

Environmental Risk Factors and Parkinson’s Disease – A Study Report

S. Kanagaraj, M.S. Hema, M. Nageswara Gupta

Abstract: *Parkinson’s Disease (PD) also known as Parkinson’s is the painful and dangerous disease that occurs when the nerve cells or neurons in the brain die or become enervated. The risk of Parkinson’s takes place due to environmental risk factors such as age, gender, head injury, area of residence, occupation, pesticide exposure, herbicide exposure, exposure to metals, solvents and polychlorinated biphenyls (PCBs) and genetic predisposition. The current research is to study the people of TamilNadu state with list of questionnaires to find them experiencing various symptoms in their routine life. In this article the study is carried out to identify environmental factors and their origins for Parkinsonism. The outcome of this paper is to discriminate healthy people from those with PD based on environmental risks and other factors that affects the ageing people.*

Keywords: *Parkinson’s Disease, Neurons, Environmental risk factors, Questionnaires, Smart phone, Mobile android application, PD questionnaire, Spiral test, Tapping speed.*

I. INTRODUCTION

Parkinson Disease (PD) is the second most neurodegenerative disease among the world population and known Parkinson’s or Parkinsonism. James Parkinson coined the term Parkinson’s about 200 years back and which was previously known as ‘paralysis agitans’. The study shows that the causes of Parkinson’s are unknown and progressively affects the central nervous system [1], and affects the motor system the human body. The genetic and environmental factors lead to abnormal deposits of a protein in the brain nerve cells that helps for communication and such deposits are known as synuclein. Study shows that 10 million of the world population are living with Parkinson’s. Among the countries China, Europe, USA and India are most to be affected by the disease. The early symptoms may be minor and is usually unnoticed by the person’s, so it is an important phenomenon to identify such causes and to classify the symptoms [18] and signs that leads to other causes of Parkinsonism. The ageing of population in most countries and management of Parkinson’s is an important and challenging part of the neurologist and the various physicians. Treatment of PD must be at earlier stages or in the later stages, must provide guidelines and management of Parkinson’s is an important factor. Understanding the causes of PD is of significant, which provides new approaches for deterrence and treatment of the disease.

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II. LITERATURE SURVEY

A. Symptoms in Parkinson’s Disease

Voluntary and non-voluntary are the primary causes of Parkinson’s which will usually starts with one side of the human body. The disease starts with mild symptoms and leads to severe by affecting the brain nerve cells. The cell that yield dopamine are massively affected and loss from 60% to 80% of normal dopamine to be observed.

B. Clinical Features

The PD are to be categorized as motor and non- motor symptoms in accordance with the clinical features.

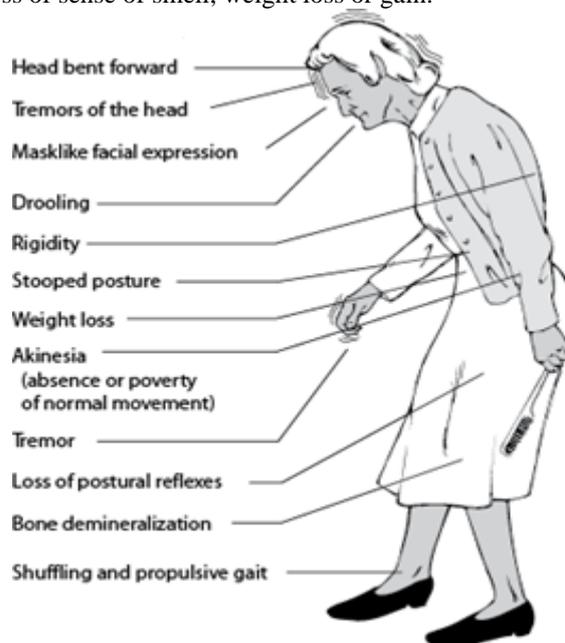
i) Motor Symptoms

Tremor

Tremor or shaking [1] are among the most common and main type of symptoms of Parkinson’s with slow movement and rigidity of the hand with uncontrollable movements. Tremor [4] may be caused over hand, legs, head and even in voice either due to resting tremor or action tremor.

ii) Non- Motor symptoms

Non-motor symptoms [4] encompasses mood disorders, cognitive changes, hallucination and delusions, sleep disorders, pain, fatigue, vision problem, excessive sweating, loss of sense of smell, weight loss or gain.



C. Pain in PD

Aching or burning, pain from nerve and sudden sharp pain that occurs are common types of pain found to occur in most of PD person's. Musculoskeletal or muscle pain found to occur in joints of legs and arms. Muscle cramps among older people roots to sleep disorder and restless [5]. Dystonia which caused by evolutionary muscle action in ankles, toes and fingers. Radicular or shooting pain travels down from the arm or leg and grounds to involuntary movements. Dyskinetic and restless leg syndrome are related with involuntary movements [8].

D. Environmental Risk Factors

Environmental risk factors include the environmental toxins, living in rural environment, exposure to toxic substances and agricultural employment [10]. Studies shown about longest exposure of agricultural workers towards various toxins leads to relative risk of Parkinson's Disease [12].

E. Rural living

Evidence suggest that people in rural place are more prevalent to PD than the metropolitan areas [15]. The association between the rural living and increased exposure to agriculture toxins may increase the risk of disease. The health-related quality of life (HRQUOL) studies on different population concluded with median [11] PDQ – 39 SI score of 26.6 for rural and median of 18.4 for people of metropolitan.

F. Ground Water Drinking

Private well water drinking for an average of over 5 years were more likely to be affected by the PD. Water supplies and sources of private well water are found to be largely unfettered and not monitored for contaminants, which has chemicals. Those people who lived near the fields and the chemical used for the agriculture increases high risk of disease.

G. Agriculture & Farming

Farmers are mostly affected than the normal population. Exposure to pesticides and toxins causes high risk of neurodegenerative disorder, and contribute to Parkinson's.

H. Pesticide

70% of incidence are to be found with PD, when they are exposed to pesticides during agricultural activities or water as a source with toxin contamination. Paraquat and rotenone makes the depletion of dopaminergic neurons by free radical production, which causes cell damage by burglary electrons from molecules [2]. Rotenone degrade the normal protein and accumulate faulty protein to end up with irregular cellular process. The chemical MPTP [7] (1-methyl-4-phenyl-1, 2, 3, 6 tetrahydropyridine) origins PD by binding with extra-neural enzyme [3], monoamine oxidase (MAO). The process of oxidation transforms MPTP to MPP⁺ which is a toxic pyridinium metabolite (1-methyl-4-phenylpyridium). MPP⁺ now joins with melanin at an optimum level of concentration in the dopaminergic neurons and destroys the cells of neurons.

I. Genetic Factors & Family history

Evidence suggest that at least in part of disease causes are due to genetic factors [13] and consistent association of PD with family history causes increases risks of Parkinson's. National Institute of Health discovered that gene mutation called SNCA and other mutation linked with Parkinson's is about 10 percent. In continents of Africa and Europe the scientist discovered mutation in the gene LRRK2 [14] causes Parkinson's in several families which accounts for the 2 percent of all the Parkinson's cases identified [17].

J. Solvents

Solvents such as alcohols, saturated and non-saturated hydrocarbons, ethers, ketones, hydrocarbons and aldehydes forms the organic compounds with diversity of chemical structures. Exposure to the above-mentioned solvents are linked to the neurological symptoms that causes memory impairment, sleep disturbance and psychiatric disorders.

K. Lifestyle & Dietary Factors

Exploration of diet and lifestyle of a person which lead to PD are under study and however NIEHS researchers discovered low risks are associated for Parkinson's. People who are dieted with polyunsaturated fatty acids and low in saturated fat, development of low risk of PD is possible. Vitamin D which provides necessary supplements for good body balance and muscle strength, protects our body from infections and diseases. The caffeine intake is under study about the connotation between the lower risk of Parkinson's both in men and women.

L. Smoking

Large number of studies are conducted on the cigarette smokers and tobacco using population based on the smoking status never smoked, ever smoked, current smoker and ex-smoker [15]. The development of Parkinson's was about 44% than with the people who had smoked and it was stated that 22% less likely to confirmed with Parkinson's than the people who had at no time smoked.

III. METHODOLOGY

A. Participants

The proposed methodology is to involve people with categories of person with advanced PD and a healthy person, to diagnose the presence of Parkinson's through PD questionnaire (PDQ), spiral drawing and tap test using mobile android application to identify the presence of disease. The traditional method of data collection involves in person or interview type of mode to collect the details of questionnaire. The current methodology involves the use of android application where the people responds to the different domains to identify the symptoms of PD at early stage.

B. Mobile Android Application

Android OS to forecast for more than 80% of the total smart phone sales and to be increased to 85% by 2020. The increasing popularity of android devices due its large number of apps in the Google play store and number to be 2.8 million apps.

People incited towards current trends and the number applications in the app store satisfies the desires by the applications available. Android uses Linux Kernel, which is open source framework designed for mobile devices. Android uses Java and which uses life cycle methods to application development. With the above landscapes android has been chosen as the platform to detect motor symptoms of Parkinson's patient and collect the data of through PD questionnaire, spiral drawing and tapping speed test.

C. Data Collection

The smart phone with android application for questionnaire, spiral test and tap speed to intricate to the people who are willing to test the presence of PD symptoms. The subjects are used to perform motor test by tapping and spiral drawing test, along with the set of PD questionnaire to be completed. The patient to be tested uses his fore finger to draw the spiral starting from the centre and proceeding towards the outer circle. The tapping test to involve the tapping of the two different square fields that has been displayed on the screen. Both the right and left-hand fingers to be involved in the test and the test to be repeated for three times. The PDQ questionnaire gives difficulties for the quality of life by the various dimensions collected through the questionnaire.

D. Data Processing and Analysis

a. Feature Extraction

The spatiotemporal time, distance, speed and velocity are to be taken into consideration and then the 25 tapings and 10 spiral drawings are considered for feature selection. The tapping features such as the total number of taps, mean tapping speed from left to right, mean tapping speed from right to left are to be used to calculate the patients motor activity. The spiral drawing features such as mean drawing speed, radial velocity and mean time difference to be used to identify the patient's symptoms identification. The PDQ – 8 which includes questionnaire for quality of life and its features are incorporated to identify the presence of PD.

b. Feature Selection

The feature selection methods such as forward selection which includes the feature to be added to develop a model with which highest performance is obtained, backward elimination – the removal of feature happens to increase the performance of the model and recursive feature elimination – which uses greedy optimization to rank the features based on their best or work performing feature.

c. Classification

The various classification algorithms help to classify whether the presence of PD or not. The Neural Network technology offers tools and methods to classify and recognize the disease presence. Neuro fuzzy provides fuzzy operations which uses single neuron to with large training set to obtain the higher accuracy level. Expert knowledge in the domain helps to classify the features with high accuracy. Support Vector Machine (SVM) is the most influential supervised classification algorithm which smooths mapping

the input feature into a high dimensional space by means of the core functions which may be either linear or nonlinear. Multivariate logistic regression helps to distinguish the

presence of Parkinson's from a normal person. Hard and soft classifier, with the former find the boundary classification without probability estimation and later uses the probability estimation. The Artificial Neural Network used to learn about the spiral matching by the number inputs, number of hidden layers and the training function. The outcome of ANN to provide the accuracy of spiral drawn by the patient and to compare with the original spiral.

E. Treatment

a. Medications

Problems with walking, movement and tremor can be treated with medications which increases the dopamine that act as neurotransmitter in the brain.

b. Carbidopa-Levodopa

The symptoms identified to be subjected to oral therapies for PD such as Dopamine precursors called Levodopa which has been effectiveness over a period, that increases the central exposure and decreases the side effects. The Carbidopa-Levodopa is a natural chemical that are provided to increase the dopamine.

c. Dopamine Agonists

Dopamine Agonists unlike Levodopa which mimics the dopamine effects in the brain. The dopamine agonists last longer and used as quick relief treatment using injectable dopamine agonists called Apokyn.

d. MAO-B

MAO-B are commonly used to block the process of enzymes that reduces the downing of the dopamine which are used for either early stages or at a later stage. Metabolizes the dopamine level in the brain and helps to prevent the breakdown of brain dopamine level.

e. COMT Inhibitors

It is used to prolong the treatment of levodopa which act as blocking agent to the enzymes that breakdown the dopamine. The liver damage and liver failure are the drawback of COMT inhibitors.

f. Anticholinergics and Amantadine

These medicines are used for longer period that helps to provides short-term relief, control tremor and control of involuntary movements of Parkinson's patients.

F. Surgery

a. Deep brain stimulation (DBS)

Electrodes are implanted into the specific part of the brain which sends electrical pulses for the brain and reduces the risk of Parkinson's. People with advanced Parkinson's must undergo DBS to reduce or prevent involuntary movements and tremor.

b. Pallidotomy

The treatment destroys the globus pallidus, which acts like brake and when it works hard causes movement of body tougher. With the treatment of pallidotomy makes the patients to feel better, ease of tremor, improve balance and makes movement easier.

c. Thalamotomy

Thalamus a part in human brain are which causes tremor and which is in charge for body balance and movements of hands and legs. By treatment with thalamotomy it removes the part that makes thalamus to dysfunction that causes tremor. The treatment using thalamotomy reduces the tremors and has high risk of side effects.

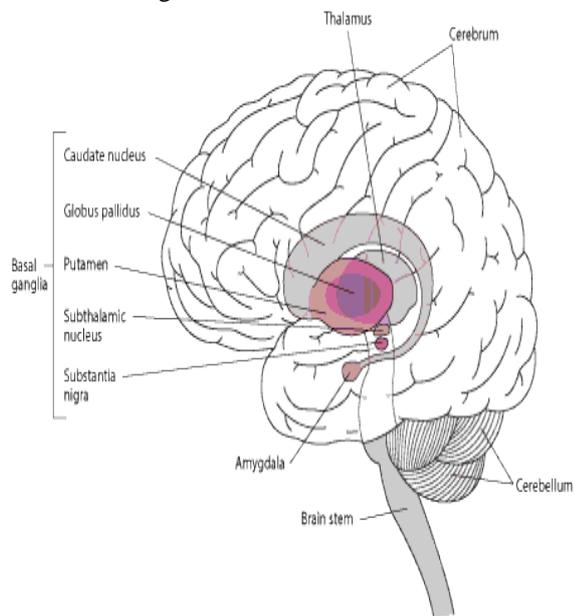


Fig. 2. Brain showing substantia nigra and the region of thalamus

IV. DISCUSSION

The proposed study discuss about usage of smart phone helps to identify the severity of Parkinson's by the doctors. The mobile application to measure the patient's condition based on spiral test, tapping speed and the questionnaire which helps to identify symptoms for PD.

V. CONCLUSION

The causes of Parkinson's due to environmental factors with which smart phone application used to identify the various symptoms using mobile app survey has been deliberated in the study. In future the application can be built to recognize the voice, balance and gait where the doctors access the symptoms and provide the medication based the severity of patient's condition

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