy Logic (Kundu, Nasipuri, & Basu, 1998), Support Vector Machine (SVM) (Maldonado, Leija, Vera, & Alvarado, 2016), K-Nearest Neighbor (K-NN) method (Faziludeen & Sankaran, 2016) and Artificial Neural Network (ANN) (Gautam & Giri, 2016). Amongst them, the ANN-based algorithms are gaining popularity in recent years (Roza, de Almeida, & Postolache, 2017). This may be attributed to the fact that ANN provides the facility to improve the classification accuracy easily because of its multi-parametric nature (Alexakis et al., 2003). Taking the motivation from the above-mentioned discussion, we have attempted to investigate the effect of regular bhang abuse on the cardiac electrophysiology of Indian women working in the paddy fields. The ECG signals were acquired from the volunteers, and WPD analysis of the ECG signals was performed to extract features. Statistical significance of the features was analyzed using linear and non-linear statistical methods, and ANN classification was carried out using the statistically significant features.

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