

# Recent Research in Medical and Life Sciences



## Editors

**Dr. M. Usha Rani**  
**Dr. Neha Singh**

**Dr. Rajiv Ratan Singh Yadav**  
**Dr. Priyanka Singh**



**MKSES PUBLICATIONS**  
**LUCKNOW, INDIA**

# Recent Research in Medical and Life Sciences

## Editors

**Dr.M.Usha Rani**

Professor & Head

Department of Physiology

Andhra Medical College, Visakhapatnam, Andhra Pradesh

**Dr. Neha Singh,**

Senior Scientist

Virology Lab, Department of Microbiology

Pt JNM Medical College, Raipur, Chhattisgarh

**Dr. Rajiv Ratan Singh Yadav**

Professor (Junior Grade)

Department of Emergency Medicine

Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, UP

**Dr Priyanka Singh**

Associate Professor

Department of Oral Pathology and Microbiology

King George's Medical University, Lucknow, UP



**MKSES Publisher (India)**

**MKSES Publisher (India)**

**Publisher Address:** Head Office: 1st Floor, Building No-85A, (Nanak Arcade near Sani Mandir, Parag road, LDA colony, Kanpur Road, Lucknow-226012

**Mobile No:** +91 9838298016, +91 8299547952 Office Land line No: +91 5223587193

**E-mail:** mkpublication@gmail.com

**Website:** www.mksepublications.com

**Copyright©** MKSES Publisher Lucknow India

First Published: **May 2023**

**ISBN: 978-93-91248-77-2**

**Page No.** 1-219

**Disclaimer:** The views expressed by the authors are their own. The editors and publishers do not own any legal responsibility or liability for the views of the authors, any omission or inadvertent errors.

© All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means without the prior written permission of the publishers.

## Preface

This Edited book “Recent Research in Medical and Life Sciences” is based on the proceedings of the “2nd Online International Conference on Advance Interdisciplinary Research (ICAIR-2023)”, Jointly Organized by Digvijay Nath Post Graduate College, Gorakhpur, U.P. & Science-Tech Institute run by Manraj Kuwar Singh Educational Society, Lucknow, U.P. during April 07 -09, 2023. The aim of this conference was to bring together the young as well as experienced researchers on one platform to discuss the recent findings in the aforesaid areas of Physical and Chemical Sciences. After peer reviewing process, relevant research papers were finally included in this book as chapters.

The present volume is based on the contributions made by various authors on different important topic of **“Recent Research in Medical and Life Sciences”** and introduces the subject along the following topics: To Study the Aggressive Behavioral Changes Observed in School Children between 8-18 Years Age after the Restart of Offline Regular Classes, Post COVID-19 Lockdown; Utility of Principles of Ayurveda In Myocardial Reperfusion Injury: A Review; Artificial Intelligence as a Diagnostic Tool for Prolapsed Intervertebral Disc: A Literature Review; Perspectives of patients having Diabetes Peripheral Neuropathy about Physiotherapy intervention: A Literature Review; The Psychological impact and coping mechanism of Covid- 19 on Staff Nurses’- A retrospective study; Detection of pathogen *Candidatus Liberibacter asiaticus* (CLas) causing Citrus Greening Disease by gene primer method; Tenofovir induced nephrotoxicity; Use of E-learning & Face to Face learning strategies for Nursing students in relation to their some personal variables; Assess knowledge gap on morbidities, its preventive, control measures and practice of using preventive measures related to air pollution among Traffic police in W.B (Kolkata); A Questionnaire based Survey on Student’s Opinion on the Prevailing Methods in Medical Education during the COVID Pandemic; Therapeutic potential of Ayurveda management in atrial fibrillation with special reference to paroxysmal and Lone AF; Occlusal Wear of CAD-CAM fabricated restorations – A Review of Current Literature; Covid-19: Neurological and Psychological Effects (A Review Study); Hepato and Nephro Protective Potential of *Saraca indica* Methanolic Extract against Lead Acetate Induced Toxicity in Rats; Phytochemical analysis and evaluation of antioxidant activity in methanolic extracts of *Macrotyloma uniflorum* (Lam); Reusable versus Disposable Surgical Gowns: A Preference Comparison among the Surgical Staff based on Comfort and Protection Performances of the Surgical Gowns; Lived Experiences of Incarceration: A narrative review; and Evaluation of effect of grafting

materials on implant stability and bone regeneration in patients with transcrestal approach for sinus augmentation at three different time intervals - An Experimental study

We must place on record our sincere gratitude to the authors not only for their effort in preparing the papers for the present volume, but also their patience in waiting to see their work in print. Finally, we are also thankful to our publishers **Mrs. Shweta Singh** M/S MKSES Publishers, Lucknow for taking all the efforts in bringing out this volume in short span time.

Editors

## Contents

| Chapter No. | Chapter Name                                                                                                                                                                                                                          | Page No. |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 1.          | To Study the Aggressive Behavioral Changes Observed in School Children between 8-18 Years Age after the Restart of Offline Regular Classes, Post COVID-19 Lockdown<br><i>Dr. Sunitha K, Aishwarya Pathalavath and Dr. Niva Shirke</i> | 1-27     |
| 2.          | Utility of Principles of Ayurveda In Myocardial Reperfusion Injury: A Review<br><i>Reshmi. A. S, Mini.V. G and Giri.P. V</i>                                                                                                          | 28-38    |
| 3.          | Artificial Intelligence as a Diagnostic Tool for Prolapsed Intervertebral Disc: A Literature Review<br><i>Sandeep Pattnaik and Manu Goyal</i>                                                                                         | 39-49    |
| 4.          | Perspectives of patients having Diabetes Peripheral Neuropathy about Physiotherapy intervention: A Literature Review<br><i>Rittu Sharma and Prof. (Dr.) Manu Goyal</i>                                                                | 50-62    |
| 5.          | The Psychological impact and coping mechanism of Covid- 19 on Staff Nurses'- A retrospective study<br><i>Ms Usha Mallick</i>                                                                                                          | 63-78    |
| 6.          | Detection of pathogen <i>Candidatus Liberibacter asiaticus</i> (CLas) causing Citrus Greening Disease by gene primer method<br><i>Ishu Priya, Mohammad I. Ali and Rashmi Saini</i>                                                    | 79-85    |
| 7.          | Tenofovir induced nephrotoxicity<br><i>Aparna Matpathi</i>                                                                                                                                                                            | 86-91    |
| 8.          | Use of E-learning & Face to Face learning strategies for Nursing students in relation to their some personal variables<br><i>Rumi Sen and Dr. Ratna Chhaya Singh</i>                                                                  | 92-104   |
| 9.          | Assess knowledge gap on morbidities, its preventive, control measures and practice of using preventive measures related to air pollution among Traffic police in W.B (Kolkata)<br><i>Snita Bhunia and Dr. Ratna Chhaya Singh</i>      | 105-115  |
| 10.         | A Questionnaire based Survey on Student's Opinion on the Prevailing Methods in Medical Education during the COVID Pandemic<br><i>Dr. Monika Mishra</i>                                                                                | 116-121  |
| 11.         | Therapeutic potential of Ayurveda management in atrial fibrillation with special reference to paroxysmal and Lone AF<br><i>Dr Mini V G and Dr Giri P V</i>                                                                            | 122-131  |
| 12.         | Occlusal Wear of CAD-CAM fabricated restorations – A Review of Current Literature<br><i>Dr. Yogesh S. Ingole, Dr. Ranu S. Ingole, Dr. Sattyam Wankhade, Dr. Brajesh Dammani and Dr. Usha Radke</i>                                    | 132-149  |
| 13.         | Covid-19: Neurological and Psychological Effects (A Review Study)<br><i>Dr. Anita Kumari</i>                                                                                                                                          | 150-163  |
| 14.         | Hepato and Nephro Protective Potential of <i>Saraca indica</i> Methanolic Extract against Lead Acetate Induced Toxicity in Rats<br><i>Brijesh Shivhare, Maneesha Pandey and Ramesh Kumar</i>                                          | 164-178  |
| 15.         | Phytochemical analysis and evaluation of antioxidant activity in                                                                                                                                                                      | 179-185  |

- methanolic extracts of *Macrotyloma uniflorum* (Lam)  
***Ritu Mahajan, Muskaan Sharma, Shajaat Hussain and Nisha Kapoor***
16. Reusable versus Disposable Surgical Gowns: A Preference Comparison among the Surgical Staff based on Comfort and Protection Performances of the Surgical Gowns 186-193  
***M. Nazeem Banu and Dr. Shabiya Thaseen***
17. Lived Experiences of Incarceration: A narrative review 194-209  
***Kiran Sharma and Dr. Pawan Kumar Sharma***
18. Evaluation of effect of grafting materials on implant stability and bone regeneration in patients with transcrestal approach for sinus augmentation at three different time intervals - An Experimental study 210-220  
***Sattyam Wankhade, Dr. Yogesh Ingole, Dr. Jyoti Wankhade, Archit Kapadia, Samiksha Lalsare***

**Chapter: 1****To Study the Aggressive Behavioral Changes Observed in School Children between 8-18 Years Age after the Restart of Offline Regular Classes, Post COVID-19 Lockdown****Dr Sunitha K<sup>1</sup>, Aishwarya Pathalavath<sup>2</sup> and Dr Niva Shirke<sup>3</sup>****<sup>1</sup>Professor and Head, Department of Practice of Medicine, Bhagawan Buddha Homoeopathic Medical College and Hospital affiliated to RGUHS, Bangalore, Karnataka****<sup>2</sup>Student scholar Bhagawan Buddha Homoeopathic Medical College and Hospital affiliated to RGUHS, Bangalore, Karnataka****<sup>3</sup>Guest Faculty, Professor, Department of Practice of Medicine, Bhagawan Buddha Homoeopathic Medical College and Hospital affiliated to RGUHS, Bangalore, Karnataka****E-mail: drsuni2003@gmail.com**

**Abstract:** A Questionnaire survey was done on school children 8-18 years of age, in 2022-23 to look for any behavioural changes after regular offline classes restarted, post covid-19 lockdown. Any changes in their academic performances were also looked for. A Google form of the Questionnaire was shared among hundred parents. Behaviour performances, grade of aggressiveness, etc. were the parameters assessed. Out of these, fifty children were screened with the help of Child Academic Behaviour Checklist. One case study was done to showcase the aggressive changes in a child and its treatment by homoeopathic approach. A detailed study was done from the questionnaires that reported aggressive behaviour and academic changes. Results showed less progress in academic and classroom performances, mild changes in social-skills and moderate changes in their self-esteem. More changes were seen in children between 8-14 years and moderately in 15-18 years of age.

**Keywords:** Aggressive behaviour in a child, Academic Behaviour Checklist, Mobile abuse, Video games, Homoeopathic treatment.

**Introduction:** Aggressive behavioural changes are described as acts of becoming impulsive, throwing temper tantrums, making mistakes, destroying objects/ property, being cruel with others, difficulty in handling me-alone time or unable to play calmly etc. If untreated, it can lead to behavioural disorders, conduct or pervasive developmental problems requiring treatment and counselling. After Covid-19 many children had problems in adjustment from online classes taken in the comfort of homes to offline classroom classes coming with different set of etiquettes, discipline and social interactions.

In my study the changes observed in school children as they started going to regular classes as per the feedback form/ observations noticed by parents were as follows: - not concentrating in studies, taking long time for performing study-related activities, poor

performance in examinations, restlessness and inability to sit in one place for long, occupied in playing mobile video games and not doing regular homework. Few feedbacks were also taken orally during the parent –teachers’ meeting.

Children often express anger and irritability as an aggressive behaviour towards others. These changes were seen as the School Classes transformed from online to regular offline mode. The children had adapted to excessive mobile usage during online classes which had created a severe distraction. They would watch different videos in between the Classes.

A questionnaire survey was done in children between age group 8-18 years. The Academic Behaviour Checklist (ABC CHECKLIST) was used to identify the changes. Survey was done in Google form, sent to 100 parents out of whom screening was done from 50 children (as the rest gave invalid responses) with respect to the changes observed in behavioural performance, academic performance and response to stimuli.

In these children, management of aggressive behaviour can be done with appropriate homoeopathic medicines, controlled less usage of mobile, getting them occupied in outdoor games and if requiring individual / family counselling, etc.

### **Objectives:**

- To study in detail aggressive behaviour.
- To identify the changes seen in children tending to develop aggressive behaviour by using questionnaire survey.
- To study the impact of behavioural changes seen in children by using academic behaviour checklist.
- Scope and homoeopathic management in a case study.

### **Methodology**

**Study design:** Questionnaire method used - The Academic Behavioural Checklist (ABC checklist)

**Study setting:** This study was based on data collected online through Google form from the parents of school going children between 8-18 years of age.

**Sampling method:** Randomly selected parents from the neighbourhood and relatives who agreed to participate. The Questionnaire was sent to 100 parents online, out of which 50 responses were used for the study.

**Study procedure:** CHILD AGGRESSIVE BEHAVIOUR CHECKLIST (ABC checklist).

| INCLUSIVE CRITERIA                                                                                                                 | EXCLUSIVE CRITERIA                                                                                                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The age group of 8-18 years were taken for the study                                                                               | The age group below 8 years and above 18 years were excluded from the study.                                                                                               |
| The aggressive changes seen after they started going for regular offline classes was observed.                                     | The aggressive behavioural changes causing attention deficit, conduct behavioural problems, depression and addictive behaviour causing violence/ aggression were excluded. |
| Only academic behavioural changes (child behaviour in classroom, academic performances, social skills and self-esteem) were noted. | Child behaviour problems excluded like hyperactivity, dysfunctional peer relationships, anti-social behaviour.                                                             |

## Review of literature

Factors for aggression can be:

1. Biological Factors: Irregular brain development with increased activity in amygdala and decreased activity in the pre-frontal cortex, to aggression, genetics and hormonal imbalance / changes with adolescent.
2. Psychological Factors: Aggressive behaviour can happen in conditions like conduct disorders, ADHD, PTSD, autism, depression and certain personality disorders.
3. Environment Factors: In school children, they can get addicted to gadgets, watching videos and playing video games. Usage of mobile phones for online classes during Covid-19 and lack of communication with other children led to its easy addiction.

Aggression may lead to arguments, impulsiveness, poor academic performance and addiction to other media and game apps etc. along with the following:

- Violent temper tantrums
- Taunting/ bullying/ insulting/provoking/ threatening others
- Lying and stealing

- Destroying other peoples' belongings/ property
- Using toys or other objects as weapon
- Talking excessively, abusive language use
- Initiating physical fights
- Has difficulty waiting in line
- Making careless mistakes, confusion
- Does not seem to listen, when spoken to directly
- Has difficulty in organizing / completing tasks
- Runs about or climbs excessively at inappropriate times
- Blurts out answers before questions have been completed.
- Anxiety and inferiority complex.

In school going children the observation of aggression were: less concentration in studies, slow performance in activities, inability to sit in one place while being taught, overexcited and tired at same time, involved in playing mischief, anger expressions and being irritable, impulsive, inferiority complex, etc.

### **General management and Treatment:**

History of the child should be taken in detail. Changes in behaviour should be observed and assessed and then the best way should be found and suggested where we can help him/her to express the emotions through words and friendly actions. This will help him/her to not resort to aggression as a means of expression.

- Parents should be the role models. The child should be nurtured to develop a sense of security.
- Children should be taught to value people and objects. Stories about them will help develop a bond so that they do not harm them in aggression
- Acceptable and unacceptable behaviour to be explained. Rules to be adhered to.
- Regular physical activities like outdoor games should be encouraged so that they spend excess of their energy meaningfully.
- Encouraging them to read books and spend quality time with family.
- Proper counselling to be given to children

### **Analysis of the Data**

Questionnaire survey study is as follows

- Questionnaire containing 100 questions
- Screening done from 50 forms with valid data.
- This survey consists of classroom behavioural performance, academic performance, their response to stimuli and at last the grade of aggressiveness is measured.

#### Google form Response of 50 screened children

| Age group (Years) | Responses Received |
|-------------------|--------------------|
| 8                 | 2                  |
| 9                 | 6                  |
| 10                | 11                 |
| 11                | 1                  |
| 12                | 6                  |
| 13                | 3                  |
| 14                | 3                  |
| 15                | 8                  |
| 16                | 4                  |
| 17                | 3                  |
| 18                | 3                  |



Figure 1: Age response and sex ratio

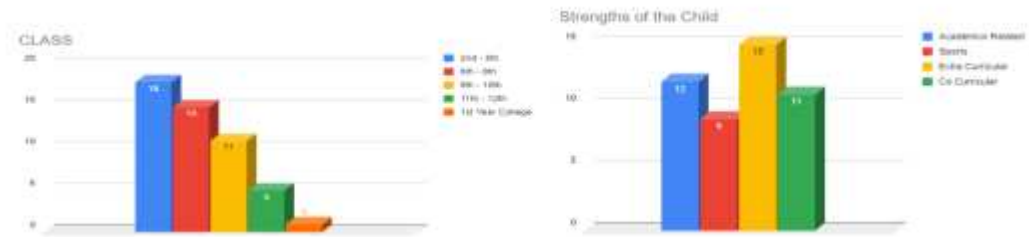


Figure 2: Class distribution and strength of the child percentage

## SENSES

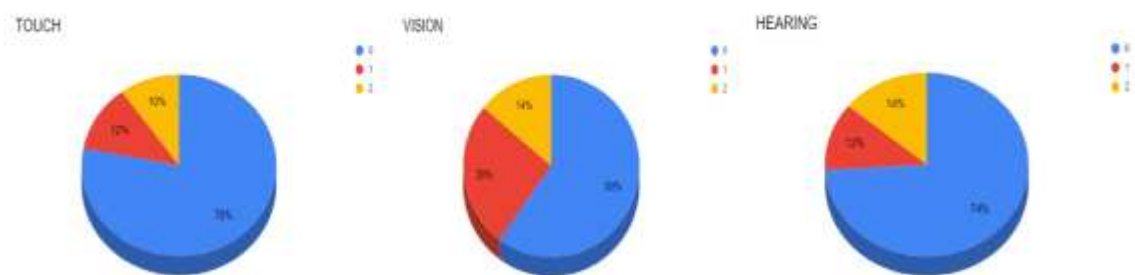


Figure 3: Senses percentage in CBCL

| Senses  | Above average | average | problematic |
|---------|---------------|---------|-------------|
| Touch   | 76%           | 12%     | 10%         |
| Hearing | 74%           | 12%     | 14%         |
| Vision  | 60%           | 26%     | 14%         |

## ATTENTION

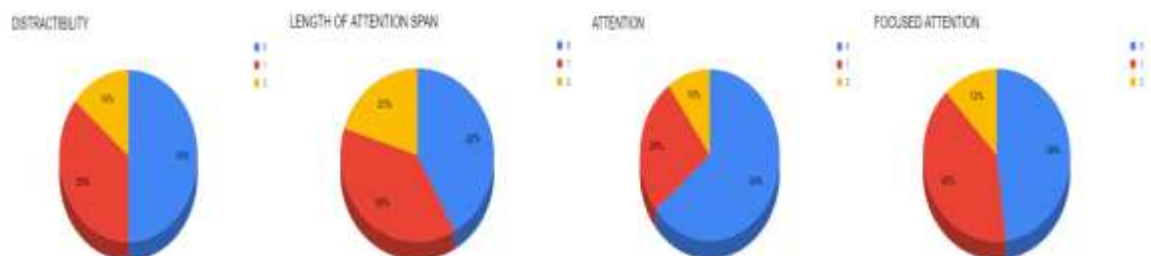
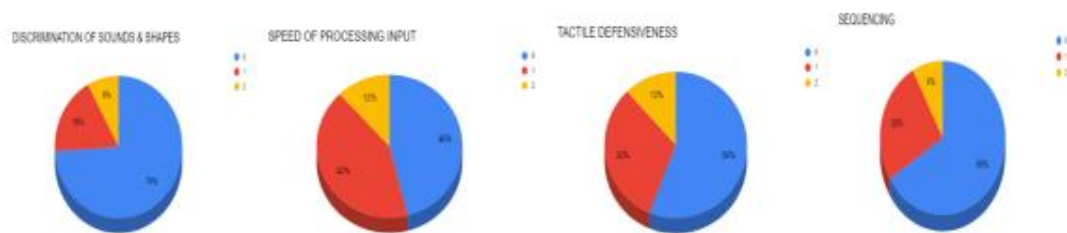


Figure 4: Percentage of attention in children

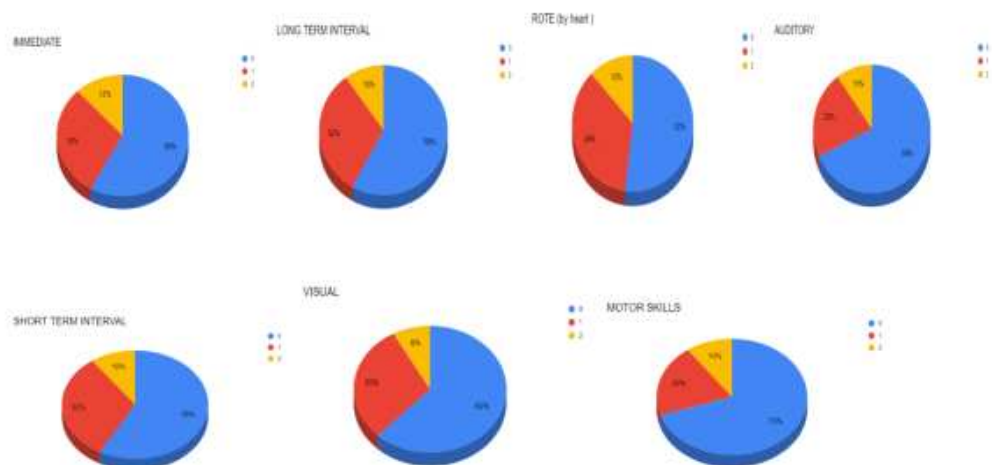
| ATTENTION                | Above average | AVERAGE | problematic |
|--------------------------|---------------|---------|-------------|
| Alertness                | 64%           | 26%     | 10%         |
| Distractibility          | 50%           | 26%     | 14%         |
| Focussed attention       | 48%           | 40%     | 12%         |
| Length of attention span | 42%           | 38%     | 20%         |

## PERCEPTUAL



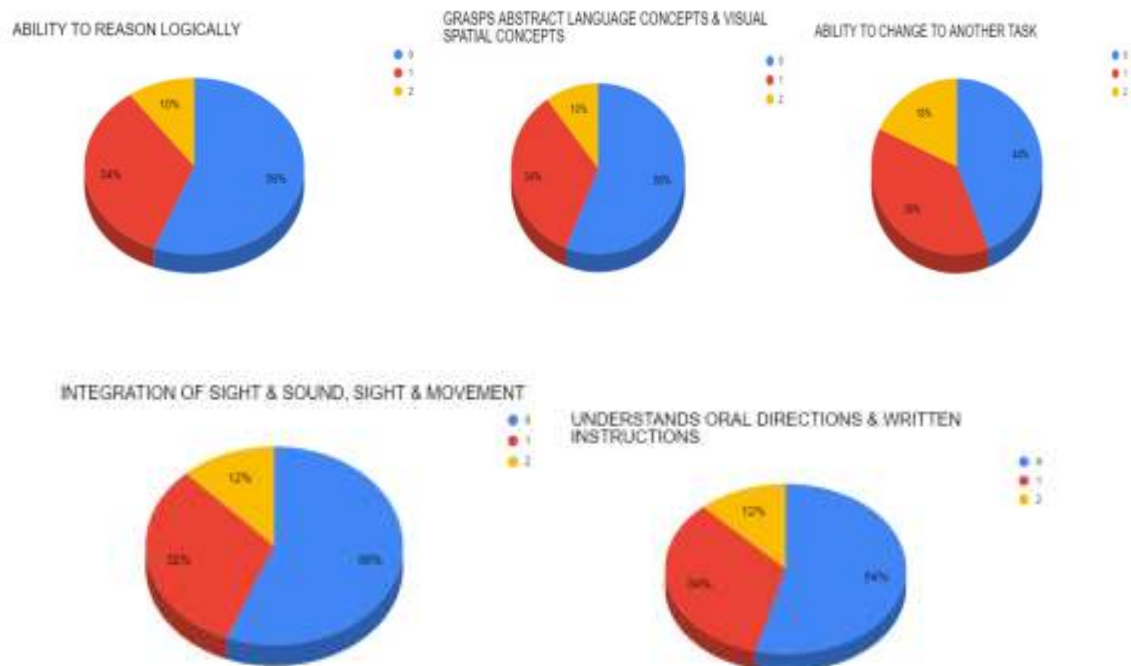
| PERCEPTUAL                        | ABOVE AVERAGE | AVERAGE | PROBLEMATIC |
|-----------------------------------|---------------|---------|-------------|
| DISCRIMINATION OF SOUNDS & SHAPES | 74%           | 18%     | 8%          |
| TACTILE DEFENSE                   | 56%           | 32%     | 12%         |
| SEQUENCING                        | 66%           | 26%     | 8%          |
| SPEED OF PROCESING UNIT           | 46%           | 42%     | 12%         |

## MEMORY



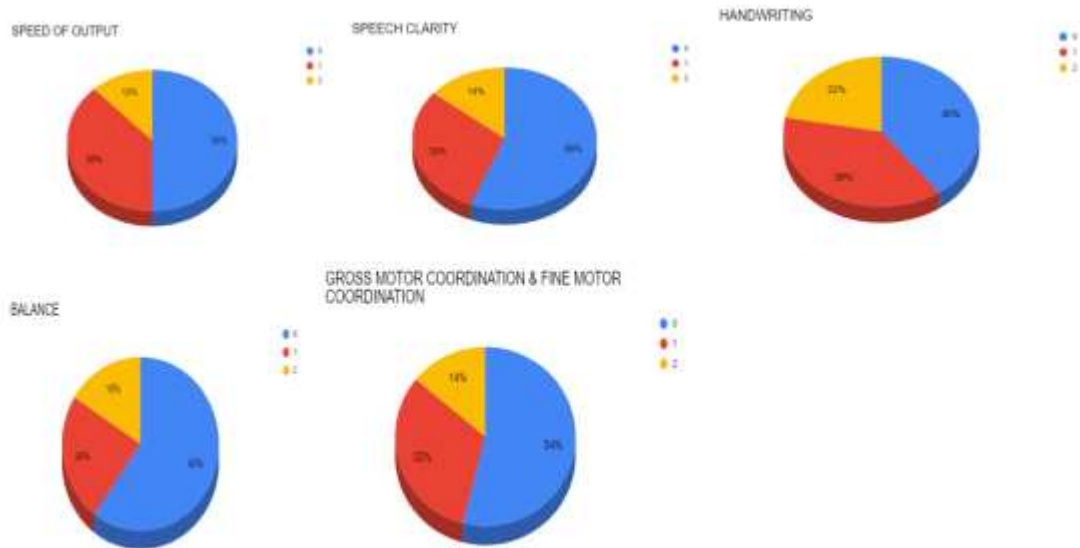
| MEMORY              | ABOVE AVERAGE | AVERAGE | PROBLEMATIC |
|---------------------|---------------|---------|-------------|
| Immediate memory    | 58%           | 30%     | 12%         |
| Short-term retrival | 58%           | 32%     | 10%         |
| Rote by heart       | 52%           | 38%     | 10%         |
| Long term retrival  | 58%           | 32%     | 10%         |
| Auditory            | 68%           | 22%     | 10%         |
| Visual              | 62%           | 30%     | 8%          |
| Motor skills        | 70%           | 20%     | 10%         |

## CONCEPTUAL



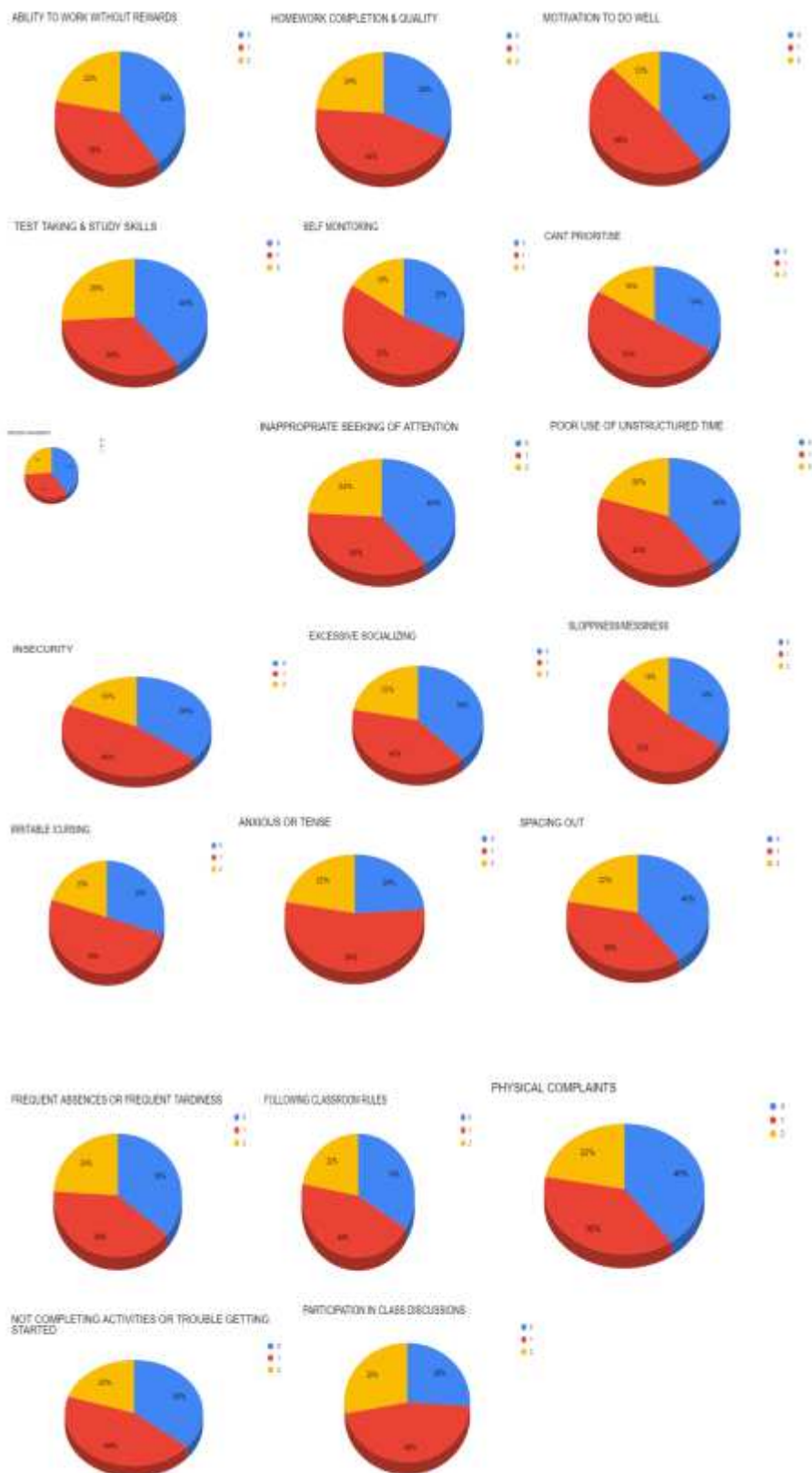
| CONCEPTUAL                                      | ABOVE AVERAGE | AVERAGE | PROBLEMATIC |
|-------------------------------------------------|---------------|---------|-------------|
| Grasps language concept & visual                | 56            | 34      | 10          |
| Ability to change to anthor task                | 44            | 38      | 18          |
| Ability to reason logically                     | 56            | 34      | 10          |
| Integration of sight & sound, sight & movement. | 56            | 32      | 12          |
| Understands oral & written directions           | 54            | 34      | 12          |

## MOTOR



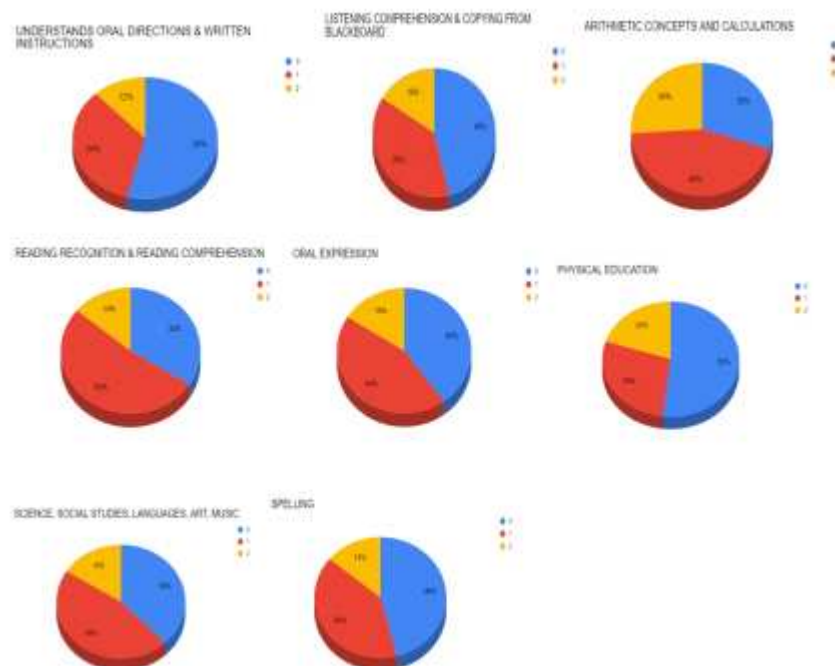
| MOTOR            | ABOVE AVERAGE | AVERAGE | PROBLEMATIC |
|------------------|---------------|---------|-------------|
| SPEED OF OUTPUT  | 50%           | 38%     | 12%         |
| SPEECH CLARITY   | 56%           | 30%     | 14%         |
| HANDWRITING      | 40%           | 38%     | 22%         |
| BALANCE          | 60%           | 24%     | 16%         |
| GROSS-MOTOR&FINE | 54%           | 32%     | 14%         |
| COORDINATION     |               |         |             |

## CLASSROOM BEHAVIORAL PERFORMANCE



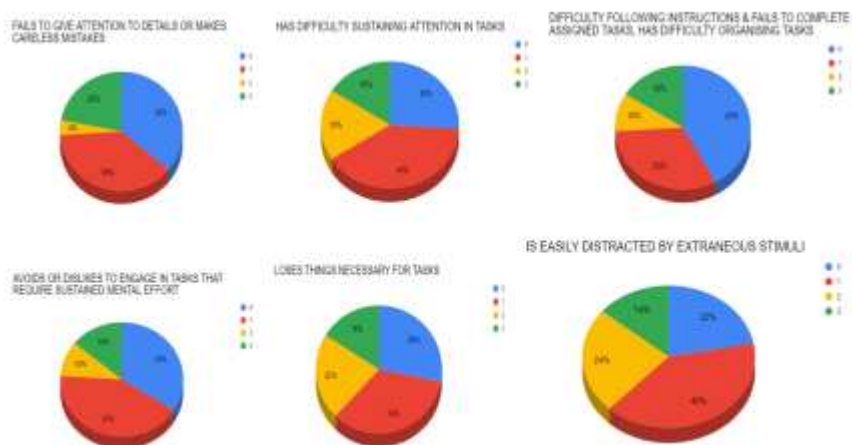
| CLASSROOM BEHAVIOURAL PERFORMANCE  | Above average | Average | Problematic |
|------------------------------------|---------------|---------|-------------|
| ABILITY TO WORK WITHOUT REWARDS    | 40%           | 38%     | 22%         |
| HOMEWORK COMPLETION & QUALITY      | 32%           | 44%     | 24%         |
| MOTIVATION TO DO WELL              | 40%           | 48%     | 12%         |
| TEST TAKING & STUDY SKILLS         | 40%           | 34%     | 26%         |
| SELF MONITORING                    | 32%           | 52%     | 16%         |
| CANNOT PRIORITISE                  | 34%           | 50%     | 16%         |
| FREQUENT ARGUMENTS                 | 40%           | 34%     | 26%         |
| INAPPROPRIATE SEEKING OF ATTENTION | 40%           | 36%     | 24%         |
| POOR USE OF UNINSTRUCTED TIME      | 40%           | 40%     | 20%         |
| INSECURITY                         | 36%           | 46%     | 16%         |
| EXCESSIVE SOCIALISING              | 38%           | 40%     | 22%         |
| SLOPINESS/ MESSINESS               | 34%           | 50%     | 14%         |
| IRRITABLE/ CURSING                 | 30%           | 50%     | 20%         |
| ANXIOUS/TENSE                      | 24%           | 54%     | 22%         |
| SPACING OUT                        | 40%           | 38%     | 22%         |
| FREQUENT ABSENT                    | 36%           | 40%     | 24%         |
| FOLLOWING CLASSROOM RULES          | 34%           | 44%     | 24%         |
| PHYSICAL COMPLAINTS                | 40%           | 38%     | 20%         |
| NOTCOMPLETING ACTIVITIES           | 36%           | 44%     | 20%         |
| PARTICIPATION IN CLASS DISCUSSION  | 26%           | 46%     | 28%         |

## ACADEMIC PERFORMANCE



| ACADEMIC PERFORMANCE                  | ABOVE AVERAGE | AVERAGE | PROBLEMATIC |
|---------------------------------------|---------------|---------|-------------|
| WRITTEN EXPRESSION                    | 42%           | 42%     | 16%         |
| UNDERSTANDS ORAL & WRITTEN DIRECTIONS | 54%           | 34%     | 12%         |
| LISTENING & COPY FROM BLACKBOARD      | 46%           | 38%     | 16%         |
| ARITHMETIC CONCEPTS & CALCULATIONS    | 30%           | 44%     | 26%         |
| READING RECOGNITION & COMPREHENSION   | 34%           | 52%     | 14%         |
| ORAL EXPRESSION                       | 40%           | 44%     | 16%         |
| PHYSICAL EDUCATION                    | 52%           | 28%     | 20%         |
| SOCIAL SCIENCE, LANGUAGES, ART, MUSIC | 38%           | 48%     | 16%         |
| SPELLING                              | 46%           | 40%     | 14%         |

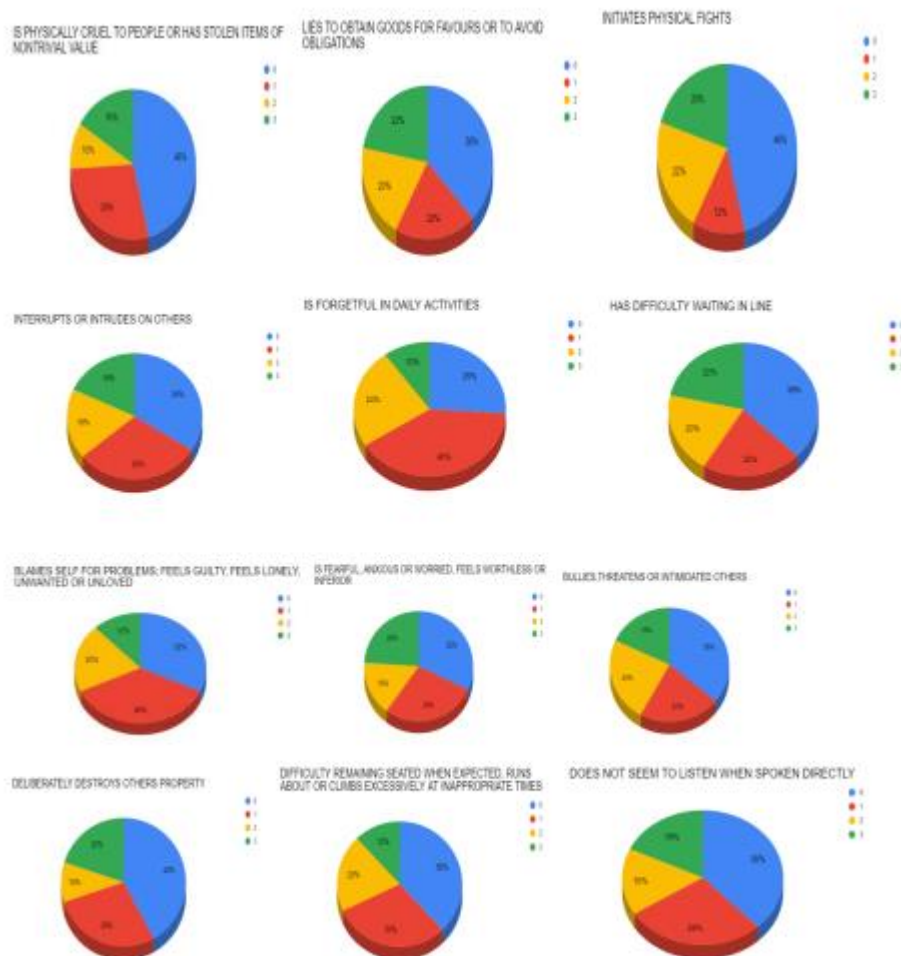
## SYMPTOMS

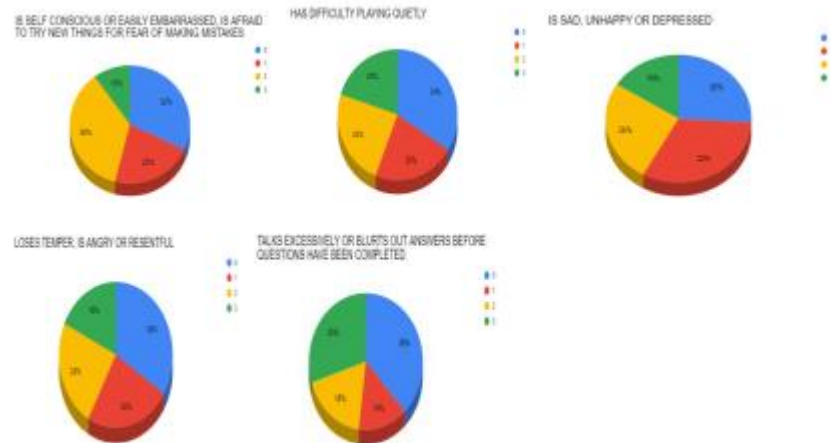


| <b>SYMPTOMS</b>                                               | <b>NO PROBLEM</b> | <b>OCCASIONAL CONCERN</b> | <b>FREQUEN CONCERN</b> | <b>VERY OFTEN A PROBLEM</b> |
|---------------------------------------------------------------|-------------------|---------------------------|------------------------|-----------------------------|
| FAILS TO GIVE ATTENTION TO DETAILS OR MAKES CARELESS MISTAKES | 36%               | 28%                       | 4%                     | 22%                         |
| HAS DIFFICULT SUSTAINING ATTENTION IN TASKS                   | 26%               | 40%                       | 18%                    | 16%                         |
| DIFFICULT FOLLOWING TASKS                                     | 42%               | 32%                       | 10%                    | 16%                         |
| AVOIDS OR DISLIKES TO ENGAGE IN TASKS                         | 34%               | 42%                       | 10%                    | 14%                         |
| LOSES THINGS NECESSARY FOR TASK                               | 28%               | 34%                       | 22%                    | 16%                         |
| IS EASILY DISTRACTED BY EXTRANEIUS STIMULI                    | 22%               | 40%                       | 24%                    | 14%                         |

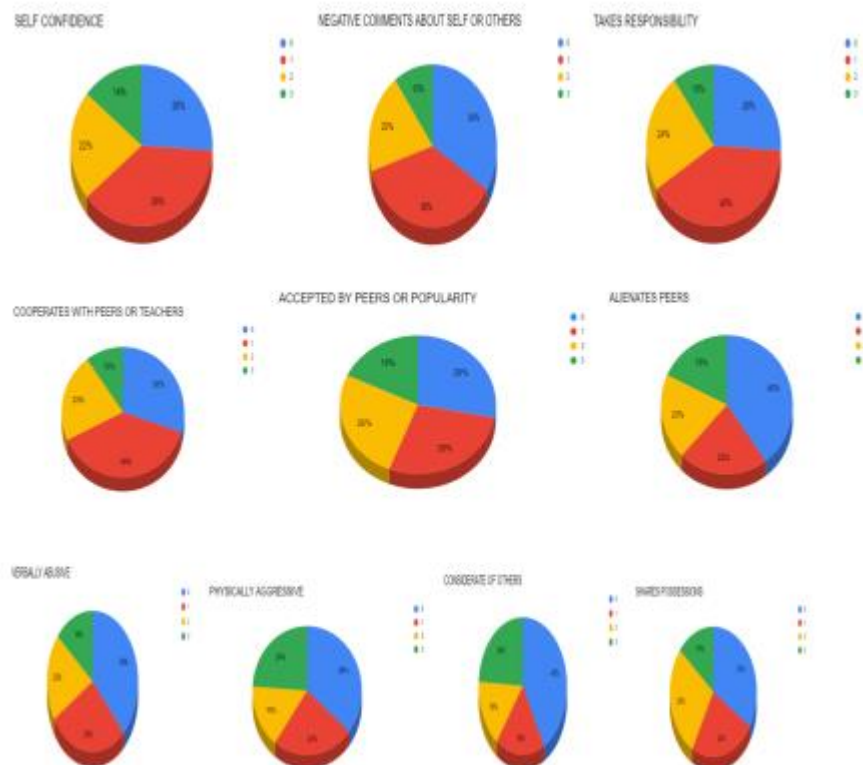
|                                                   |     |     |     |     |
|---------------------------------------------------|-----|-----|-----|-----|
| HAS DIFFICULTY WAITING IN LINE                    | 38% | 22% | 20% | 22% |
| INTERRUPTS OR INTRUDES ON OTHERS                  | 34% | 30% | 18% | 18% |
| IS PHYSICALLY CRUEL TO PEOPLE OR HAS STOLEN ITEMS | 46% | 28% | 10% | 16% |
| LIES TO OBTAIN GOODS FOR FAVOURS                  | 38% | 20% | 20% | 22% |
| INTIATES PHYSICAL FIGHT                           | 46% | 12% | 22% | 20% |
| IS FORGETFUL IN DAILY ACTIVITIES                  | 26% | 40% | 24% | 10% |
| IS FEARFUL,ANXIOUS,FEELS WORTHLESS                | 32% | 28% | 16% | 24% |
| BULLIES THREATENS OR INTIMATED OTHERS             | 36% | 22% | 24% | 18% |
| DELIBERATELY DESTROYS OTHERS PROPERTY             | 42% | 28% | 10% | 20% |
| DIFFICULTY REMAINING SEATED & CLIMBS EXCESSIVELY  | 38% | 30% | 20% | 12% |
| DOES NOT SEEM TO LISTEN WHEN SPOKEN DIRECTLY      | 38% | 28% | 16% | 18% |

|                                                    |     |     |     |     |
|----------------------------------------------------|-----|-----|-----|-----|
| IS SELF CONSCIOUS, AFRAID, FEAR OF MAKING MISTAKES | 32% | 22% | 36% | 10% |
| HAS DIFFICULT PLAYING QUIETLY                      | 34% | 22% | 24% | 20% |
| IS SAD, UNHAPPY OR DEPRESSED                       | 26% | 32% | 26% | 16% |
| LOSES TEMPER, IS ANGRY                             | 34% | 24% | 24% | 18% |
| BLURTS OUT ANSWER BEFORE QUESTION                  | 38% | 14% | 18% | 30% |





## SELF ESTEEM & SOCIAL SKILLS



| SELF ESTEEM & SOCIAL SKILLS            | NO PROBLEM | OCCASIONAL CONCERN | FREQUENT CONCERN | VERY OFTEN A PROBLEM |
|----------------------------------------|------------|--------------------|------------------|----------------------|
| SELF CONFIDENCE                        | 26%        | 36%                | 22%              | 14%                  |
| NEGATIVE COMMENTS ABOUT SELF OR OTHERS | 34%        | 36%                | 20%              | 10%                  |
| TAKES RESPONSIBILITY                   | 26%        | 40%                | 24%              | 10%                  |
| COOPERATES WITH TEACHERS OR PEERS      | 30%        | 38%                | 22%              | 10%                  |
| POPULARITY OR ACCEPTED BY PEERS        | 28%        | 28%                | 26%              | 18%                  |
| ALIENATES PEERS                        | 40%        | 22%                | 20%              | 18%                  |
| VERBALLY ABUSIVE                       | 38%        | 28%                | 20%              | 14%                  |
| SOCIAL ISOLATION                       | 38%        | 24%                | 24%              | 14%                  |
| PHYSICALLY AGGRESSIVE                  | 36%        | 24%                | 28%              | 14%                  |
| CONSIDERATE OF OTHERS                  | 42%        | 18%                | 16%              | 24%                  |
| SHARES POSSESSIONS                     | 34%        | 24%                | 28%              | 14%                  |

**Results:** The responses collected were as follows:

- **Male: Female ratio** 52: 48
- **Senses**

**Touch-** 10% children were problematic, average was 12%.

**Hearing-**14% children were problematic and were advised for ENT opinion.

**Vision-** 26% children had average vision. The last benchers could not see the blackboard clearly. 14% children had problematic vision and were advised eye-examination for corrective spectacles.

- **In attention:** The length of attention span is problematic for 20% of children. Counselling was given.
- In perceptual area, 8-12% children felt problematic. These were explained to their parents for corrective action.

- Memory retrieval ability was found to be problematic in 8-12 %.
- In different conceptual problems 10-18 % were problematic.
- In handwriting, totally 22% were found to be problematic and 38% had average handwriting skills. Children were encouraged to practice in Handwriting practice books for improvement.
- In classroom behavioural problems, commonest were inability to participate in class discussion - 28%, not completing activities - 20%, inappropriate seeking of attention - 24%, frequent absence - 24%, inability to follow classroom rules - 24%.

Homework completion was problematic for 24% children, average - 44%. Parents and teachers were informed to take special interest these children at home and in school respectively. Test taking and study skills was above average for 34% children and 26% was problematic in some children, so proper attention was given to these children during studies and examination to improve their grades. In areas like excessive socialising - 22%, spacing out - 22%, insecurity -16%, sloppiness - 14%, irritable or cursing - 20%, anxiousness - 22% were the problematic percentages.

- In the ability to work without rewards, 22% felt problematic and 38% were average so they were encouraged to finish their work without any guidance or rewards. Reasonable mild forms of appreciation relatable to the efforts put-in were allowed.
- In academic performance area like arithmetic concepts and calculations, oral expression, social science, language, music, art, etc. all these areas, very often problematic children were of 12- 26%, So they were given proper counselling. They were encouraged in academics to get good grades.
- Symptoms like in-attentiveness - 22%, difficulty following tasks - 16%, getting easily distracted - 14%, difficulty waiting in line - 22%, interrupting others - 18%, being cruel to others and stealing - 16%, initiating fights - 20%, lying - 22%, being fearful/ anxious - 24%, bullies/ threatens - 18%, losing temper - 18%, were the problematic percentage.
- Lack of self-confidence - 14%, physically aggressive and verbally abusive - 14%, inconsiderate of others - 24% were the main difficult social skills lack observed in problematic. They were advised counselling.

**Conclusion:** We are able to identify the impact of aggressiveness in children and how their academic performance was reduced. A survey was done using Questionnaire and certain changes were done along with proper counselling to the children. A case has been included in

my study to show the scope of homeopathic management in aggressive-behaviour changes in children. According to the survey and research conducted it was found that playing video games and watching videos leads to aggressive behaviour in children. Children are extremely vulnerable to violence and tend to imitate what they observe. If a child was playing a violent video game, then he would adopt the belief that, the harmful acts the character in the game is committing is acceptable in real life also. These children should be given screen-time under the supervision of parents or any adult. Children should be allowed to play outdoor games and interact with other playmates. Children should be reasonably praised for good deeds, achievements and good behaviour so that they are motivated and turn themselves into good human beings.

### **Case Study (details taken mainly from the mother and physicians' observation)**

A 12 years boy, student of 6<sup>th</sup> standard, had taken counselling session with psychologist for assessment of psychological changes observed from past 8-10 months. The presenting problem was lack of concentration in studies; his academic performance came down to 60% from 90%+. He was an intelligent top ranking student of the class previously. There were behavioural changes observed in school by parents and teachers. His writing had become slow. After coming home from class, he used to play online games on mobile for hours. If his mother scolded, he used to get angry and behave obstinately. He would not answer properly to questions from parents. He had psychiatric counselling 2-3 times. The parents of the patient wanted homoeopathic treatment.

### **Past History:**

\*Recurrent cold and cough for which he had taken homeopathic treatment on and off.

\*Dermatitis, better after applying moisturizing ointments.

\*Aggressive behaviour, taken counselling from psychiatrist.

### **Birth History**

Birth Wt- 2.8 kgs, a full-term, vaginal normal delivery, cried immediately after birth, 2<sup>nd</sup> child, breast feeding done for 1 year and 2 months.

\*No significant history of mother elicited during pregnancy. Thyroid profile was normal. Mother was 32 years during the pregnancy.

Socio economic status: middle class

**Personal History:**

- Appetite- 3times/day, satiated
- Taste- normal, appreciable
- Thirst: 2l/day
- Desire: oily food
- Aversion: milk and milk products
- Stool: 2/day, satisfactory • Micturition: 5-6/d, 0-1/n
- Sweat: profuse, generalised
- Sleep: 9 hours, refreshed, occasionally sleeplessness if mentally excited, very happy
- Dreams: nothing specific.

**Thermals:**

- Food: cold
- Bathing: warm water
- Fanning: required
- Covering: not required.
- Patient is thermally towards hot.

**Activity of Child:**

Behaviour is aggressive when he wants things and they are not given. Will get agitated, shout and scream and throws things within his reach

Never keeps his things in their proper place at home.

Slow in writing.

Likes to play with his toys, like train, battery operated cars etc. likes to play alone mostly. Does not share his toys.

Likes to go out, likes outings for shopping, for playing, trips to new places etc. Enjoys it. Loves to shop for anything that catches his fancy. Will throw a tantrum if parents don't buy it. Will be happy there. Likes to sing and dance or recite something. Even mimics others. Will be very excited and cheerful then.

During such outings or trips, it will be difficult to make him sleep. Remains very excited then. Has become very restless.

Parents have noticed his fear towards stray dogs or cats although no episode of them being unfriendly has been there. Had not noticed it before the lockdown.

### **Genral Physical Examination**

1. Built and nourishment: Well-built and nourished
2. Height: 138 cm
3. Weight: 39 kg
4. Anaemia/ Icterus/ Cyanosis/ Oedema/ Clubbing: absent
5. Skin: healthy, dark complexion
6. Gait: normal

7. Vitals:

BP: 120/80mmhg

PR: 72/min

TEMP: Afebrile

RR: 16/min

In the systemic examination done in detail, nothing abnormal was detected in the RS, CVS, GIT, CNS and skin.

### **ANALYSIS OF THE CASE:**

#### **TOTALITY OF SYMPTOMS**

MIND – ALONE; being- desire to be alone

MIND - COMPANY- aversion to

MIND –THROWS AWAY- ANGER

MIND – SCREAMING, anger with

MIND – FEAR, animals

MIND – CHEERFUL, singing

#### **AGGRESIVENESS**

MIND - RESTLESSNESS

MIND - CONCENTRATION; lack off;

MIND – SLOWNESS, writing

MIMICRY

GENERALITIES: AVERSION: MILK

SLEEPLESSNESS, mental excitement from.

Remedy selected: Based on the above totality, referring to Synthesis Repertory, Stramonium came out as the predominantly similar remedy.

**FIRST PRESCRIPTION:**

- STRAMONIUM 1M one dose every 15 days. 2 doses given
- FOLLOW UP AFTER 1 month
- CHILD ANGER ISSUES WERE MANAGED BY 60%
- COUNSELING WAS continued to the child. The patient felt 80% better after medication

**Second Prescription:** Placebo 200 BD x 3 months.

## References

1. Allen, B. (2010). Childhood Psychological Abuse and Adult Aggression: The mediating role of self-capacities. *Journal of Interpersonal Violence*, 26, 2093-2110
2. Baumrind, D. (1966). Effects of authoritative control on child behavior, *Child Development* 37, 887-907
3. Fraser, W. M. (1996). Aggressive behavior in childhood and early adolescence: An ecological developmental perspective on youth violence. *National Association of Social Work*, 41, 346-361
4. Gershoff, E. T. (2002). Corporal punishment by parents and associated child behaviors and experiences: A meta-analytic and theoretical review. *Psychological Bulletin*, 128, 539-579.
5. Giant, C. L, & Vartanian, L. R. (2003). Experiences with parental aggression during childhood and self-concept in adulthood: The importance of subjective perceptions. *Journal of family violence*, 18, 361-370
6. Hale, W. W. Van der Valk & Meeus, W. (2008) The interplay of early adolescents' depressive symptoms, aggression, and perceived parental rejection: A four-year community study. *Journal of Youth and Adolescence* 37, 928-940
7. Hardy, M., Beers, B., & Burgess, C. (2009), Personal experiences and perceived acceptability of sibling aggression. *Journal of Family Violence* 25, 65-71
8. Margolia, G. Gordis, B. E., Medina, M. A., & Oliver, H. P. (2003). The co-occurrence of husband-to-wife aggression, family-of-origin aggression, and child abuse potential in community sample: Implications for parenting. *Journal of Interpersonal Violence*, 18, 413-440
9. Rodriguez, M.C. (2010). Parent - child aggression: Association with child abuse. violence and victims 25, 1-26
10. Vaillancourt, T., & Shelley, H. (2006). Aggression and social status: The moderating roles of sex and peer-valued characteristics. *Aggressive Behavior* 32, 396-408
11. Prime H, Wade M, Browne DT. Risk and resilience in family well-being during the COVID19 pandemic. *Am Psychol*. 2020; 75(5):631-43. mid:32437181
12. Feldman DH. Cognitive development in childhood: A contemporary perspective. In: Weiner IB, editor. *Handbook of Psychology: Vol 6 Developmental Psychology*. Wiley; 2012. p. 197-214.
13. Flavell JH. Cognitive development: Children's knowledge about the mind. *Annu Rev Psychol*. 1999; 50:21-45. mid:10074674
14. Eisenberg N, Fabes RA. Emotion and its regulation in early development. In: Eisenberg N, Fabes RA, editors. *New directions for child development*, No 55: The Jossey-Bass education series. Jossey-Bass; 1992.
15. Best JR, Miller PH. A developmental perspective on executive function. *Child Dev*. 2010; 81(6):1641-60. mid:21077853

16. Chin M, Sung M, Son S, Yoo J, Lee J, Chang YE. Changes in family life and relationship during the COVID-19 pandemic and their associations with perceived stress. *Fam Environ Res.* 2020; 58(3):447-61.
17. Marques de Miranda D, da Silva Athanasio B, Sena Oliveira AC, Simoes-e-Silva AC.
18. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet.* 2020; 395(10227):912-20. pmid:32112714
19. Bowlby J. Attachment and loss, Vol. 1: Attachment. Basic Books; 1982.
20. Thompson RA. The legacy of early attachments. *Child Dev.* 2000; 71(1):145-52. pmid:10836568
21. Beauchaine TP, Cicchetti D. Emotion dysregulation and emerging psychopathology: A transdiagnostic, transdisciplinary perspective. *DevPsychopathol.* 2019; 31(3):799-804. pmid:31290735
22. Cicchetti D, Ackerman BP, Izard CE. Emotions and emotion regulation in developmental psychopathology. *DevPsychopathol.* 1995;7(1):1-10.
23. Synthesis Repertory, version 9.1, by Frederik Schroyens
24. Homœopathic Materia Medica, by William BOERICKE, M.D.
25. A Dictionary of Practical Materia Medica, by John Henry Clarke, M.D.
26. Lectures on Homœopathic Materia Medica, by JAMES TYLER KENT, A.M., M.D.

**QUESTIONNAIRE:**

|                                                                                                                            |                                                                       |
|----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
|  <p><small>medina center</small></p>      | <h2 style="margin: 0;">The Academic<br/>Behavior Checklist (ABC)</h2> |
| <p>Today's Date: _____</p>                                                                                                 |                                                                       |
| <p>Student's Name: _____ Age: _____ Gender: M / F</p>                                                                      |                                                                       |
| <p>Grade: _____ Teacher: _____ Subject: _____</p>                                                                          |                                                                       |
| <p>Class Time: _____ How long have you known this student? _____</p>                                                       |                                                                       |
| <p>School name: _____ School Phone: _____ School Fax: _____</p>                                                            |                                                                       |
| <p>Please list any strengths this child has.</p> <p>_____</p> <p>_____</p> <p>_____</p>                                    |                                                                       |
| <p>In what areas do you think this child needs help?</p> <p>_____</p> <p>_____</p> <p>_____</p>                            |                                                                       |
| <p>Does the child receive any special education services? Yes _____ No _____ Please Explain:</p> <p>_____</p> <p>_____</p> |                                                                       |
| <p>Has testing been performed? Yes _____ No _____ What were the results?</p> <p>_____</p> <p>_____</p>                     |                                                                       |
| <p>Is testing currently being considered? Yes _____ No _____</p>                                                           |                                                                       |
| <p>What have you tried in the classroom to help this student?</p> <p>_____</p> <p>_____</p> <p>_____</p>                   |                                                                       |

Please circle the number that best describes this child's performance

Rating Code: 0 = Above Average 1 = Average 2 = Problematic

| Senses:     |   |   |                                   |
|-------------|---|---|-----------------------------------|
| 0           | 1 | 2 | Vision                            |
| 0           | 1 | 2 | Hearing                           |
| 0           | 1 | 2 | Touch                             |
| Attention:  |   |   |                                   |
| 0           | 1 | 2 | Alertness                         |
| 0           | 1 | 2 | Distractibility                   |
| 0           | 1 | 2 | Focused attention                 |
| 0           | 1 | 2 | Length of attention span          |
| Perceptual: |   |   |                                   |
| 0           | 1 | 2 | Discrimination of sounds          |
| 0           | 1 | 2 | Discrimination of shapes          |
| 0           | 1 | 2 | Tactile defensiveness             |
| 0           | 1 | 2 | Sequencing                        |
| 0           | 1 | 2 | Speed of processing input         |
| Memory:     |   |   |                                   |
| 0           | 1 | 2 | Immediate                         |
| 0           | 1 | 2 | Short-term retrieval              |
| 0           | 1 | 2 | Rote (by heart)                   |
| 0           | 1 | 2 | Long-term retrieval               |
| 0           | 1 | 2 | Visual                            |
| 0           | 1 | 2 | Auditory                          |
| 0           | 1 | 2 | Motor Skills                      |
| Conceptual: |   |   |                                   |
| 0           | 1 | 2 | Understands oral directions       |
| 0           | 1 | 2 | Understands written instructions  |
| 0           | 1 | 2 | Grasps abstract language concepts |
| 0           | 1 | 2 | Grasps visual-spatial concepts    |
| 0           | 1 | 2 | Integration of sight and sound    |
| 0           | 1 | 2 | Integration of sight and movement |
| 0           | 1 | 2 | Ability to change to another task |
| 0           | 1 | 2 | Ability to reason logically       |
| Motor:      |   |   |                                   |
| 0           | 1 | 2 | Gross motor coordination          |
| 0           | 1 | 2 | Fine motor coordination           |
| 0           | 1 | 2 | Balance                           |
| 0           | 1 | 2 | Handwriting                       |
| 0           | 1 | 2 | Speech clarity                    |
| 0           | 1 | 2 | Speed of output                   |
|             |   |   |                                   |
|             |   |   |                                   |



Please circle the number that best describes this child's behavior

| Rating Code                          | 0 = No Problem | 1 = Occasional Concern | 2 = Frequent Concern | 3 = Very Often A Problem                                                   |
|--------------------------------------|----------------|------------------------|----------------------|----------------------------------------------------------------------------|
| <b>Symptoms</b>                      |                |                        |                      |                                                                            |
| 0                                    | 1              | 2                      | 3                    | Fails to give attention to details or makes careless mistakes              |
| 0                                    | 1              | 2                      | 3                    | Has difficulty sustaining attention in tasks                               |
| 0                                    | 1              | 2                      | 3                    | Does not seem to listen when spoken to directly                            |
| 0                                    | 1              | 2                      | 3                    | Difficulty following instructions and fails to complete assigned tasks     |
| 0                                    | 1              | 2                      | 3                    | Has difficulty organizing tasks                                            |
| 0                                    | 1              | 2                      | 3                    | Avoids or dislikes to engage in tasks that require sustained mental effort |
| 0                                    | 1              | 2                      | 3                    | Loses things necessary for tasks                                           |
| 0                                    | 1              | 2                      | 3                    | Is easily distracted by extraneous stimuli                                 |
| 0                                    | 1              | 2                      | 3                    | Is forgetful in daily activities                                           |
| 0                                    | 1              | 2                      | 3                    | Fidgets with hands or feet or squirms in seat                              |
| 0                                    | 1              | 2                      | 3                    | Difficulty remaining seated when expected                                  |
| 0                                    | 1              | 2                      | 3                    | Runs about or climbs excessively at inappropriate times                    |
| 0                                    | 1              | 2                      | 3                    | Has difficulty playing quietly                                             |
| 0                                    | 1              | 2                      | 3                    | Is "on the go" or often acts as if "driven by a motor"                     |
| 0                                    | 1              | 2                      | 3                    | Talks excessively                                                          |
| 0                                    | 1              | 2                      | 3                    | Bursts out answers before questions have been completed                    |
| 0                                    | 1              | 2                      | 3                    | Has difficulty waiting in line                                             |
| 0                                    | 1              | 2                      | 3                    | Interrupts or intrudes on others                                           |
| 0                                    | 1              | 2                      | 3                    | Loses temper                                                               |
| 0                                    | 1              | 2                      | 3                    | Actively defies or refuses to comply with adult's rules                    |
| 0                                    | 1              | 2                      | 3                    | Is angry or resentful                                                      |
| 0                                    | 1              | 2                      | 3                    | Is spiteful and vindictive                                                 |
| 0                                    | 1              | 2                      | 3                    | Bulies, threatens, or intimidates others                                   |
| 0                                    | 1              | 2                      | 3                    | Initiates physical fights                                                  |
| 0                                    | 1              | 2                      | 3                    | Goes to obtain goods for favors or to avoid obligations                    |
| 0                                    | 1              | 2                      | 3                    | Is physically cruel to people                                              |
| 0                                    | 1              | 2                      | 3                    | Has stolen items of nominal value                                          |
| 0                                    | 1              | 2                      | 3                    | Deliberately destroys others' property                                     |
| 0                                    | 1              | 2                      | 3                    | Is fearful, anxious, or worried                                            |
| 0                                    | 1              | 2                      | 3                    | Is self-conscious or easily embarrassed                                    |
| 0                                    | 1              | 2                      | 3                    | Is afraid to try new things for fear of making mistakes                    |
| 0                                    | 1              | 2                      | 3                    | Feels worthless or inferior                                                |
| 0                                    | 1              | 2                      | 3                    | Blames self for problems; feels guilty                                     |
| 0                                    | 1              | 2                      | 3                    | Feels lonely, unwanted, or unloved                                         |
| 0                                    | 1              | 2                      | 3                    | Is sad, unhappy, or depressed                                              |
| <b>Self-Esteem and social skills</b> |                |                        |                      |                                                                            |
| 0                                    | 1              | 2                      | 3                    | Self-confidence                                                            |
| 0                                    | 1              | 2                      | 3                    | Negative comments about self                                               |
| 0                                    | 1              | 2                      | 3                    | Negative comments about others                                             |
| 0                                    | 1              | 2                      | 3                    | Takes responsibility                                                       |
| 0                                    | 1              | 2                      | 3                    | Cooperates with peers                                                      |
| 0                                    | 1              | 2                      | 3                    | Cooperates with teachers                                                   |
| 0                                    | 1              | 2                      | 3                    | Accepted by peers                                                          |
| 0                                    | 1              | 2                      | 3                    | Popularity                                                                 |
| 0                                    | 1              | 2                      | 3                    | Social isolation                                                           |
| 0                                    | 1              | 2                      | 3                    | Alienates peers                                                            |
| 0                                    | 1              | 2                      | 3                    | Physically aggressive                                                      |
| 0                                    | 1              | 2                      | 3                    | Verbally abusive                                                           |
| 0                                    | 1              | 2                      | 3                    | Shares possessions                                                         |
| 0                                    | 1              | 2                      | 3                    | Considers of others                                                        |

© 2002 Child Care Clinic, Santa Ana, California, AZ 92704 (951) 943-0001 [www.childcareclinic.com](http://www.childcareclinic.com)

**Chapter: 2****Utility of Principles of Ayurveda in Myocardial Reperfusion Injury: A Review****Reshmi. A. S<sup>1</sup>, Mini.V. G<sup>2</sup> and Giri.P. V<sup>3</sup>****<sup>1</sup>PG Scholar, Department of Kayachikitsa, Govt.Ayurveda College,  
Thiruvananthapuram, 695001****<sup>2</sup>PhD Scholar, Department of Kayachikitsa, Vaidyaratnam Ayurveda College,  
Ollur, Trissur, 680306****<sup>3</sup>Professor and HOD, Department of Kayachikitsa, Vaidyaratnam Ayurveda College,  
Ollur, Trissur, 680306****E-mail: asreshmipournami@gmail.com**

**Abstract:** The consequences of coronary artery disease are attributable to the detrimental effects of acute myocardial reperfusion injury typically seen in patients with ST elevation myocardial infarction. It is thought to be mediated by critical factors namely free radicals, neutrophil-endothelium interactions, apoptosis, altered NO formation and intracellular Ca<sup>2+</sup> overload resulting in a series of biochemical and metabolic transformations within the myocardium. Cells constantly generate reactive oxygen species (ROS) during aerobic metabolism. Oxidative stress occurs in cells when ROS overwhelms the cell's natural antioxidant defences. The corner-stone of therapy for preventing acute MI and limiting the size of infarct is timely reperfusion with interventions such as thrombolysis or primary percutaneous coronary intervention (PPCI). However, the process of myocardial reperfusion can itself induce further cardiomyocyte degeneration and death. Therefore, reducing oxidative stress level, free radical scavenging property and improving regeneration potential will be an effective strategy for cessation of adverse effects. As there is always a preference for natural antioxidants rather than synthetic one, it is an important matter of research for evaluating its activity prior to patient administration. There arises the utility of Ayurveda principles. Many modalities are told in Ayurveda classical texts that have to be explored in an evidence-based way. Therapeutic formulations particularly rasayana would be of great importance as it can combat with tissue degeneration. Also, it acts as antioxidant which can prevent many diseases.

**Keywords:** Myocardial Reperfusion Injury, Apoptosis, Necroptosis, Inflammation, Hridroga, Rasayana.

## Introduction

The heart holds the monumental yet monotonous task of maintaining circulation.<sup>1</sup> Cardiovascular diseases (CVDs) refers to all conditions affecting the heart and blood vessels. They comprise the most prevalent serious disorders in industrialized nations and are a rapidly growing problem in developing nations.<sup>2</sup> The World Health Organisation reported that CVD is responsible for 17 million deaths every year, which translates to approximately 31% of all deaths globally and expects this figure to rise to over 23 million by 2030.<sup>3</sup> The annular number of deaths from CVD in India is projected to rise from 2.26 million (1990) to 4.77 million (2020). Coronary heart disease prevalence rates in India have been estimated over the past several decades and have ranged from 1.6% to 7.4% in rural population and from 1% to 13.2% in urban populations.<sup>4</sup> Approximately half of all CVD-related deaths are caused by ischemic heart disease (IHD), which results in loss of cardiomyocytes within the myocardium leading to ventricular dysfunction and heart failure.<sup>5</sup>

Acute Myocardial Ischemia (MI) occurs when the blood flow is less than the demand resulting in deficiency of oxygen, glucose and other factors needed for metabolism. Reperfusion is an effective strategy to arrest further progression by reducing infarct size and improving clinical outcome. But due to restoration of blood to oxygen deprived ischemic myocardium, various alterations occur such as inflammation and oxidative stress induced oxidative damage that can culminate in tissue regeneration and finally necrosis. Oxidative stress is a phenomenon caused by an imbalance between production and accumulation of Reactive Oxygen Species (ROS) in cells and tissues and the ability to detoxify these reactive products.<sup>6</sup> ROS are produced, mainly by mitochondria, as a result of normal cellular metabolism. In mild to moderate concentration, it aids in physiological cellular metabolism. But at high concentrations, they produce adverse transformations of cell components like lipids, proteins and DNA. Commonly defined ROS includes superoxide radicals ( $O_2^{\cdot-}$ ), Hydrogen Peroxide ( $H_2O_2$ ), hydroxyl radicals ( $\cdot OH$ ) and singlet oxygen ( $O_2$ ). Cardiovascular injury due to ischemic reperfusion has been linked to excess ROS accumulation. Restoration of blood flow is essential to reinstate ischemic myocardial tissues. This phenomenon, termed myocardial reperfusion injury, can paradoxically reduce the beneficial effects of myocardial reperfusion and lead to lethal damage to myocardium by the triggering of apoptosis.<sup>7</sup> Using antioxidants to scavenge free radicals or targeting the source of ROS may be potential to reduce consequences of myocardial reperfusion injury. The role of ROS in myocardial reperfusion injury is evident, but lacks adequate clinical approach to combat these. This led to

the relevance of development of new modalities with clear experimental basis prior to direct patient administration. The possible intervention is the reduction of apoptosis caused by oxidative stress by making the myocardial tissues potent with antioxidant drugs so that the adverse effects can be minimised.<sup>8</sup>

### **Pathophysiology**

In MI, rapid restoration of blood flow to the ischemic myocardium by reperfusion either by thrombolysis or angioplasty has become the corner-stone of therapy.<sup>9,10</sup> Reperfusion therapy should be performed within the first 12h of infarction to limit infarct size (IS), improve survival and prevent post-ischemic HF.<sup>11</sup> However, sudden restoration blood flow leads activation of various intracellular cascades damaging cardiac cells.<sup>12</sup> Since the initial description of this phenomenon by Jennings et al.<sup>13</sup> near 40 years ago, our understanding of the mechanisms of reperfusion injury has increased considerably. The pathogenicity is linked mainly to regulated cell death (RCD) under the control of numerous biochemical and cellular processes such as a burst of reactive oxygen species (ROS), loss of ionic homeostasis, mitochondrial dysfunction and inflammation.<sup>14</sup> The viable cardiac cells undergo apoptotic death due to this reperfusion injury. The reason for this can be attributed to lack of regeneration to cardiac cells. So, the dead cells cannot be restored.<sup>15</sup> At that moment, no pharmacological treatment is available to prevent reperfusion injury.<sup>16,17</sup> So more should be explored to find an effective strategy to attain the same.

### **Modes of Cell Death during Reperfusion Injury**

Multifactorial and highly integrated mechanisms contribute to reperfusion injury. This in turn triggers cascade of biochemical and metabolic events causing adverse side effects including cell death. This may be the possible reason for development of chronic heart failure and mortality even in early reperfused individual.<sup>18</sup> Studies in animal models suggest that reperfusion lesion is responsible for 25 to 50% of the final IS.<sup>19</sup>

Cells can die from necrosis which is usually triggered by unexpected injury or attack, escaping from any controlled molecular mechanisms.<sup>20,21</sup> Qualitatively, necrosis is the major mechanism of cardiomyocyte death during ischemia as a direct consequence of oxygen deprivation leading to severe injury. In contrast, during reperfusion, cardiomyocytes die from regulated cell death (RCD) mechanisms involving genetically defined effector molecules and precise signaling cascades such as apoptosis and necroptosis.<sup>12</sup>

## **Apoptosis**

Characterized by cell shrinkage, chromatin condensation and distinctive blebbing (budding) of the plasma membrane. This can be due to some intrinsic or extrinsic pathways converging into Caspase-activation (Caspases belongs to family of cysteine proteases, exist as inactive zymogens, that execute programmed cell death i.e. apoptosis) and DNA fragmentation.<sup>22</sup> Specific DNA fragmentation is mainly detected in the myocardium after reperfusion and not during ischemia, suggesting that its activation is specifically triggered at the onset of reperfusion, depending on the recovery of ATP production.<sup>23,24</sup> This is supported by a major IS reduction observed after the administration of inhibitors of pro-apoptotic mediators at early reperfusion.<sup>25,26</sup> Moreover, the gold standard of cardio protection, ischemic postconditioning (rapid sequential intermittent interruption of blood flow applied during early moments of reperfusion) from which it is derived.<sup>27-29</sup> Cardio protection results from anti-apoptotic strategies<sup>22</sup> such as peptides targeting the first apoptosis signal (FAS) death-dependent apoptotic receptor<sup>30,31</sup> or the mitochondrial permeability transition pore (mPTP) such as Cyclosporine-A (CsA) with however inconsistent preclinical and clinical results.<sup>32</sup>

## **Necroptosis**

Necroptosis has been identified as a lytic form of cell death leading to the release of proinflammatory intracellular molecules.<sup>33,34</sup> Even if necroptosis is morphologically similar to necrosis, this pathway could also depend on Caspase-8 activity and therefore, be pharmacological modulable (i.e., inhibited by necrostatin-1).<sup>35</sup> Necroptosis is triggered only if Caspase-8, responsible for the cleavage of RIPK1 (Receptor-Interacting serine/threonineProtein Kinase 1), is inhibited. Phosphorylated RIPK1 and RIPK3 together with MLKL (Mixed Lineage Kinase Domain Like Pseudo kinase) form the necrosome leading to phosphorylation and oligomerization of MLKL, which translocate to the plasma membrane to induce membrane rupture.<sup>36</sup>

## **Autophagy-Dependent Cell Death**

Autophagy is an evolutionary process to maintain cell homeostasis based on the degradation of intracellular materials and components within the lysosomal compartment of eukaryotic cells.<sup>21</sup> Autophagy was believed to be a cytoprotective catabolic mechanism of substrate recycling for ATP generation and cell survival. Autophagy is activated by ATP-depletion and subsequent AMPK (AMP-dependant Protein Kinase) activation, calcium overload and ROS, which are found during prolonged ischemia, IR and HF.<sup>37,38</sup> A high level of Beclin-1 is

critical for early autophagosome formation and its activity can be reduced by BCL-2 (B-cell lymphoma-2) or BCL-XL (B-cell lymphoma extra-large). Beclin-1 is cleaved by Caspases, showing the existence of a crosstalk between autophagy and apoptosis.<sup>39</sup> More recently autosis was described as a new form of autophagy responsible for continuous cardiomyocyte death in the late phase of reperfusion although cell death processes should be completed within 2h of reperfusion.<sup>40,41</sup>

### Inflammation

Necrotic cardiomyocytes in the infarcted area initiates the post-infarction inflammatory response through the release of DAMPs (Damage-Associated Molecular Patterns) in concert with the complement cascade and ROS activation, mobilizing the resident immune cells of the heart at the onset of AMI. Neutrophil infiltration, innate immunity activation as well as cell-mediated damage are pathological mechanisms of inflammation-related IR injury observed after MI exemplified through experimental and clinical studies.<sup>42</sup> During ischemia, the proinflammatory response is rapidly facilitated to remove the necrotic cells and thereby repairing the infarcted myocardium. This is exacerbated by reperfusion leading to cardiomyocyte death and MIRI within 6h and 24h post-reperfusion. TLR2, TLR4, TLR9 (Toll-Like Receptors) and NLRP3 in the NLRP3-ASC-Caspase-1 inflammasome contribute to the strong and short inflammatory outburst following reperfusion through IL-1 (Interleukin-1), IL-6 and active Caspase-1 mediators via the NF- $\kappa$ B pathway.<sup>43</sup> Inflammation involved in the pathophysiology of MIRI but also in fibrosis formation and in post-infarct remodeling leading to HF.<sup>44</sup> Because inflammation contributes to IS and cardiac remodeling, it is a major predictor of adverse events after AMI.<sup>45,46</sup>

### Ayurvedic Aspect

All pathologies related to heart and blood vessels can be related to Hridroga. But exact correlation to Myocardial Reperfusion is not available. The main principles of Ayurveda lie upon *Tridosha* and *Panchabhuta*. *Ahara* (dietetics), *Vihara* (regimens) and *Manasika bhavas* (Psychological factors) are responsible for the disequilibrium of these factors. Violation of principles of diet (including junk, fatty foods) and other etiological factors (smoking, alcoholism, sedentary habits, over stress) leads to dosha dushti which further causes dushti of jataragni (impaired metabolism) causing the formation of ama (unwanted metabolic wastes) and thus *dhatwagni mandya* (impairment of tissue fire). So proper *dhatu parinama* (transformation) never occurs because of improper *pachana of rasa* (digestion of food) so

that Sama Rasa may be formed. The sama rasa favours the formation of *sama medodhatu* and *kapha* in its mala form. Rasa circulates in conjunction with rakta from yakrut and pleeha. Hridaya, being the *moola sthana* of rasa, it gets vitiated and *sthanasamsraya* (localisation) occurs in concerned *srothus* (channels) present in *hridaya*. This causes *srothorodha* (obstruction to channels) and in MI it can be related with *hriddhamani rodha* and the condition may be called *dhamani pratichayam* (atherosclerosis). If *sama rasa* is associated with *vata*, it causes hridshula. Due to occlusion, oxygen and nutrient supply are diminished leading to the *hrid pesi poshana abhava* (lack of nutrition to cardiac muscles). On further necrosis, if pitta predominates, *sara bhava* (liquefaction) increases which causes orchestrated flow of rasa dhatu along with rakta, damage of myocardium occurs which can be correlated with *dhatu paka avastha*. By considering the *lakshanas* of MI, it is similar to *vata-paittika hridroga* and this dhatu paka may be related with reperfusion injury. On further progression, *vata dosha* predominates causing cell death.

The pathology of Ischemia followed by reperfusion injury reflects damage to myocardium and as a result degeneration occurs. The prime reason behind it is a *srothorodha* and *dhatwagni mandya* which hampers the normal circulatory function (*rakta chankramana*). As a result of unavailability of *prakrita rakta dhatu* to the myocardial cells, its function called *jeevana* not occurs to the target site.

### Utility

The main aim of Ayurveda in this respect is to remove that *srothorodha* and correcting the *dhatwagni*. Initial aim is to boost up this impaired jataragni by giving agnivardhaka medicines like *vacha-hingu-lavanadi choornam*<sup>47</sup> or available *hinguvachadi choornam* in markets.<sup>48</sup> This corrects the agni, reduces ama formation and thereby reducing *srothorodha*. This can be done in the initial stage evidenced by elevated lipid profile values. When it enters into a *dhatupaka avastha*, more *pitta-kapha* pacifying drugs should be administered. Medicines intended for this purpose are *Rasayanas* like *Silajatu*, *Brahma Rasayana*, *Amalaka Rasayana* and *Agastya Rasayana*.<sup>49</sup> So *Rasayana prayogas* are prime in reperfusion injury considering the status of doshas. In case of degeneration and stage of cell death, medicated *ghritha* or *taila* can be given. Examples include *Bala taila*, *Sukumara ghritha*, *Yashtyahva Shatapaka taila* or *Mahasneha*.<sup>50</sup>

Some of the cardioprotective drugs mentioned in classics include *Hrudya daseimani*, *Parushakadi gana*, *Vidaryadi Gana* etc. Drugs proven to have cardioprotective activity

include *Hareethaki*, *Ajamoda*, *Pippali*, *Shunti*, *Rasna*, *Pushkaramoola*, *Lasuna*, *Guduchi*, *Dadimaphala*, *Kharjura*, *Eranda taila*, *Madira*, *Amla varga*, *Vacha*, *Gomutra*, *Guggulu*, *Triphala*, *Tamra*, *Baladwayam*, *Sthiradwayam* and *Arjunatwak*. These can be given to patients in varied formulations considering the personal factors.

Many single drugs and compounds are said in Ayurveda classics that must be explored in a more scientific way to get an evidence-based acceptance. Pre-clinical as well as clinical trials are needed in this field to know the mode of action of the above medicines and to give an explanation on the basis of modern parameters. This could be encouraged in future to restore the authenticity of Ayurveda, the science of life.

## References:

1. Kazu Kikuchi and Kenneth P Poss. Cardiac regenerative capacity and mechanism [Internet]. 2012. Available from: <https://doi.org/10.1146/annurev-cellbio-101011-155739>.
2. Jameson, Fauci, Kasper. Approach to the patient with possible cardiovascular disease. Harrison's principles of internal medicine, 20th ed. New Delhi, India: Mc Graw Hill Education, 2018, ch.231, sec.1, pp.1649.
3. Cardiovascular Disease 2020-2030; Trends, Technologies & outlook. <http://www.idtechex.com>.
4. Murray CJ, Lopez AD. Alternative projections of mortality and disability by cause 1990-2020: Global Burden of Disease Study. [Internet] Lancet. [Published May 24 1997] . Available from: [https://doi.org/10.1016/S0140-6736\(96\)07492-2](https://doi.org/10.1016/S0140-6736(96)07492-2).
5. Gupta R, Joshi P, Mohan V, Reddy KS, Yusuf S. Epidemiology and causation of coronary heart disease and stroke in India. Heart 2008 Jan; 94(1):16- Riching AS and Song K(2021) Cardiac Regeneration: New insights into the frontier of Ischemic Heart Failure Therapy. Front. Bioeng. Biotechnol. [Published 27 January 2021]. Available from <https://doi.org/10.3389/fbioe.2020.637538>.
6. Riching AS and Song K(2021) Cardiac Regeneration: New insights into the frontier of Ischemic Heart Failure Therapy. Front. Bioeng. Biotechnol. [Published 27 January 2021]. Available from <https://doi.org/10.3389/fbioe.2020.637538>.
7. Sang Jin Ha and Weon Kim. Mechanism of Ischemia and Reperfusion Injury to the heart: From view point of nitric oxide and mitochondria. Chonnam Medical Journal Vol 46, No3, pp 129-139 [Published online: 23 December 2010] <https://doi.org/10.4068/cmj.2010.46.3.129>.
8. Huaying Fan, Liu Yang, Fenghue Fu, Huiru, Qiuggang Meng, Haibo Zhu, Lirong Teng, Mingyan Yang, Leiming Zhang, Ke Liu. Cardioprotective effects of Salvianolic Acid A on Myocardial Ischemia-Reperfusion Injury In vitro and In vivo. Evidence based complementary and alternative medicine; 2012; Article ID 508938 as accessed in [www.hindawi.com/journals/ecam/2012/50893826](http://www.hindawi.com/journals/ecam/2012/50893826). doi:10.1136/hrt.2007.132951. PMID: 18083949.
9. Gallego-Colon E, Bonaventura A, Vecchie A, Cannata A, Fitzpatrick CM. Cardiology on the cutting edge: updates from the European Society of Cardiology (ESC) Congress 2020. BMC Cardiovasc Disord. (2020) 20:448. Doi: 10.1186/s12872-020-01734-4.
10. Thiele H, Jobs A. [ESC guidelines 2020: acute coronary syndrome without persistent ST-segment elevation: what is new?]. Herz. (2021) 46:3–13. doi: 10.1007/s00059-020-05002-1.
11. Reed GW, Rossi JE, Cannon CP. Acute Myocardial Infarction. Lancet Lond Engl. (2017) 389:197–210. doi: 10.1016/S0140-6736(16)30677-8.

12. Davidson SM, Adameová A, Barile L, Cabrera-Fuentes HA, Lazou A, Pagliaro P. et al. EU-CARDIOPROTECTION COST Action (CA16225). Mitochondrial and mitochondrialindependent pathways of myocardial cell death during ischaemia and reperfusion injury. *J Cell Mol Med.* (2020) 24:3795–806. doi: 10.1111/jcmm.15127.
13. Jennings RB, Reimer KA. Factors involved in salvaging ischemic myocardium: effect of reperfusion of arterial blood. *Circulation.* (1983) 68:I25–36.
14. de Groot H, Rauen U. Ischemia-reperfusion injury: processes in pathogenetic networks: a review. *Transplant Proc.* (2007) 39:481–4. doi: 10.1016/j.transproceed.2006.12.012.
15. Li Yan, He Lingjuan, Huang Xiuzhen, Bhaloo Shirin Issa, Zhao Huan, Zhang Shaohua, et al. Genetic lineage tracing of non-myocyte population by dual recombinases. *Circulation.* (2018) 138:793–805. doi: 10.1161/CIRCULATIONAHA.118.034250.
16. Braunwald E, Kloner RA. Myocardial reperfusion: a double-edged sword? *J Clin Invest.* (1985) 76:1713–9. doi: 10.1172/JCI112160.
17. Hausenloy DJ, Yellon DM. Preconditioning and postconditioning: new strategies for cardioprotection. *Diabetes Obes Metab.* (2008) 10:451–9. doi: 10.1111/j.1463-1326.2007.00762.x.
18. Moe GW, Marín-García J. Role of cell death in the progression of heart failure. *Heart Fail Rev.* (2016) 21:157–67. doi: 10.1007/s10741-016-9532-0.
19. Simonis G, Strasser RH, Ebner B. Reperfusion injury in acute myocardial infarction. *Crit Care.* (2012) 16:A22. doi: 10.1186/cc11280.
20. Tang D, Kang R, Berghe TV, Vandenabeele P, Kroemer G. The molecular machinery of regulated cell death. *Cell Res.* (2019) 29:347–364. doi: 10.1038/s41422-019-0164-5.
21. Del Re DP, Amgalan D, Linkermann A, Liu Q, Kitsis RN. Fundamental mechanisms of regulated cell death and implications for heart disease. *Physiol Rev.* (2019) 99:1765–817. doi: 10.1152/physrev.00022.2018.
22. Jose Corbalan J, Vatner DE, Vatner SF. Myocardial apoptosis in heart disease: does the emperor have clothes? *Basic Res Cardiol.* (2016) 111:31. doi: 10.1007/s00395-016-0549-2.
23. Gottlieb RA, Burleson KO, Kloner RA, Babior BM, Engler RL. Reperfusion injury induces apoptosis in rabbit cardiomyocytes. *J Clin Invest.* (1994) 94:1621–8. doi: 10.1172/JCI117504.
24. Zhao ZQ, Nakamura M, Wang NP, Wilcox JN, Shearer S, Ronson RS, et al. Reperfusion induces myocardial apoptotic cell death. *Cardiovasc Res.* (2000) 45:651–60. doi: 10.1016/S0008-6363(99)00354-5.
25. Mocanu MM, Gadgil S, Yellon DM, Baxter GF. Mibefradil, a T-Type and L-Type calcium channel blocker, limits infarct size through a glibenclamide-sensitive mechanism. *Cardiovasc Drugs Ther.* (1999) 13:115–22. doi: 10.1023/A:1007732025184.

26. Holly TA, Drincic A, Byun Y, Nakamura S, Harris K, Klocke FJ, et al. Caspase inhibition reduces myocyte cell death induced by myocardial ischemia and reperfusion in vivo. *J Mol Cell Cardiol.* (1999) 31:1709–15. doi: 10.1006/jmcc.1999.1006.
27. Piot CA, Padmanaban D, Ursell PC, Sievers RE, Wolfe CL. Ischemic preconditioning decreases apoptosis in rat hearts in vivo. *Circulation.* (1997) 96:1598–604. doi: 10.1161/01.CIR.96.5.1598.
28. Zhao Z-Q, Corvera JS, Halkos ME, Kerendi F, Wang N-P, Guyton RA, et al. Inhibition of myocardial injury by ischemic postconditioning during reperfusion: comparison with ischemic preconditioning. *Am J Physiol Heart Circ Physiol.* (2003) 285:H579–88. doi: 10.1152/ajpheart.01064.2002.
29. Wang H-C, Zhang H-F, Guo W-Y, Su H, Zhang K-R, Li Q-X, et al. Hypoxic postconditioning enhances the survival and inhibits apoptosis of cardiomyocytes following reoxygenation: role of peroxynitrite formation. *Apoptosis Int J Program Cell Death.* (2006) 11:1453–60. doi: 10.1007/s10495-006-7786-z.
30. Boisguérin P, Covinhes A, Gallot L, Barrère C, Vincent A, Busson M, et al. A novel therapeutic peptide targeting myocardial reperfusion injury. *Cardiovasc Res.* (2020) 116:633–44. doi: 10.1093/cvr/cvz145.
31. Covinhes A, Gallot L, Barrère C, Vincent A, Sportouch C, Piot C, et al. Anti-apoptotic peptide for long term cardioprotection in a mouse model of myocardial ischemiareperfusion injury. *Sci Rep.* (2020) 10:18116. doi: 10.1038/s41598-020-75154-x.
32. Javadov S, Jang S, Parodi-Rullán R, Khuchua Z, Kuznetsov AV. Mitochondrial permeability transition in cardiac ischemia-reperfusion: whether cyclophilin D is a viable target for cardioprotection? *Cell Mol Life Sci CMLS.* (2017) 74:2795–813. doi: 10.1007/s00018-017-2502-4.
33. Adameova A, Goncalvesova E, Szobi A, Dhalla NS. Necroptotic cell death in failing heart: relevance and proposed mechanisms. *Heart Fail Rev.* (2016) 21:213–21. doi: 10.1007/s10741-016-9537-8.
34. Adameova A, Hrdlicka J, Szobi A, Farkasova V, Kopaskova K, Murarikova M, et al. Evidence of necroptosis in hearts subjected to various forms of ischemic insults. *Can J Physiol Pharmacol.* (2017) 95:1163–9. doi: 10.1139/cjpp-2016-0609.
35. Galluzzi L, Vitale I, Aaronson SA, Abrams JM, Adam D, Agostinis P, et al. Molecular mechanisms of cell death: recommendations of the nomenclature committee on cell death 2018. *Cell Death Differ.* (2018) 25:486–541. doi: 10.1038/s41418-017-0012-4.
36. Mishra PK, Adameova A, Hill JA, Baines CP, Kang PM, Downey JM, et al. Guidelines for evaluating myocardial cell death. *Am J Physiol Heart Circ Physiol.* (2019) 317:H891–H922. doi: 10.1152/ajpheart.00259.2019.

37. Zhu H, Tannous P, Johnstone JL, Kong Y, Shelton JM, Richardson JA, et al. Cardiac autophagy is a maladaptive response to hemodynamic stress. *J Clin Invest.* (2007) 117:1782–93. doi: 10.1172/JCI27523.
38. Tannous P, Zhu H, Johnstone JL, Shelton JM, Rajasekaran NS, Benjamin IJ, et al. Autophagy is an adaptive response in desmin-related cardiomyopathy. *Proc Natl Acad Sci.* (2008) 105:9745–50. doi: 10.1073/pnas.0706802105.
39. Gottlieb RA, Mentzer RM. Autophagy during cardiac stress: joys and frustrations of autophagy. *Annu Rev Physiol.* (2010) 72:45–59. doi: 10.1146/annurev-physiol-021909-135757.
40. Nah J, Zablocki D, Sadoshima J. Autosis: a new target to prevent cell death. *JACC Basic Transl Sci.* (2020) 5:857–69. doi: 10.1016/j.jacbts.2020.04.014.
41. Nah J, Zhai P, Huang C-Y, Fernández ÁF, Mareedu S, Levine B, et al. Upregulation of rubicon promotes autosis during myocardial ischemia/reperfusion injury. *J Clin Invest.* (2020) 130:2978–91. doi: 10.1172/JCI132366.
42. Turer AT, Hill JA. Pathogenesis of myocardial ischemia-reperfusion injury and rationale for therapy. *Am J Cardiol.* (2010) 106:360–8. doi: 10.1016/j.amjcard.2010.03.032.
43. Ong S-B, Hernández-Reséndiz S, Crespo-Avilan GE, Mukhametshina RT, Kwek X-Y, Cabrera-Fuentes HA, et al. Inflammation following acute myocardial infarction: multiple players, dynamic roles, and novel therapeutic opportunities. *Pharmacol Ther.* (2018) 186:73–87. doi: 10.1016/j.pharmthera.2018.01.001.
44. Vincent A, Lattuca B, Merlet N, Sportouch-Dukhan C, Barrère-Lemaire S. New insights in research about acute ischemic myocardial injury and inflammation. *anti-Inflamm AntiAllergy Agents Med Chem.* (2013) 12:47–54. doi: 10.2174/1871523011312010007.
45. Roubille F, Cayla G, Picot M-C, Pradet V, Massin F, Gervasoni R, et al. [C-Reactive Protein (CRP) After Revascularized STEMI: Is CRP a Prognostic Factor?]. *Rev Med Interne.* (2008) 29:868–74. doi: 10.1016/j.revmed.2008.01.026.
46. Akodad M, Sicard P, Fauconnier J, Roubille F. Colchicine and myocardial infarction: a review. *Arch Cardiovasc Dis.* (2020) 113:652–9. doi: 10.1016/j.acvd.2020.04.007.
47. Prof.K.R. Srikantha Murthy. Vagbhata's Astanga Hrdayam. Vol II, Chowkhamba Krishnadas Academy, Varanasi, 2014, pp278.
48. Prof.K.R. Srikantha Murthy. Vagbhata's Astanga Hrdayam. Vol II, Chowkhamba Krishnadas Academy, Varanasi, 2014, pp406.
49. Prof.K.R. Srikantha Murthy. Vagbhata's Astanga Hrdayam. Vol II, Chowkhamba Krishnadas Academy, Varanasi, 2014, pp279.
50. Prof.K.R. Srikantha Murthy. Vagbhata's Astanga Hrdayam. Vol II, Chowkhamba Krishnadas Academy, Varanasi, 2014, pp277.

**Chapter: 3**  
**Artificial Intelligence as a Diagnostic Tool for Prolapsed Intervertebral Disc: A Literature Review**

**Sandeep Pattnaik<sup>1</sup> and Manu Goyal<sup>2</sup>**

<sup>1</sup>Research Scholar, M.M Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala

<sup>2</sup>Professor, M.M Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala

**Abstract**

**Background:** Prolapsed intervertebral disc (PIVD) is a concentrated displacement of the content within the intervertebral disc beyond its natural limits as sequelae to the degenerative disc disease. It is commonly diagnosed with physical examination, X-ray, computed tomography scan, and magnetic resonance imaging (MRI) out of which MRI is considered to be the gold standard. In recent decades with the development of the sub-fields of artificial intelligence (AI) such as computer vision, computer-aided diagnosis, and deep learning, clinicians have turned towards its use as an alternative to the conventional method of diagnosis for PIVD.

**Objective:** The objective of this review is to appraise the role and utility of AI in the efficient diagnosis of PIVD.

**Methods:** Different search media were searched to gather published literature stating and examining the use of AI as a diagnostic tool for the diagnosis of PIVD.

**Discussion:** All of the included studies showed relatively moderate to high accuracy in the diagnosis of PIVD. Most of these studies used MRI images as the main source of input. They not only demonstrated higher test accuracy but also demonstrated good training accuracy. Most of those AI are based on the classification model of the computer-aided diagnosis design. AI in almost all the used models has arrived at the diagnosis based on the data extracted from the radiological findings, especially MRI without considering the physical examination findings and analysis of symptoms. This ignores the fact that there is a moderate relationship between radiological findings and symptoms in patients with PIVD. So future

research in developing AI for the diagnosis of PIVD based on the physical findings along with the radiological findings can be considered.

**Conclusion:** From this viewpoint, the study concludes that the use of AI may effectively improvise the diagnosis process in patients affected by PIVD.

**Keywords:** Prolapsed intervertebral disc; Disc herniation; Disc bulge; Artificial intelligence, Computer-aided diagnosis; Diagnosis

## Introduction

Artificial intelligence (AI) since its birth in 1950, has been evolving and spreading its roots to various departments, occupations, and work practices. Owing to its creative computational appliance and intelligence, it has been able to support as well as substitute human work and intelligence. It has revolutionized the field of health care in the last few decades. AI has helped healthcare professionals detect diseases faster, provide personalized treatment plans, evaluate outcomes, and automate diagnostics or new drug discovery processes.[1] Keeping in mind the versatility of AI in clinical practice, its employment in medical research has been increasingly explored in recent times.

One of the commonest fields of health care that has been extensively investigated is the diseases related to the spine and low back pain. With the advancement in the sub-fields of AI such as machine learning, deep learning, neural network, computer vision, computer-aided diagnosis and cognitive computing, human minds have started inspecting the role of different AI in diagnosing, planning out treatment, evaluating outcomes following any spinal disorders or low back pain.[2] Especially, computer vision and computer-aided diagnosis have been shown to extract data from radiological datasets, imaging and non-imaging data to support clinicians in arriving at a correct diagnosis related to spinal disorders.[3][4]

Amongst all the spinal disorders, which a physiotherapist deals with in their clinical practice, discogenic disorders are the commonest among different age groups. Discogenic disorders are defined as disorders of intervertebral disc (IVD) origin. IVD is composed of the nucleus pulposus in the centre and annulus fibrosis enclosing it as an outer shell, present between each adjacent vertebra with some exceptions. They are mainly responsible for shock and stress absorption to prevent the grinding of the vertebral bodies into each other.[5] Discogenic disorders may vary from developmental disorders to infections, degenerative/traumatic lesions, neoplastic disorders and morphological variants that can occur individually or multiple of them may occur simultaneously.[6]

The prolapsed intervertebral disc (PIVD), commonly known as the herniated disc of all discogenic disorders should be the disorder of prime concern. This is so because PIVD is one of the most prevalent musculoskeletal disorders of the modern world that is precipitated by a sedentary lifestyle, obesity, secondary habits and socioeconomic status.[7][8] Patients with PIVD are ordinarily diagnosed with magnetic resonance imaging (MRI) along with the help of computed tomography scan (CT scan) and X-ray.[9] In clinical practice, these investigatory findings are further aided by the clinical symptoms and findings.[10]

MRI amongst all is considered to be the gold standard for the diagnosis of PIVD. But in most instances, it shows abnormal findings of IVD without the patient demonstrating any signs or symptoms.[11] Secondly, clinical diagnoses are dependent on the skill of the therapists and their thought process, thus subjected to variability. With encounters in abundance, it becomes difficult for a physiotherapist to diagnose and classify patients with PIVD. Hence, it is essential to address the difficulty and search for alternatives to solve the arisen problems with the conventional method of diagnosis. Here AI comes into action to aid human minds to arrive at a conclusive diagnosis for which the therapist may have struggled. Due to the essentiality of developing an AI that best fulfils as an alternative to the conventional diagnostic methods of PIVD, this literature review aimed to present and discuss the findings of the research that examined the development and utility of AI to diagnose PIVD.

## **Methods**

### **Databases**

A systematic literature search was undertaken on March 2023 in order to inspect the role of AI in the diagnosis of PIVD. The electronic databases investigated were, Google Scholar, PubMed and Scopus, covering the period from 2018 to 2023 respectively.

### **Search Strategy**

The PICO search strategy was adopted for the study, where the participant (P) was defined by PIVD; intervention (I) by AI; and diagnosis as the outcome (O). Control (C) was not relevant from the study's point of view. The strategy was adapted and modified for each database. Keywords used were PIVD, disc herniation, disc bulge, diagnosis, AI, computer vision, segmentation, neural networking, and related terms. MeSH (Medical Subject Headings) terms, alike keywords, along with Boolean operators such as 'OR' and 'AND' using advanced search options were included.

## Inclusion Criteria

All the articles explicitly explaining the role of any aspect of AI in the diagnosis of PIVD were included, irrespective of the type of the study. All types of manuscripts identified through the databases search were included in this literature review on the condition that the full version of the original articles was available in English. The references of the systematic reviews within the search period were also identified and included in the study.

Studies not available in full length, published before the search period, published in other languages, and animal studies were excluded.

## Procedure

The initial search was confined to the search of keywords within the title and abstract. Then the abstracts of the articles meeting the restricted search strategy were assessed based on the inclusion criteria and in cases of uncertainty, full articles were also retrieved. The identified potentially relevant articles were then obtained in full length and two authors took the final decision regarding their incorporation into the study. All the included articles were then reviewed to extract the key components relevant to the aim of the study.

## Result

Fifteen articles were identified using the aforesaid search strategy. 10 of these 15 articles were excluded and only the remaining 5 were added to the study. Of the excluded articles, 6 were not addressing the role of AI in the diagnosis of PIVD but rather were related to either IVD degeneration or any other disc-related diseases;[12][13][14][15][16][17] 1 was related to the role of AI-based analysis of CT images as an outcome measure following treatment;[18] and the other 3 were excluded due to the unavailability of the full text.[19][20][21]

Out of the included 5 articles, 4 articles deals with the interaction of AI with the MRI findings to arrive at a conclusive diagnosis of PIVD;[22][23][24][25] and the other 1 investigates the AI-based diagnosis of PIVD using foot-force.[26] The findings of these articles are summarized in Table 1.

**Table 1: Summary table of the articles**

| Author                | Year | AI method                          | Aim                                                         | Outcomes                           | Results                       |
|-----------------------|------|------------------------------------|-------------------------------------------------------------|------------------------------------|-------------------------------|
| Mumtaz et al.<br>[22] | 2022 | Convolutional<br>Neural<br>Network | Detect the lumbar<br>herniated disc in lumbar<br>spine MRI. | Diagnosis of<br>disc<br>herniation | Accuracy = 95.38% -<br>96.86% |

|                            |      |                                           |                                                                                                                                                                 |                                        |                  |
|----------------------------|------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------|
| Tsai et al. [23]           | 2021 | Deep learning                             | Automatic detection to assist the initial lumbar disc herniation exam for lower back pain on MRI.                                                               | Auto-detection of disc herniation      | Accuracy = 81.1% |
| Pan et al. [24]            | 2021 | Region-based Convolutional Neural Network | Present an automatic system for diagnosing disc bulge and herniation that saves time and can effectively and significantly reduce the workload of radiologists. | Diagnosis of disc bulge and herniation | Accuracy = 88.8% |
| Sundarsingh & Kesavan [25] | 2019 | Machine learning (Random forest)          | Multiclass classification of IVD abnormality, that is, normal, disc bulge and disc desiccation.                                                                 | Classification IVD abnormality.        | Accuracy = 94.7% |
| Šušteršič et al. [26]      | 2020 | Machine learning (Decision tree)          | Investigate the best methodology for disc hernia diagnosis using foot force measurements from the designed platform.                                            | Diagnosis of disc herniation           | Accuracy = 85%   |

The utilization of AI in PIVD can be split into either computer vision or computer-aided diagnosis. With respect to the PIVD, their application may be concerned with either segmentation, feature extraction, or classification incorporating any of the AI branches.[27] The included articles embraced the branches of artificial intelligence such as machine learning,[25][26] deep learning,[23] or neural networking [22][24] fulfilling one of the above-mentioned utilization.

MRI being the gold standard for the diagnosis of PIVD, the majority of the included studies used MRI imaging. Mumtaz et al. [22] evaluated the MRI data from 87 patients using sequential and parallel convolutional neural networks (CNN) to arrive at a diagnosis by classifying the obtained data into the normal or herniated disc in the lumbar spine MRI. It showed a higher test accuracy of 96.86% and 95.38% for sequential and parallel models respectively. Pan et al. [24] on the other hand trained a faster region-based CNN (R-CNN) to automatically diagnose and classify disc bulging and herniation with the use of axial lumbar MRI images from 500 subjects, involving 5 steps. It had a mean accuracy of 88.8% over the five lumbar IVDs for classifying them into the normal disc, herniated disc, or disc bulge, following IVD localization and identification. But the use of this model could be fundamentally compromised or limited by the quality of the images.

Contrary to that YOLO v3 model was employed to train and detect changes in small objects as in lumbar disc herniation on MRI images of 168 subjects using the deep learning method

by Tsai et al. [23] It achieved 81.1% accuracy following data augmentation, preventing under- and over-fitting in the object detection model. The use of an older version of the YOLO model, even with the presence of the newer version with betterment in the data augmentation was its limitation.

Lastly, Sundarsingh & Kesavan [25] proposed forward the use of the Histogram of Oriented Gradients (HOG) for shape feature extraction and the Local Sub-Rhombus Binary Relation Pattern (LS-RBRP) techniques for texture feature extraction from MRI images of 63 subjects to discriminate between healthy, bulging and desiccated discs with random forest (RF) classifier. They achieved an average of 87% for HOG and 90.2% for LS-RBRP with RF classifier separately as compared to the 94.7% accuracy for combined HOG and LS-RBRP with RF classifier.

One additional study diagnosed disc herniation of PIVD without using MRI imaging. Šušteršič et al. [26] investigated the best methodology for the diagnosis of disc herniation by using force sensors embedded in designed platforms for the measurement of foot force. They used the feature extraction method to diagnose the type of disc herniation in 33 patients. Among the entire tested machine learning models, two algorithms decision tree and Naïve Bayes achieved the best accuracy of 85% depending on the normalization method. The use of a primitive foot platform in this study resulted in some measurement errors that could not be avoided and thus can be considered as its greatest limitation.

## Discussion

The incidence of PIVD is very common among people between the 3<sup>rd</sup> and 5<sup>th</sup> decades. It is one of the most familiar musculoskeletal conditions that physiotherapists encounter in their clinical practice with an annual prevalence of 5 to 20 per 1000 individuals, primarily more seen in males as compared to females [28]. With the increase in the acceptance of a more sedentary lifestyle, smoking, and obesity, superimposed by the use of incorrect posture and lifting techniques its incidence is increasing day by day, especially in the younger age group.

Being a painful and disabling condition with its presentation varying from moderate to severe low back pain to muscle weakness, sensory impairment and deformity associated with the severity of the condition, make it a matter of worry. Early diagnosis followed by the suggestion of the most effective treatment for the condition at present may help in avoiding the incapacitating effect of the condition. This shows the importance of a genuine and correct diagnosis.

Even with the availability of investigatory findings to the like of MRI that is most extensively used, with moderate to high specificity and sensitivity towards the diagnosis of PIVD ranging from 55 to 100% and 64 to 93% respectively coming to a definite diagnosis is still a demanding job and are subject to errors. Investigatory imaging is often exposed to diagnostic error because of its dependency on the human skill, may it be imaging skills or the image evaluation skill. Such errors are not only confined to the MRI but are also applicable to CT scans and myelography.

AI may help in minimizing these human errors associated with the conventional method of diagnosing PIVD through the MRI, CT scan, and myelography; and in reaching a conclusive diagnosis within the least time. It may also assist in summarising multiple measurement scales data, and different imaging data, to fully interpret and plan out individualised treatment approaches, which often become difficult for the healthcare professional to carry out.

AI is the state of art and with recent advancements; it has revolutionized research as well as clinical practice by developing automated systems that have repeatedly executed the tasks critical to the diagnosis of disease conditions with greater accuracy of which PIVD has not been spared. The development of tools, such as computer-aided diagnosis systems, especially the classification algorithm has supported the process of diagnosing and classifying lumbar disc herniation into predetermined classes by assigning a numerical value to the input samples. Most of the articles included in the study used different CAD models to execute the function of classification, whose accuracy was more over on the higher side.[22][23][24][26] They are thus supporting the idea of using AI for the diagnosis of PIVD or disc herniation.

Not only those developed AI tools have executed the task of diagnosing PIVD, but they have also trained themselves at a higher accuracy to incorporate the function of repeatability in executing the diagnosis with high reliability.[24] Most of the articles included, have shown moderate to high train accuracy also. This indicates the function of AI in acquiring knowledge related to the assigned task and the available scope for betterment in its execution with the development of adroitness.

Lumbar MRI imaging has been the main source of input as a sample in 4 out of 5 studies. In all of those studies, the investigated AI models were able to diagnose disc herniation or disc bulge based on the intensity of the IVD in sagittal or axial T2- weighted MRI images with accuracy ranging from 81.1% - 96.86%. One of the articles has proposed a different model,

where the authors have used foot force measurement instead of MRI, but that have also demonstrated moderate accuracy with the decision tree algorithm.

Even though the above-stated studies have shown exceptional accuracy in the diagnosis of PIVD, the authors have not considered the cost-effectiveness of the used techniques. From an economical point of view, the use of AI in either accessing the MRI or the force platform is not protecting the patient's pocket from spending highly valued imaging and other related tests. Moreover, these techniques are still dependent on skilled humans to carry out the diagnosis of the condition such as radiologists, physicians or physiotherapists. The patients won't be able to execute it by themselves. Lastly, irrespective of the established utility of those investigatory findings, sometimes they fail to explain the presence of abnormal findings in those investigations, even without any complaint of signs and symptoms from the patient's end. Future studies concentrated on developing an AI system based on a more cost-effective diagnostic method, that can be executed by the patients themselves can be developed. One such can be based on the clinical findings instead of any investigatory finding.

## **Conclusion**

AI is undoubtedly revolutionizing the healthcare sector. In this study, we have reviewed the available literature on the use of AI in supporting the process of diagnosis in patients affected by PIVD. AI has been shown to have a high accuracy in the diagnosis of PIVD as demonstrated by all the included studies. The commonly used models of AI include feature extraction, deep learning, classification, etc. under the branches of AI like computer-aided diagnosis and computer vision. From this viewpoint, the study concludes that the use of AI may effectively improvise the diagnosis process in patients affected by PIVD.

## References

1. Kim EE. Artificial Intelligence and Computer-aided Diagnosis in Medicine. *Current Medical Imaging*. 2020 Jan 1; 16(1):1-1.
2. Ruffle JK, Farmer AD, Aziz Q. Artificial intelligence-assisted gastroenterology—promises and pitfalls. *Official journal of the American College of Gastroenterology| ACG*. 2019 Mar 1; 114(3):422-8.
3. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJ. Artificial intelligence in radiology. *Nature Reviews Cancer*. 2018 Aug;18(8):500-10.
4. Chan HP, Hadjiiski LM, Samala RK. Computer-aided diagnosis in the era of deep learning. *Medical physics*. 2020 May; 47(5):e218-27.
5. Waxenbaum JA, Reddy V, Futterman B. Anatomy, Back, Intervertebral Discs. In: *StatPearls*. StatPearls Publishing, Treasure Island (FL); 2022. PMID: 29262063.
6. Fardon DF. Nomenclature and classification of lumbar disc pathology. *Spine*. 2001 Mar 1; 26(5):461-2.
7. Demirel A, Yorubulut M, Ergun N. Regression of lumbar disc herniation by physiotherapy. Does non-surgical spinal decompression therapy make a difference? Double-blind randomized controlled trial. *J Back Musculoskelet Rehabil*. 2017; 30:1015–22.
8. Schroeder GD, Guyre CA, Vaccaro AR. The epidemiology and pathophysiology of lumbar disc herniations. *Semin Spine Surg*. 2016; 28:2–7.
9. Amin RM, Andrade NS, Neuman BJ. Lumbar Disc Herniation. *Curr Rev Musculoskelet Med*. 2017 Dec; 10(4):507-516.
10. Singla S, Sharma R, Sharma R, Singh A, Dhillon AS, Satti SK. Comparison between clinical finding and magnetic resonance imaging finding of lumbar prolapsed intervertebral disc. *Int. J. Orthop. Sci*. 2020; 6(4):670-4.
11. Buirski G, Silberstein M. The symptomatic lumbar disc in patients with low-back pain. Magnetic resonance imaging appearances in both a symptomatic and control population. *Spine*. 1993 Oct 1; 18(13):1808-11.
12. Gao F, Liu S, Zhang X, Wang X, Zhang J. Automated Grading of Lumbar Disc Degeneration Using a Push-Pull Regularization Network Based on MRI. *Journal of Magnetic Resonance Imaging*. 2021 Mar; 53(3):799-806.
13. Lewandrowski KU, Muraleedharan N, Eddy SA, Sobti V, Reece BD, ramírez León JF, Shah S. Feasibility of deep learning algorithms for reporting in routine spine magnetic resonance imaging. *International Journal of Spine Surgery*. 2020 Dec 1; 14(s3):S86-97.

14. Beulah A, Sharmila TS, Pramod VK. Degenerative disc disease diagnosis from lumbar MR images using hybrid features. *The Visual Computer*. 2022 Aug; 38(8):2771-83.
15. Niemeyer F, Galbusera F, Tao Y, Kienle A, Beer M, Wilke HJ. A deep learning model for the accurate and reliable classification of disc degeneration based on MRI data. *Investigative Radiology*. 2021 Feb 1; 56(2):78-85.
16. Sneath RJ, Khan A, Hutchinson C. An Objective Assessment of Lumbar Spine Degeneration/Ageing Seen on MRI Using An Ensemble Method—A Novel Approach to Lumbar MRI Reporting. *Spine*. 2022 Mar 1; 47(5):E187-95.
17. Natalia F, Meidia H, Afriliana N, Young JC, Yunus RE, Al-Jumaily M, Al-Kafri A, Sudirman S. Automated measurement of anteroposterior diameter and foraminal widths in MRI images for lumbar spinal stenosis diagnosis. *PLoS One*. 2020 Nov 2; 15(11):e0241309.
18. Salehi E, Yousefi H, Rashidi H, Ghanaati H. Automatic Diagnosis of Disc Herniation in Two-Dimensional MR Images with Combination of Distinct Features Using Machine Learning Methods. In 2019 Scientific Meeting on Electrical-Electronics & Biomedical Engineering and Computer Science (EBBT) 2019 Apr 24 (pp. 1-6). IEEE.
19. Fan X, Qiao X, Wang Z, Jiang L, Liu Y, Sun Q. Artificial Intelligence-Based CT Imaging on Diagnosis of Patients with Lumbar Disc Herniation by Scalpel Treatment. *Computational Intelligence and Neuroscience*. 2022 May 27; 2022.
20. Ranković V, Milanković I, Peulić M, Filipović N, Peulić A. A fuzzy model for supporting the diagnosis of lumbar disc herniation. In 2015 IEEE 15th International Conference on Bioinformatics and Bioengineering (BIBE) 2015 Nov 2 (pp. 1-5). IEEE.
21. Jamaludin A, Lootus M, Kadir T, Zisserman A, Urban J, Battié MC, Fairbank J, McCall I, Genodisc Consortium. ISSLS PRIZE IN BIOENGINEERING SCIENCE 2017: Automation of reading of radiological features from magnetic resonance images (MRIs) of the lumbar spine without human intervention is comparable with an expert radiologist. *European spine journal*. 2017 May; 26:1374-83.
22. Mumtaz M, Ahmad M, Baig MR, Haq NU. Sequential and Parallel CNN Structures for the Classification of Lumbar Herniated Disc in MRI.
23. Tsai JY, Hung IY, Guo YL, Jan YK, Lin CY, Shih TT, Chen BB, Lung CW. Lumbar disc herniation automatic detection in magnetic resonance imaging based on deep learning. *Frontiers in Bioengineering and Biotechnology*. 2021 Aug 19; 9:708137.
24. Pan Q, Zhang K, He L, Dong Z, Zhang L, Wu X, Wu Y, Gao Y. Automatically diagnosing disk bulge and disk herniation with lumbar magnetic resonance images by using deep convolutional

- neural networks: method development study. JMIR medical informatics. 2021 May 21; 9(5):e14755.
25. Sundarsingh S, Kesavan R. Diagnosis of disc bulge and disc desiccation in lumbar MRI using concatenated shape and texture features with random forest classifier. International Journal of Imaging Systems and Technology. 2020 Jun; 30(2):340-7.
  26. Šušteršič T, Milovanović V, Ranković V, Filipović N. A comparison of classifiers in biomedical signal processing as a decision support system in disc hernia diagnosis. Computers in Biology and Medicine. 2020 Oct 1; 125:103978.
  27. D'Antoni F, Russo F, Ambrosio L, Vollero L, Vadalà G, Merone M, Papalia R, Denaro V. Artificial intelligence and computer vision in low back pain: a systematic review. International Journal of Environmental Research and Public Health. 2021 Oct 17; 18(20):10909.
  28. Dydyk AM, Ngnitewe Massa R, Mesfin FB. Disc Herniation. In: StatPearls. StatPearls Publishing, Treasure Island (FL); 2022. PMID: 28722852.

**Chapter: 4****Perspectives of patients having Diabetes Peripheral Neuropathy about Physiotherapy intervention: A Literature Review****Rittu Sharma<sup>1</sup> and Prof. (Dr.) Manu Goyal<sup>2</sup>**<sup>1</sup>Ph.D. Scholar, Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana<sup>2</sup>Professor, Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana**Abstract**

**Background:** 70% of diabetic population experience mild to severe damage to nervous system leading to Diabetic Peripheral Neuropathy (DPN), defined as the presence of symptoms or signs of peripheral nerve dysfunction after exclusion of other causes.

**Objectives:** To review patient perspectives about Physiotherapy interventions for the management of DPN.

**Methods:** PubMed/Medline, Scopus, Google Scholar were searched to gather recent published qualitative literature stating patient perspectives of Physiotherapy interventions for the management of DPN.

**Discussion & Conclusion:** Physiotherapy interventions can be the more potentiate intervention for the management of DPN. Facilitators and barriers were identified: Facilitators are Family support, Emphasis by nurses and patient's knowledge about reduction in weight & blood sugar, and awareness of complications, and Barriers like social issues, lack of perception of obesity as a health issue, inability to link exercise with blood sugar control and lack of infrastructure. By knowing patients perspectives about facilitators and barriers in the management of DPN help in the treatment of DPN individuals to get more beneficial results and help in future implementation in clinical practice for better and fast recovery by focusing on barriers of the DPN.

**Keywords:** Diabetic Peripheral Neuropathy, Type 2 Diabetes Mellitus, Physiotherapy, Intervention.

**Introduction**

A common non-communicable disease called diabetes mellitus is thought to impact 65.1 million people in India alone. In the modern world, diabetes and its complications are now a leading cause of mortality and morbidity. The American Diabetes Association (ADA) recommends treating people with diabetes with food, exercise, and medications in order to achieve a glycated haemoglobin (HbA1c) of 7% or below in order to prevent long-term problems.<sup>1</sup>

Self-management includes physical activity and all of its various forms of exercise, including aerobics, strengthening, stretching, and balance drills. By having a good impact on glycaemic management, physical activity with a focus on aerobic activities has been proven to help prevent or delay the onset of type II diabetes long-term consequences. Evidence indicates that those with diabetes tend to be less physically active and less active overall than those without diabetes. Exercise lowers cardiovascular risk, enhances glycemic management and insulin action, aids in weight loss, and promotes overall wellbeing. In a systematic review and meta-analysis of clinical trials lasting 8 weeks that examined the benefits of structured exercise programmes, it was shown that the exercise group's post-intervention HbA1c was considerably lower.<sup>1,2,3,4,5</sup>

According to the ADA's recommendations, adults with diabetes should be encouraged to engage in weight training exercises and at least 150 mins/week of moderate-intensity aerobic physical activity (50%-70% of max. HR), expanded over at least 3 days per week with no more than 2 days without exercise. Despite this, it has been found that the majority of diabetics neglect to fit exercise into their daily routines. So, this literature review aimed to know about the perspectives about Physiotherapy interventions for the management of DPN, and their facilitators and barriers during performing exercise.<sup>6,7,8</sup>

## **Methods**

### **Databases**

A systematic literature search was undertaken on March 2023 in order to evaluate the perspectives of patients having Diabetic Peripheral Neuropathy about Physiotherapy interventions. The electronic databases investigated were, Google Scholar, PubMed and Scopus, covering the period from 2017 to 2023 respectively.

**Search Strategy**

The PICO search strategy was adopted for the study, where participant (P) was defined by Diabetic Peripheral Neuropathy (DPN); intervention (I) by Physiotherapy interventions; and diagnosis as the outcome (O). Control (C) was not relevant from the study's point of view. The strategy was adapted and modified to each databases. Keywords used were Diabetic Peripheral Neuropathy, qualitative study, Physiotherapy interventions, Exercise, Physical activity and related terms. MeSH (Medical Subject Headings) terms, alike keywords, along with Boolean operators such as 'OR' and 'AND' using advanced search options were included.

**Inclusion Criteria**

All the qualitative studies explicitly explaining the perspectives of Diabetic Peripheral Neuropathy patients about Physiotherapy interventions were included. All types of qualitative manuscripts identified through the databases search were included in this literature review on condition that the full version of original articles was available in English.

**Procedure**

The initial search was confined to the search of keywords within the title and abstract. Full article was retrieved based on the inclusion criteria. Abstracts and the titles were kept track of by two of the authors. A total of 6 articles were added in this literature review.

## Results

Eleven articles were identified by using the search strategy. 5 articles were excluded out of eleven and only the remaining 6 were included in this review. Those 5 articles were not addressing the perspectives of physiotherapy interventions.

| Sr. no. | Authors                       | Title                                                                                                                          | Objectives                                                                                                                                                                                                     | Results                                                                                                                                                                                                                                                                                    | Conclusion                                                                                                                                                                                                                                                                            |
|---------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.      | Advika T.S et al <sup>1</sup> | Exercise in patients with Type 2 diabetes: Facilitators and barriers – A qualitative study                                     | To explore the views of diabetic patients regarding the practice of exercise as a part of their diabetes self-care                                                                                             | Themes and sub-themes were summarized in figure 1 from transcripts of 13 patients                                                                                                                                                                                                          | The identified barriers and facilitators should serve as a framework for improving knowledge about and adherence to exercise of diabetic patients. The diabetic educators need to be trained appropriately to identify and tackle each patient's exercise habits at a personal level. |
| 2.      | Che S et al <sup>9</sup>      | Perceptions of exercise and exercise instruction in patients with type 2 diabetes mellitus and sarcopenia: A qualitative study | To explore the following issues to help healthcare professionals develop appropriate exercise models for their patients: (1) the perceptions, attitudes, exercise routines and reasons for exercise in Chinese | Four themes and 12 subthemes were identified from the 16 patients transcripts regarding the experiences of patients with T2DM and sarcopenia: theme (1) knowledge-attitudes-practices regarding exercise; theme (2) motivators for exercise; theme (3) barriers to exercise; and theme (4) | Exercise is a simple and effective intervention helping to stabilize blood glucose and improve muscle strength. More attention and comprehensive support are needed from healthcare professionals to develop individualized exercise programmes that address barriers to              |

|           |                              |                                                                                                                                                                      |                                                                                                                                                                                                       |                                                                                                                                                                                                                                |
|-----------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |                              | patients with T2DM and sarcopenia; (2) the motivators and barriers to exercise in these patients and their expectations regarding professional exercise instruction. | attitudes towards professional exercise instruction.                                                                                                                                                  | exercise and strengthen the motivators to increase compliance with exercise and maintain physical function.                                                                                                                    |
| <b>3.</b> | Stokes T et al <sup>10</sup> | Implementation of the Diabetes Community Exercise and Education Programme (DCEP) for the management of type 2 diabetes: qualitative process evaluation               | To examine the context-specific delivery factors, facilitators and barriers to implementation of the DCEP using the Reach, Effectiveness, Adoption, Implementation and Maintenance (RE-AIM) framework | 17 individuals with type 2 diabetes were interviewed and 5 domains were identified i.e Individual, inner setting, Outer setting, Characteristics of individuals.                                                               |
| <b>4.</b> | Lepesis V et al <sup>2</sup> | Experiences of foot and ankle mobilisations combined with home stretches in people with diabetes: a                                                                  | To explore the experiences of the study participants to understand how the participants experienced the intervention to inform a full-                                                                | Themes highlighted positive influences by physiotherapists, the motivation of doing exercises while participating in a study, improving the perceived range of motion in their foot and ankle and reducing discomfort in these |

|           |                                   | qualitative study<br>embedded in a proof-<br>of-concept<br>randomised<br>controlled trial                 | scale RCT.                                                                                                                                                                    | others to do the exercises; 2)<br>psychological<br>factors to motivate exercise<br>adherence; 2) physical factors<br>contributing to exercise<br>adherence; 4) acceptability of<br>home exercises during and<br>beyond the study. Other themes<br>described barriers: 5) social<br>factors that contributed to<br>exercise disengagement; 6)<br>emotional limitations that<br>influence exercise avoidance; 7)<br>physical circumstances that made<br>exercise participation<br>burdensome. | joints whilst being more active with daily<br>activities.                                                                                                                                                                                                                         |
|-----------|-----------------------------------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>5.</b> | Nielsen SG et<br>al <sup>11</sup> | Transforming<br>Motivation for<br>Exercise in a Safe<br>and Kind<br>Environment—A<br>Qualitative Study of | Aimed to gain insights into<br>needs, barriers,<br>and motivation based on<br>experiences with exercise<br>participation among<br>individuals with<br>complications to T2D to | Four themes were generated from<br>30 participants: People like us,<br>Getting started with exercise,<br>Game changers, and Moving<br>forward.                                                                                                                                                                                                                                                                                                                                              | The overarching theme, "The<br>transformation of motivation when<br>exercising in a safe and kind environment,"<br>unites the themes and illustrates how<br>motivation can change from being<br>externally motivated and filled with<br>insecurities to becoming internalised and |

|    |                              |                                                                                                                                   |                                                                                                                                                                                                       |                                                                              |                                                                                                                                                                                                                                                                                                                                           |
|----|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                              | Experiences among Individuals with Type 2 Diabetes                                                                                | adjust and develop new types of tailored and supervised exercise classes in specialized care at three hospitals in Denmark.                                                                           |                                                                              | self-assured, which is similar to the development of physical literacy. The study did highlight a significant downside, however, as participants expressed fear about continuing to exercise on their own following the intervention, highlighting the need for professional and social assistance.                                       |
| 6. | Cartagena et al <sup>8</sup> | Successful Practices in Performing and Maintaining Physical Activity in Adults with Type 2 Diabetes Mellitus: A Qualitative Study | To thoroughly explore how this change in habit in the performance of PA occurs in adults with DM2 in a community environment, as well as identify how the motivation for performing PA is maintained. | 2 themes and 5 subthemes were identified from the transcripts of 10 patients | A good adherence to physical activity was achieved thanks to motivation maintained over time related to autonomous motivation and the psychological and physiological benefits that physical activity provides patients, external support and encouragement, and the allocation of time to adhere without making great lifestyle changes. |

Abbreviations: T2DM: Type 2 diabetes mellitus, DCEP: Diabetes Community Exercise and Education Programme, RCT: Randomized Controlled Trial, PA: Physical activity

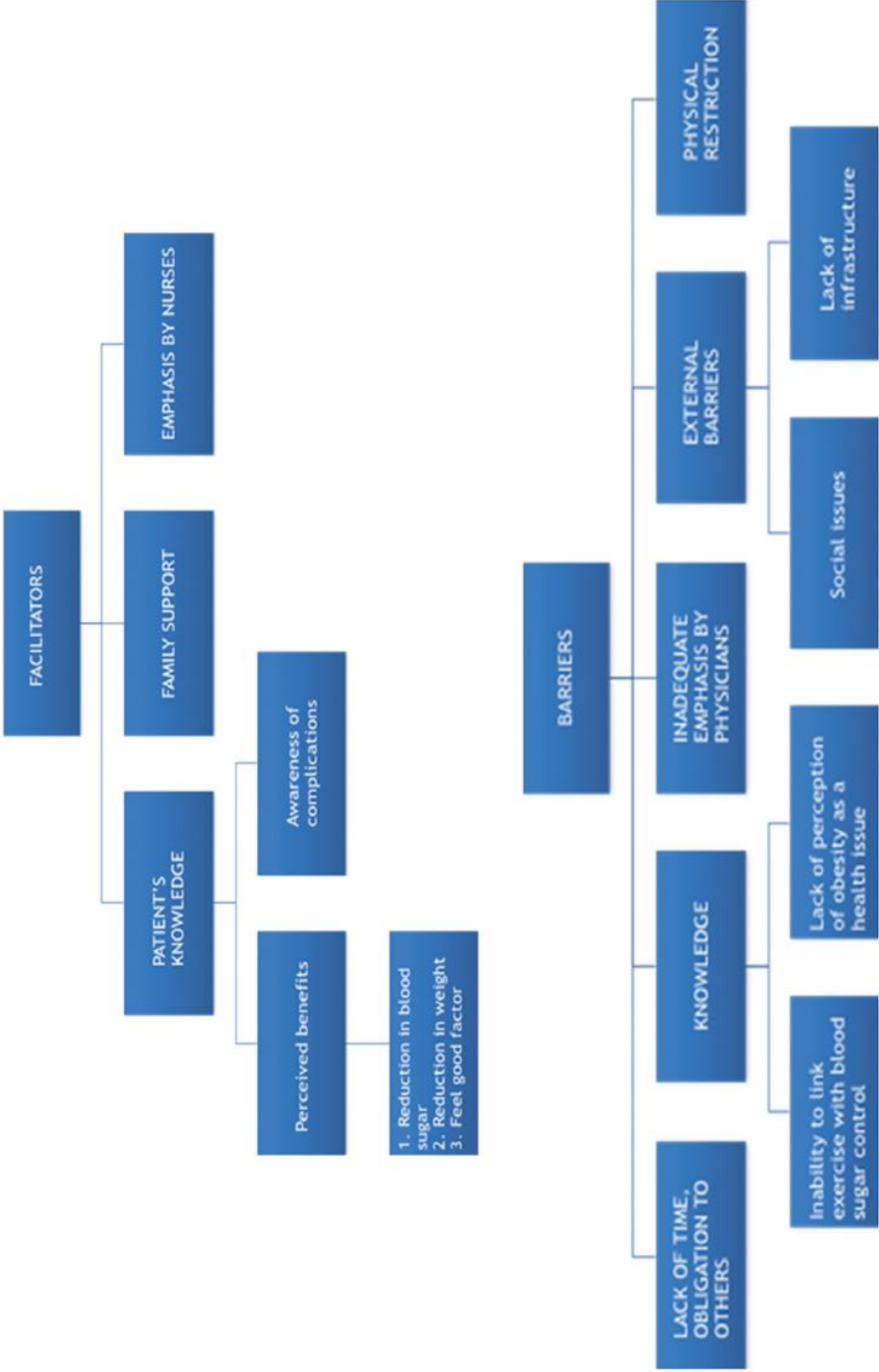


Figure 1: Facilitators and barriers to physical activity in patients with Type 2 diabetes<sup>1</sup>

## Discussion

Since last decade, there has been a pandemic of type 2 diabetes in India, which is diversified over different culture, socioeconomic classes, geography and people with varying food habits, leading different lifestyle approaches and challenges of daily living. Several factors cumulatively leading our country to become the world capital of diabetes. Diabetes mellitus (DM) type 2 itself is not a disease rather a mother disorder to other pathological conditions, that may include retinopathy, nephropathy, cardiovascular diseases, stroke, peripheral vascular disease, osteoporosis, arthritis and neuropathy.<sup>13</sup> One of the most common neurological condition, that a physiotherapist encounter in abundance is diabetic peripheral neuropathy (DPN), that can be assorted from affection of sensory nervous system to motor and autonomic nervous system. DM is estimated to affect almost 35.7 million people in India within the year of 2045, out of which 50% are prone to develop complication of DPN.<sup>14</sup>

Physiotherapy interventions always have a significant role in the management of patients with DM. It comprises a major aspect of the whole intervention protocol. Starting from the stage of prevention to the stage of precaution, from the treatment of complications to the rehabilitation following impairment, physiotherapy plays its part in all the stages. Some of these physiotherapeutic interventions may include aerobic exercises in the sub-maximal level, preventive and precautionary measure to avoid any complications by bringing changes in the lifestyle, treatment with modalities, strengthening exercises; sensory re-education, and autonomic training etc.<sup>15</sup>

With the advancement in the field of physiotherapy, backed by strong research evidence there has been different therapeutic regimen to counter DM and its every possible complication to keep them under control. But the success of any therapeutic regimen doesn't depend solely on efficacy of the regimen itself, rather it also depend on the level of adherence that patients shows to the prescribed course of action. Adherence is thus essential to the success of any therapeutic regimen. Despite therapeutic advances, many patients around the world still struggle to control their blood sugar levels to the levels they desire.

In clinical practice physiotherapist often find non-adherence attitude of patients towards the exercise and other therapeutic regimen. Such behaviour was explored in one of the included studies. The authors listed down the possible cause that may result in such type of non-adherence behaviour which he termed as various. Some of those barriers were lack of infrastructure, social issues, lack of knowledge about diabetes and its complications, etc. In

contrary to that they also put forward list of factors that may act as facilitators to promote adherence behaviour towards physiotherapeutic exercise and intervention protocol, such as family support, emphasis by nurses and patient's knowledge about reduction in blood sugar & weight, and awareness of complications.<sup>1</sup>

Advika et al in their study defined a set of psychological factors that affect patient compliance with any treatment plan for disease control by identifying perceived vulnerability, severity, benefits, and barriers among patients as components of the basic health belief model for diabetes. They identified a significant gap between health behaviour and the motivating factors influencing it. Those aforesaid studies emphasized on the need of proper addressal towards those possible barriers to the exercise regimen and subsequent tackle of each patient's habit at a individual personal level so as to strengthen the motivation and improve compliance to the therapeutic protocol. Counselling, education, empowerment and giving of standard advices regarding the duration and type of exercise by health care professionals may aid in improving knowledge regarding the benefits of exercise and promote adherence and compliance towards physiotherapeutic exercise.<sup>1,2,12</sup>

The role of motivation in the treatment of patients with type 2 DM can further be supported by the findings of Lepesis V et al who demonstrated that with positive influences and motivation for doing exercises by the physiotherapist while undergoing therapeutic interventions resulted in the improvement of perceived ankle and foot ROM and reduction in discomfort around these joints while being pro-active with daily activities.<sup>2</sup> Findings of Nielsen et al and Cartagena et al further strengthened the idea of motivation as a part of therapeutic intervention to demonstrated that motivation maintained over time along with psychological support, encouragement without making great lifestyle changes within a safe and kind environment resulted in a good adherence towards the physical activity associated with physiotherapeutic exercises.<sup>5,6</sup> Community based exercise and education program as explained by Stokes et al may assist in achieving such type of environment that further may accentuate the benefits of physiotherapeutic exercise in patient with type 2 diabetes.<sup>3</sup>

To our knowledge none of the study has ever explored the perspectives of patients with DPN towards physiotherapy interventions. So our focus was to include articles stating patients viewpoint towards physiotherapy while suffering from type 2 DM. Type 2 DM was appraised because DPN is one of its complication and type 2 DM itself is the prime source for such pathology.

Despite the inclusion of studies explaining and exploring the perspectives of patients with Type 2 diabetes towards the physiotherapeutic exercise, none of them have recognized the view point of patients with complications of DM specially DPN towards specific therapeutic interventions. Future qualitative studies exploring the perspectives of patients with DPN towards specific therapeutic regimen can be considered.

### **Conclusion**

From all the included studies it is concluded that counselling, education, empowerment and giving of standard advices regarding the duration and type of exercise by health care professionals may aid in improving knowledge regarding the benefits of exercise and promote adherence and compliance towards physiotherapeutic exercise.

## References

1. Advika TS, Idiculla J, Kumari SJ. Exercise in patients with Type 2 diabetes: Facilitators and barriers - A qualitative study. *J Family Med Prim Care*. 2017; 6(2):288-292.
2. Lepesis V, Marsden J, Paton J, Rickard A, Latour JM. Experiences of foot and ankle mobilisations combined with home stretches in people with diabetes: A qualitative study embedded in a proof-of-concept randomised controlled trial. *J Foot Ankle Res*. 2022; 15(1):7.
3. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, Nathan DM; Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002; 346(6):393-403.
4. Boulé NG, Haddad E, Kenny GP, Wells GA, Sigal RJ. Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: a meta-analysis of controlled clinical trials. *JAMA*. 2001; 286(10):1218-27.
5. Hayes C, Kriska A. Role of physical activity in diabetes management and prevention. *J Am Diet Assoc*. 2008; 108(4):S19-23.
6. Colberg SR, Sigal RJ, Yardley JE, Riddell MC, Dunstan DW, Dempsey PC, Horton ES, Castorino K, Tate DF. Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. *Diabetes Care*. 2016; 39(11):2065-2079.
7. Vilafranca Cartagena M, Tort-Nasarre G, Rubinat Arnaldo E. Barriers and Facilitators for Physical Activity in Adults with Type 2 Diabetes Mellitus: A Scoping Review. *Int J Environ Res Public Health*. 2021; 18(10):5359.
8. Vilafranca Cartagena M, Arreciado Marañón A, Artigues-Barbera E, Tort-Nasarre G. Successful Practices in Performing and Maintaining Physical Activity in Adults with Type 2 Diabetes Mellitus: A Qualitative Study. *Int J Environ Res Public Health*. 2022; 19(21):14041.
9. Che S, Meng M, Jiang Y, Ye X, Xie C. Perceptions of exercise and exercise instruction in patients with type 2 diabetes mellitus and sarcopenia: a qualitative study. *BMC Geriatr*. 2022; 22(1): 892.
10. Stokes T, Wilkinson A, Jayakaran P, Higgs C, Keen D, Mani R, Sullivan T, Gray AR, Doolan-Noble F, Mann J, Hale L. Implementation of the Diabetes Community Exercise and Education Programme (DCEP) for the management of type 2 diabetes: qualitative process evaluation. *BMJ Open*. 2022; 12(5):e059853.
11. Nielsen SG, Danielsen JH, Grønbæk HN, Molsted S, Jacobsen SS, Vilsbøll T, Varming AR. Transforming Motivation for Exercise in a Safe and Kind Environment-A Qualitative Study of Experiences among Individuals with Type 2 Diabetes. *Int J Environ Res Public Health*. 2022; 19(10):6091.
12. Beverly EA, Wray LA. The role of collective efficacy in exercise adherence: a qualitative study of spousal support and type 2 diabetes management. *Health Educ Res*. 2010; 25(2):211-23.

13. Tripathi BK, Srivastava AK. Diabetes mellitus: complications and therapeutics. *Med Sci Monit.* 2006; 12(7):RA130-47.
14. Pradeepa R, Mohan V. Epidemiology of type 2 diabetes in India. *Indian J Ophthalmol.* 2021; 69(11): 2932-2938.
15. Harris-Hayes M, Schootman M, Schootman JC, Hastings MK. The Role of Physical Therapists in Fighting the Type 2 Diabetes Epidemic. *J Orthop Sports Phys Ther.* 2020; 50(1):5-16.

**Chapter: 5**  
**The Psychological impact and coping mechanism of Covid- 19 on Staff Nurses’ - A  
retrospective study**

**Ms. Usha Mallick**  
**Associate Professor cum HOD**  
**Department of Nursing, Aliah University**  
**E-mail: umallick2008@rediffmail.com**

## **Introduction**

The healthcare system across the world has been overburdened due to the COVID-19 pandemic impacting healthcare workers (HCWs) in different ways. The present study provides an insight into the psychosocial challenges faced by the HCWs related to their work, family and personal well-being and the associated stigmas. Additionally, the coping mechanisms adopted by them and their perceptions on the interventions to address these challenges were also explored.

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus. The Covid 19 syndrome is caused by SARS CoV2.

The most common symptoms of this viral infection are fever, cold, cough, bone pain and breathing problems, and ultimately leading to pneumonia.

The best way to prevent and slow down transmission is to be well informed about the COVID-19 virus, the disease it causes and how it spreads. We all need to protect ourselves and others from infection by continuously washing hands by using an alcohol-based sanitizer frequently and not touching the face.

The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it’s also important to practice respiratory etiquette (for example, by coughing into a flexed elbow). The severity of COVID-19 symptoms is highly variable, ranging from unnoticeable to life-threatening. Severe illness is more likely in elderly COVID-19 patients, as well as those who have underlying medical conditions. COVID-19 transmits when people breathe in air contaminated by droplets and small airborne particles. The risk of breathing these in is highest when people are in close proximity, but they can be inhaled over longer distances, particularly indoors. Transmission can also occur if splashed or sprayed with contaminated fluids, in the eyes, nose or mouth,

and, rarely, via contaminated surfaces. People remain contagious for up to 20 days, and can spread the virus even if they do not develop any symptoms. By implementing travel restrictions, lockdowns and quarantines, workplace hazard controls, and business closures can only reduce the spread of infection.

The coronavirus outbreak came to light on December 31, 2019 when China informed the World Health Organisation of a cluster of cases of pneumonia of an unknown cause in Wuhan City in Hubei Province. Subsequently the disease spread to more Provinces in China, and to the rest of the world. The WHO has now declared it a pandemic. The virus has been named SARS-CoV-2 and the disease is now called COVID-19<sup>23</sup>

Recommended preventive measures include social distancing, wearing face masks in public, ventilation and air-filtering, hand washing, covering one's mouth when sneezing or coughing, disinfecting surfaces, and monitoring and self-isolation for people exposed or symptomatic. Several vaccines have been developed and widely distributed in most developed countries since December 2020.

The pandemic has resulted in severe global, social and economic disruption, including the largest global recession. It has led to wide spread supply shortages exacerbated by panic buying, agricultural disruption, and food shortages. However, it has also caused temporary decreases in emissions of pollutants and greenhouse gases. Numerous educational institutions and public areas have been partially or fully closed, and many events have been cancelled or postponed. The pandemic has raised issues of racial and geographic discrimination, health equity, wealth inequality and the balance between public health imperatives and individual rights<sup>24</sup>.

This COVID-19 has affected the sources of supply and affects the global economy. All governments, health organisations and other authorities are continuously focusing on identifying the cases affected by the COVID-19. Healthcare professional face lot of difficulties in maintaining the quality of healthcare in these days.

**Gap of Existing literature** -Though there are various research works on the psychological impacts of covid19 on health care workers and many are going on. There are many studies conducted in Abroad related to burnout and psychological impact of COVID -19 outbreaks on health care workers. But the study on assessment of psychosocial and personal impact of COVID -19 outbreak on staff nurses are very few in India as well as West Bengal. As frontline workers nurses faced a lot of challenges in management of Covid19 outbreak.

Investigator herself worked a lot with the nurses during this COVID 19 pandemic period. Investigator herself experiences many psychological and physical burden of the staff nurses while they were providing the care to the patients. So, the investigator felt the need for a study to assess the Psychosocial and personal impact of COVID -19 outbreaks on staff nurses.

Maharashtra, Gujarat and West Bengal have the maximum number of COVID positive staff nurses in the country and also the highest fatality rate, TNAI, the largest nursing association in the country, released data for the first time since the beginning of the pandemic, indicating that 509 nursing staff was infected and 20 died while providing care to COVID patients.

According to the data, West Bengal reported 111 COVID positive nurses with three fatalities; Maharashtra has 75 cases with six deaths and Gujarat 96 cases with four deaths. Mizoram, Chhattisgarh, Kerala and Uttar Pradesh has the least recorded COVID case-load among nursing staff with Rajasthan, Telangana, Uttar Pradesh registering the lowest reported fatalities.

**Research Questions:** Based on the above few points, the present study is a sincerity of the investigator to answer the following questions.

Are there any impact of Covid -19 on psychological conditions of staff nurses and their coping mechanism due to their management and experience variations?

**Title of the study:** To find out the clues/answers, the pre above mention questions the title for study is stated as mentioned below.

**“The Psychological impact and coping mechanism of Covid 19 on staff Nurses**

### **Objectives**

- To assess psychological impact of COVID 19 in anxiety depression, stress,
- To assess coping mechanism of the staff nurse in COVID 19 situation
- To find out the relationship of psychological impact with the selective demographic variables of the staff nurses.
- To find out the relationship of coping mechanism with the selective demographic variables of the staff nurses.

### **Hypothesis**

H<sub>01</sub>-There does not exist any significant relationship of psychological impact due to Covid19 of staff nurses with their demographic variables at 0.01 level of significance.

H<sub>02</sub>- There does not exist any significant relationship of mean score of coping level of staff nurses due to Covid19 with their demographic variables at 0.01 level of significance.

### Operational Definition

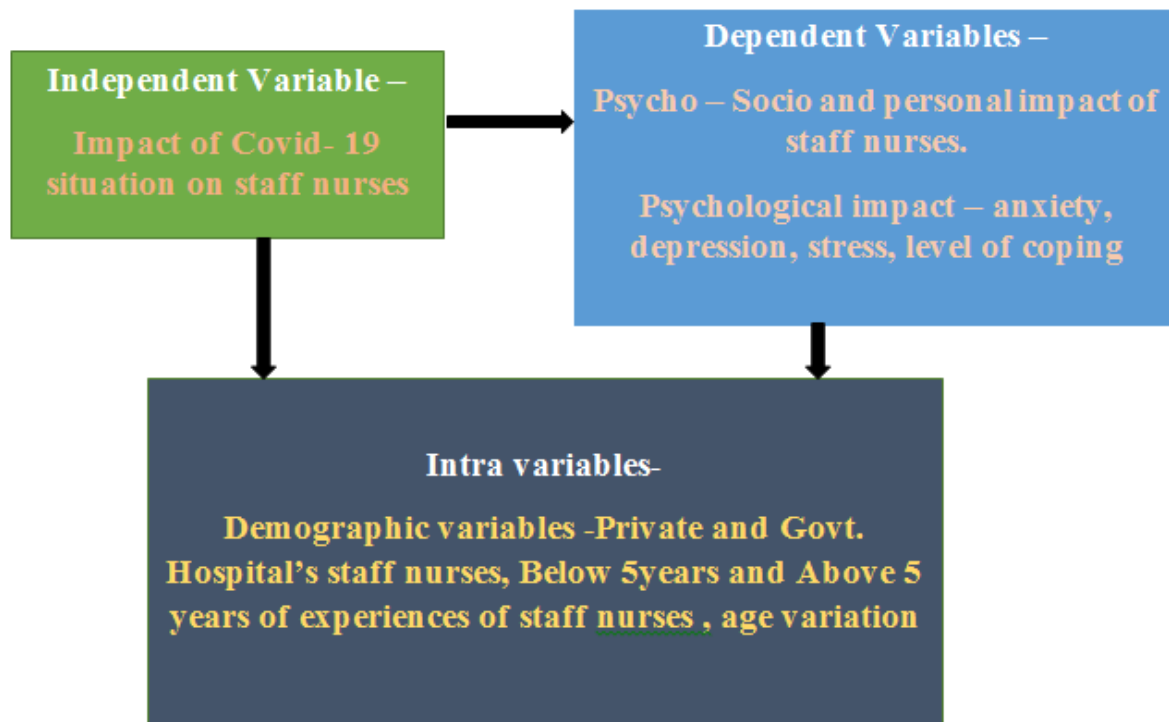
Covid19- Diseases caused by Corona Virus.

Psychological impact – In this study it's indicated anxiety, depression, stress of staff nurses as measured by DASS21 Scale

Coping Mechanism- The thoughts and behaviours mobilized to manage internal and external stressful situation as measured by Brief cope inventory

**Conceptual frame work:** The following conceptual frame work illustrates what a researcher expects to find through her research. It defines the relevant variables for her study and maps out how they might relate to each other. The following visual format represents the conceptual frame work of the following study.

The schematic representation of the conceptual frame work based on Betty Neuman system model is presented in figure 2



## Triggering factors for staff nurses

### Changes in personal life and having

#### Negative feeling:-

Fundamental changes in daily life

- Self-quarantine
- Fear of dying alone and separated From loved one
- Fear of transmitting the diseases to family members

Stressors

### Working in pandemic Era- (Covid 19)

#### Changes in personal life-

- **Workload**
- **Inadequate rest and sleep**
- **Altered nutrition**
- **Shortage of personal protective equipments**
- **Difficulty of using PPE**
- **Providing futile care**
- **Loss of control over situation**

Stressors

## Impact among staff nurses

### Psychological impact-

- > **Anxiety**
- > **Depression**
- > **stress**

### Social Impact -

Social isolation

### Personal impact-

Risk for being infected

## Relieving factors

### Coping strategies -

Family support,  
Positive thinking,  
Meditation,  
Relaxation  
Peer Group Support  
Support from Hospital

### Coping strategies -

Support from family

Members,

Support from Hospital Admin

### Coping strategies -

Adequate nutrition,  
Adequate rest and sleep,  
Adequate use of PPE,  
Completion of vaccination

## Application of Betty Newman theory model on Psycho socio and personal impact of covid- 19 on staff Nurses

**Review of Literature: -**

**Ardebili. M. E. etal<sup>1</sup>** in 2020 had done a qualitative study on Health care providers experience of working during the covid 19 pandemic in Iran where he has used a thematic analysis approach with semi-structured interviews with 97 health care professionals. Participants were health care professionals including pre-hospital emergency services (EMS), physicians, nurses, pharmacists, laboratory personnel, radiology technicians, hospital managers and managers in the ministry of health who work directly or indirectly with COVID-19 cases .Data analysis highlighted four main themes, namely: ‘Working in the pandemic era’, ‘Changes in personal life and enhanced negative affect’, ‘Gaining experience, normalization and adaptation to the pandemic’ and ‘Mental Health Considerations’ which indicated that mental ill deteriorations unfolded through a stage-wise process as the pandemic unfolded.

**Bozdag. F. etal<sup>2</sup>** in 2020 had done a study on Psychological Resilience of Healthcare Professionals during COVID-19 Pandemic - where they found that the COVID-19 pandemic as a public health issue has spread to the rest of the world. Although the wellbeing and emotional resilience of healthcare professionals are key components of continuing healthcare services during the COVID-19 pandemic, healthcare professionals have been observed in this period to experience serious psychological problems and to be at risk in terms of mental health. Therefore, this study aims to probe psychological resilience of healthcare workers. The findings of this study showed that in order to raise psychological resilience of healthcare professionals working during the COVID-19 pandemic their quality of sleep, positive emotions and life satisfaction need to be enhanced. Psychological resilience levels of healthcare workers in their later years were found to be higher. Doctors constitute the group with the lowest levels of psychological resilience among healthcare workers. The current study is considered to have contributed to the literature in this regard. Primary needs such as sleep which are determinants of quality of life, life satisfaction and psychological resilience should be met.

**Li. Q. etal<sup>3</sup>** in 2020 done a study on The Psychological Health Status of Healthcare Workers during the COVID-19 Outbreak Study in Guangdong, China. This study aimed to assess their psychological health status at the peak of COVID-19 and to identify some coping strategies.

A cross-sectional survey study was conducted during the outbreak of COVID-19. The survey was completed by 908/924 HCW (response rate 98.27%) in government-designated hospitals in Guangdong, China. A quality of life (QoL) scale, the Zung Self-Rating Anxiety Scale (SAS), and

the Zung Self-Rating Depression Scale (SDS) were used to evaluate their psychological status. Logistic regression models were used to identify the occupational factors related to anxiety or depression. A total of 221 (24.34%) respondents had varying levels of anxiety, and 299 (32.93%) of them had depression. The mean SAS (42.9) and SDS (47.8) scores of HCW indicated that they were in the normal range for both anxiety and depression. Contact with COVID-19 cases or suspected cases, worry about suffering from COVID-19, worry about their family, and dismissal during the COVID-19 period were significant work-related contributing factors to the psychological health problems of HCW (all  $p < 0.01$ ).

**Labrugae. L. J. et al<sup>4</sup>** in 2020 conducted a study on Fear of COVID-19, psychological distress, work satisfaction and turnover intention among front line nurses in China. The study was done to examine the relative influence of fear of COVID -19 on nurses' psychological distress, work satisfaction and intent to leave their organisation and profession. This was a cross sectional research design involving 261 frontline nurses in the Philippines. Five standardised scales were used for data collection. Overall, the composite score of the fear of Covid -19 scale was 19.92. Job role and attendance of COVID -19 related training predicted fear of COVID-19. An increased level of fear of COVID-19 was associated with decreased job satisfaction, increased psychological distress, and increased organisational and professional turnover intentions.

**Mathur. S. et al<sup>5</sup>** in 2020 conducted a study on Stress-related disorders in health-care workers in COVID-19 pandemic. The aim of the study was to study the impact of COVID-19 pandemic in HCWs in reference with a variety of factors. A nationwide cross-sectional online study using semi-structured pro forma along with the Adjustment Disorder New Module and the Depression, Anxiety, and Stress Scale-21 was conducted among 200 respondents. Of the 200 respondents, 174 (87%) were doctors and 26 nursing staff, with a mean age of  $42.1 \pm 12.2$  years, 62% were male, and 63% were working in the government sector. A significant number of respondents were found to be suffering from acute stress (9.5%), depression (17%), and anxiety (19.5%) which they attributed to the negative professional and personal influence of this ongoing pandemic scenario. HCWs on the front lines of this pandemic are facing compounding stressors and need robust psychiatric help to adequately take care of this need.

**Shaukat.N.et al<sup>3</sup>** 2020 conducted a study on Physical and mental health impacts of COVID-19 on healthcare workers: a scoping review. In the findings it was identified the following risk factors for COVID-19-related health impact: working in a high-risk department, diagnosed

family member, inadequate hand hygiene, suboptimal hand hygiene before and after contact with patients, improper PPE use, close contact with patients ( $\geq 12$  times/day), long daily contact hours ( $\geq 15$  h), and unprotected exposure. The most common symptoms identified amongst HCWs were fever (85%), cough (70%), and weakness (70%). Prolonged PPE usage led to cutaneous manifestations and skin damage (97%), with the nasal bridge (83%) most commonly affected site. HCWs experienced high levels of depression, anxiety, insomnia, and distress. Female HCWs and nurses were disproportionately affected.

**Chakma.T.etal<sup>20</sup> 2020** conducted a study on Psychosocial impact of COVID-19 pandemic on healthcare workers in India & their perceptions on the way forward - A qualitative study. In the findings, it was found that HCWs report major changes in work-life environment that included excessive workload with erratic timings accentuated with the extended duration of inconvenient personal protection equipment usage, periods of quarantine and long durations of separation from family. Family-related issues were manifold; the main challenge being separated from family, the challenge of caregiving, especially for females with infants and children, and fears around infecting family. Stigma from the community and peers fuelled by the fear of infection was manifested through avoidance and rejection. Coping strategies included peer, family support and the positive experiences manifested as appreciation and recognition for their contribution during the pandemic.

### **Research Methodology**

**Sources of data:** The data was collected from the staff nurses working in selected hospitals in West Bengal

**Population:** Staff nurses working in different Private and Govt hospital having at least one year experience

**Research approach:** Non Experimental quantitative survey approach

**Research design:** Descriptive survey design

**Sampling technique:** Non probability convenience sampling

**Sample size:** 300 staff nurses working in selected hospital in West Bengal.

**Setting of the study:** Study was conducted in different Private and Govt hospital in Kolkata

**Ethical Permission** – Was obtained from the competent authority

**Pilot study** – Done with 30 samples

**Time period of the study** – From August 2021 to october2022

**Criteria for selection of sample:**

**Inclusion Criteria:**

Staff nurses who are

- working in selected hospital in West Bengal
- present at the time of data collection
- willing to participate in the study
- Having at least one year of working experience

**Exclusion criteria:**

- Student nurses, teaching staff, senior nursing administrators are excluded in the study.
- Staff nurses who were very sick unable to take part in the study during the time of data collection.

**Tools for data collection:**

**Section 1:** Demographic proforma which was assessed the demographic variables of the staff nurses such as age, gender, degree, years of experience, marital status, place of residence, place of work.

**Section 2: A.** A Standardized tool (DASS 21 SCALE) was used to measure the depression, anxiety and stress level of the staff nurse due to Covid19.

DASS21 Scale is Depression, anxiety and stress scale. It was developed by Lovibond and Lovibond in 1995.

**Section 2: B.** Brief cope scale was used for measuring coping of the staff nurses. Carver.C.S 1997 Invented this scale.

**Content validity** of the tool has been obtained in consultation with guide and experts in the field of community medicine, Community Health Nursing. Psychiatry, Psychiatric Nursing, Medical Surgical nursing, Educational and Biostatistics.

**Reliability of the tool** is established by split -half and test-retest method, inter rater reliability test and by Cronbach alpha .The tool will be accepted after try out and reliability score ranges between to 0.75 to 0.95.

#### **Method of data analysis:**

Descriptive and inferential statistics was used for data analysis,

**Data collection procedure** – After taking the approval from the competent authority, Investigator has discussed about the aim of the study. Investigator has taken the consent from the staff nurses. Three tools were introduced to the staff nurses. Total 25 minutes time was given for the same. Data was collected from February 2022 to April 2022

#### **Findings of the study – For the demographic variables –**

- Majority of the staff nurses 70% (210) are belongs to female category.
- Majority of the staff nurses 65% (195) are having less than 5 years of experience.
- Majority of the staff nurses 55% (165) have completed GNM Course.
- Majority of the Staff Nurses 60% (180) are belongs urban community.
- Majority of the staff nurses 51.6% (155) are from the age group of more than 30 years.
- Majority of the staff nurses 50.6% (152) are from the Govt Hospital.

#### **DASS 21 - Depression Anxiety Stress Scale Test**

#### **Differential Analysis on Psychological Impact on Nursing Staff**

**Table 1: Categorization of the sample in their differential level on DASS 21 Scale (Depression-Psychological Impact-1)**

| Categories | Score Range | No. of sample | % of sample |
|------------|-------------|---------------|-------------|
| Normal     | 0-9         | 79            | 26.33%      |
| Mild       | 10-13       | 81            | 27%         |
| Moderate   | 14-20       | 98            | 32.67%      |
| Severe     | 21-27       | 26            | 8.67%       |

|                  |     |    |       |
|------------------|-----|----|-------|
| Extremely Severe | 28+ | 16 | 5.33% |
|------------------|-----|----|-------|

**Table 2: Categorization of the sample in their differential level on DASS21 Scale (Anxiety-Psychological Impact-1)**

| Categories       | Score Range | No. of sample | % of sample |
|------------------|-------------|---------------|-------------|
| Normal           | 0-7         | 60            | 20%         |
| Mild             | 8-9         | 89            | 29.67%      |
| Moderate         | 10-14       | 121           | 40.33%      |
| Severe           | 15-19       | 18            | 6%          |
| Extremely Severe | 20+         | 12            | 4%          |

**Table 3: Categorization of the sample in their differential level on DAS Scale (Stress-Psychological Impact-1)**

| Categories       | Score Range | No. of sample | % of sample |
|------------------|-------------|---------------|-------------|
| Normal           | 0-14        | 68            | 22.67%      |
| Mild             | 15-18       | 92            | 30.67%      |
| Moderate         | 19-25       | 103           | 34.33%      |
| Severe           | 26-33       | 23            | 7.66%       |
| Extremely Severe | 34+         | 14            | 4.67%       |

**Table 4: Categorization of the sample in their differential level on Brief-COPE Scale (Psychological Impact-2)**

| Categories       | Score Range  | No. of sample | % of sample |
|------------------|--------------|---------------|-------------|
| Excellent Coping | 57 and above | 72            | 24%         |
| Very Good coping | 29 to 56     | 162           | 54%         |
| Good coping      | 28 and Below | 66            | 22%         |

**Findings from the Brief Cope scale inventory-**

Problem focussed coping –38%

Emotional focused coping-54%

Avoidance coping- 8%

**Fig-2 Different coping mechanism in Brief Cope Inventory**

| Under problem focussed coping                                 | Under Emotional focused coping     | Under Avoidance coping-                   |
|---------------------------------------------------------------|------------------------------------|-------------------------------------------|
| Active coping- item no 2,7-18%                                | Emotional Support -item no-5,15-6% | Self-distraction -item no-1,19-4%         |
| Use of informational /instrumental support- item no-10,23-10% | Venting -item no-9,21-4%           | Substance Use-item no-4,11-NIL            |
| Positive reframing -item no-12,17-6%                          | Humour -item no-18,28-8%           | Denial -item no-3,8-2%                    |
| Planning- item no- 14,25 -4%                                  | Acceptance -item no-20,24-20%      | Behavioural disengagement-item no-6,16-2% |
|                                                               | Self-blame -item no-13,26-12%      |                                           |
|                                                               | Religion- item no-22,27-4%         |                                           |

Their scores on Psycho-Social impact were calculated for determining the significance between the means. That was adopted and the value of 't' ratio was calculated and presented in the table below:

**Table 5: Summary of test of significance of difference between the mean scores in relation to Age variation (Total Sample)**

| Age                | N   | Mean         | S. D        | SE <sub>D</sub> | 't'         | Remarks            |
|--------------------|-----|--------------|-------------|-----------------|-------------|--------------------|
| More than 30 years | 155 | <b>161.3</b> | <b>4.23</b> | <b>2.82</b>     | <b>2.31</b> | <b>Significant</b> |
| Less than 30 years | 145 | <b>160.1</b> | <b>3.14</b> |                 |             |                    |

Critical value of 't' with df (98) at 0.01=2.63 and 0.05=1.98

**Table 6: Summary of test of significance of difference between the mean scores in relation to Management variation (govt/private)- (Total Sample)**

| Type of Management | N   | Mean         | S.D        | SE <sub>D</sub> | 't'         | Remarks            |
|--------------------|-----|--------------|------------|-----------------|-------------|--------------------|
| Private            | 148 | <b>160.6</b> | <b>3.9</b> | <b>2.02</b>     | <b>3.16</b> | <b>Significant</b> |
| Government         | 152 | <b>166.2</b> | <b>6.7</b> |                 |             |                    |

Critical value of 't' with df (98) at 0.01=2.63 and 0.05=1.98

**Table 7: Summary of test of significance of difference between the mean scores in relation to Experience variation (Below 5 years/above 5 years)- (Total Sample)**

| Year of Experience | N   | Mean         | S. D        | SE <sub>D</sub> | 't'        | Remarks            |
|--------------------|-----|--------------|-------------|-----------------|------------|--------------------|
| More than 5 years  | 105 | <b>154.5</b> | <b>3.16</b> | <b>2.9</b>      | <b>2.4</b> | <b>Significant</b> |
| Less than 5 years  | 195 | <b>165.2</b> | <b>7.7</b>  |                 |            |                    |

Critical value of 't' with df (98) at 0.01=2.63 and 0.05=1.98

**Brief-COPE Scale (Psychological Impact-2)****Table 8: Summary of test of significance of difference between the mean scores in relation to Age variation**

| Age       | N   | Mean  | S. D | SE <sub>D</sub> | 't'  | Remarks |
|-----------|-----|-------|------|-----------------|------|---------|
| More than | 155 | 59.24 | 8.21 | 2.31            | 3.62 |         |

|                    |     |       |      |  |  |                    |
|--------------------|-----|-------|------|--|--|--------------------|
| 30 years           |     |       |      |  |  | <b>Significant</b> |
| Less than 30 years | 145 | 56.53 | 6.54 |  |  |                    |

Critical value of  $t'$  with df (98) at 0.01=2.63 and 0.05=1.98

**Table 9: Summary of test of significance of difference between the mean scores in relation to Management variation**

| Type of Management | N   | Mean  | S.D  | SE <sub>D</sub> | 't'   | Remarks            |
|--------------------|-----|-------|------|-----------------|-------|--------------------|
| Private            | 148 | 55.12 | 6.95 | 1.54            | 3. 12 | <b>Significant</b> |
| Government         | 152 | 57.56 | 7.67 |                 |       |                    |

Critical value of  $t'$  with df (98) at 0.01=2.63 and 0.05=1.98

**Table 10: Summary of test of significance of difference between the mean scores in relation to Experience variation**

| Year of Experience | N   | Mean  | S. D | SE <sub>D</sub> | 't'  | Remarks            |
|--------------------|-----|-------|------|-----------------|------|--------------------|
| More than 5 years  | 105 | 55.17 | 6.65 | 0.54            | 5.41 | <b>Significant</b> |
| Less than 5 years  | 195 | 58.12 | 7.39 |                 |      |                    |

Critical value of  $t'$  with df (98) at 0.01=2.63 and 0.05=1.98

**Discussion:** This descriptive study was conducted to explore exclusively front line nurses' perceptions about the psychological impacts of treating hospitalized people with COVID-19. The main psychological impacts of caring for people with COVID-19 perceived by nurses working on the front line were fear, anxiety, stress, social isolation, depressive symptoms, uncertainty, and frustration. The fear of infecting family members or being infected was the main repercussion perceived by the nurses. A different study revealed the sleep disorder of the nurses happened due to pandemic. In a recent systematic review and meta-analysis of 53 studies involving 38,189 nurses, Al Maqbali, Al Sinani, and Al-Lenjawi (2020a) found the prevalence of

stress, anxiety, depression and sleep disturbance to be 38.9, 37, 37.2 and 38.2%, respectively, during the COVID-19 outbreak.

**Conclusion:** The results of the study show that the main psychological impacts of caring for people with COVID-19 manifested by the nurses were anxiety, depression stress, and depressive. The fear of infecting family members or being infected was the main impact perceived by the nurses. As the pandemic progresses, fear prevails over stress, which was the main psychological impact in the initial phases of the pandemic. Moreover, other negative impacts that nurses suffer as the COVID-19 pandemic progress were anger, obsessive thoughts, compulsivity, introversion, apprehension. All participants reported that they could cope with the challenges they faced because of the support from their immediate family members and friends having another family member also engaged in COVID duty was a strong motivational force to deal with these tough times.

**Reference:**

1. Ardebili. M.E. et al Health care providers experience of working during the COVID -19 pandemic- A cross sectional study, AJIC published: October 05, 2020. <https://doi.org/10.1016/j.ajic.2020.10.001>
2. Bozdag. F. et al Psychological Resilience of Healthcare Professionals during COVID-19 Pandemic, SAGE journals. October13, 2020. <http://doi.org/10.1177/00332941209654773>.
3. Li. Q. et al The Psychological Health Status of Healthcare Workers During the COVID-19 Outbreak: A Cross-Sectional Survey Study in Guangdong, China, *Frontiers in Public Health*,18 September 2020.<http://www.frontiersin.org>fpubh.2020.562885>full>
4. Labrague. L. J. et al Fear of COVID-19, psychological distress, work satisfaction and turnover intention among nurses, *History current status: posted, Version 1, posted 16 June, 2020*, <https://doi.org/10.21203/rs.3.rs-35366/v1>
5. Mathur. S. et al. Stress related disorders in health care workers in Covid-19 Pandemic – A cross sectional study from India, *Indian Journal of Medical Specialist*, Volume :11, Issue :4 page:180-184, year :2020. <http://www.ijms.in/text.asp?2020/11/4/180/302078>
6. Ali. S. et al,psychological impact of the COVID-19 pandemic on healthcare workers at acute hospital settings in the South-East of Ireland: an observational cohort multicentre study, *BMJ Open*, Volume 10, Issue 12, 2020. <http://dx.doi.org/10.1136/bmjopen-2020-042930>
7. Tan. B. Y. Q. et al Psychological Impact of the COVID-19 Pandemic on Health Care Workers in Singapore, *ACP Journals, Annals of Internal Medicine*, 18 August, 2020. doi: 10.7326/M20-1083.
8. Que.J.et al Psychological impact of the COVID-19 pandemic on healthcare workers: a cross-sectional study in China, *General Psychiatr*, vol.33(3); 2020 >PMC7299004,<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7299004>
9. Chatterjee. S. S. et al. Stress, Sleep and Psychological Impact in Healthcare Workers During the Early Phase of COVID-19 in India: A Factor Analysis. *Fron. Psychol.*,25February, 2021 <https://doi.org/10.3389/fpsyg.2021.611314>
10. Nobles. J.et al. The potential impact of COVID-19 on mental health outcomes and the implications for service solutions, NIHR, *Applied Research Collaboration West*, 15 April<http://arc-w.nihr.ac.uk>covid-response>rapid-reports>. *Indian J Med Res*. 2021 May-Jun; 153(5-6): 637–648

**Chapter: 6****Detection of pathogen *Candidatus Liberibacter asiaticus* (CLas) causing Citrus Greening Disease by gene primer method****Ishu Priya<sup>1</sup>, Mohammad I. Ali<sup>2</sup> and Rashmi Saini<sup>3\*</sup>****<sup>1</sup>Research Scholar, Department of Life Sciences, Mandsaur University,  
Mandsaur, MP, India****<sup>2</sup>Associate Professor, Faculty of Life Sciences, Mandsaur University  
Mandsaur, MP, India****<sup>3</sup>Assistant Professor, Department of Zoology, Gargi College  
University of Delhi, Delhi, India****\*E-mail: dr.rashmisaini@gmail.com**

**Abstract:** Citrus is a major horticultural crop and is commercially grown worldwide. *Candidatus liberibacter asiaticus* (CLas) is most widely found phloem-restricted gram-negative bacterium found in citrus crops causing citrus greening disease in India. In this study, a set of polymerase chain reaction (PCR) primer pairs were screened to diagnose CLas, and this method enhanced the sensitivity to detect CLas up to 10 times and 100 times compared to conventional PCR primers. In total, 120 samples from 25 different citrus cultivars in 4 different cities were assayed. The results showed that 25 samples were HLB-infected; the highest positive detection rate was 70% from the Indian Agricultural Research Institute (IARI, Delhi), and the lowest positive detection rate was 10% from Haryana. The results indicated that the designed PCR primer pairs can detect CLas from different citrus cultivars and different geographic regions. The primers designed in the present study provide a very useful supplement to the current approaches for CLas detection. The *nrdB*L2F1/R1 primer sequences correspond for detection of the multicopy *nrdB* gene, which encodes the  $\beta$ -subunit of ribonucleotide reductase (RNR), a critical enzyme involving bacterial proliferation. Three *nrdB* copies were in long form (*nrdB*L, 1,059 bp), and two were in short form (*nrdB*S, 378 bp). Detection of CLas is very challenging because of its low concentration and irregular distribution in its citrus host. A lot of researchers tried to develop assays based on PCR, but the *nrdB* gene detection would provide a significant, rapid, and sensitive method to detect the pathogen early in the vector or the citrus plants. This will help in controlling the spread of the disease in non-infected plants, and thus prevent citrus crop loss. The

present study provides means to detect pathogen in early stages and subsequently stop further dissemination of pathogen thereby helping in the management of Citrus Greening Disease.

**Keywords:** Citrus greening disease, *Candidatus Liberibacter asiaticus*, primer, *Diaphorina citri* (Asian citrus psyllid), Huanglongbing (HLB).

### Introduction

Citrus is a major horticultural crop belonging to the family *Rutaceae* and is commercially grown worldwide. Citrus is an evergreen crop having medicinal properties (Bove, 2006), it originated in the Southeast Asia and has spread now around the globe. Citrus production provides employment to millions of people around the world in harvesting, handling, transportation, storage, marketing etc. In India, citrus fruits are primarily grown in Maharashtra, Andhra Pradesh, Punjab, Karnataka, Madhya Pradesh, Uttaranchal, Bihar, Orissa, Assam, and Gujarat. The mandarin orange (*Citrus reticulata* Blanco) is most common among citrus fruits grown in India. It occupies nearly 40% of the total area under citrus cultivation. In recent years citrus production shows decline worldwide because of deadly citrus greening disease (Gottwald et al., 2007). Huanglongbing (HLB)/Citrus Greening is the most severe citrus disease that is damaging citrus production worldwide. It is caused by the bacteria “*Candidatus Liberibacter spp*”, which is a gram-negative, phloem-restricted bacterium that is transmitted by insect vectors, i.e., Psyllid. Among the three strains of *Ca. Liberibacter*, “*Ca. Liberibacter asiaticus*” is most widely found pathogen in India. The causative agent of citrus greening disease in Asia is “*Ca. Liberibacter asiaticus*” (Warghane et al., 2017). The Asian citrus psyllid, *Diaphorina citri* is the principal vector for citrus greening disease and it is specific to citrus crops on which they complete their life cycle so controlling the growth of psyllid will prevent the subsequent spread of citrus greening disease in citrus crops (Batool et al., 2007).

It was reported that molecular detection techniques were sensitive to false negative results due to the HLB bacteria's uneven distribution among citrus and even among cells within distinct tissues, resulting in samples that were both positive and negative from the same citrus tree. Moreover, the same HLB bacterium species were significantly different depending on the geographic region but did not differ significantly based on the citrus cultivar. Subsequently, it is essential to choose a suitable assay technique and genetic locus to detect the suspicious HLB samples coming from a particular geographical region (Hung et al., 2004).

The recent discovery of multicopy copies (five) of *nrdB* gene, encoding  $\beta$ -subunit of ribonucleotide reductase (RNR), a critical enzyme involving bacterial proliferation, were found. Three *nrdB* copies were in long form (*nrdBL*, 1,059 bp) and two were in short form (*nrdBS*, 378 bp). *nrdBS* shared >99% identity to 3' end of *nrdBL* (Hong et al., 2019, Zheng et al., 2016). Hence, the design of PCR primers based on the *nrdB* gene will enable early disease detection from insect vectors as well as citrus plants. This primer will then be utilised to implement the bud wood certification programme, which will eventually stop the spread of the pathogen.

## **Materials and Methods**

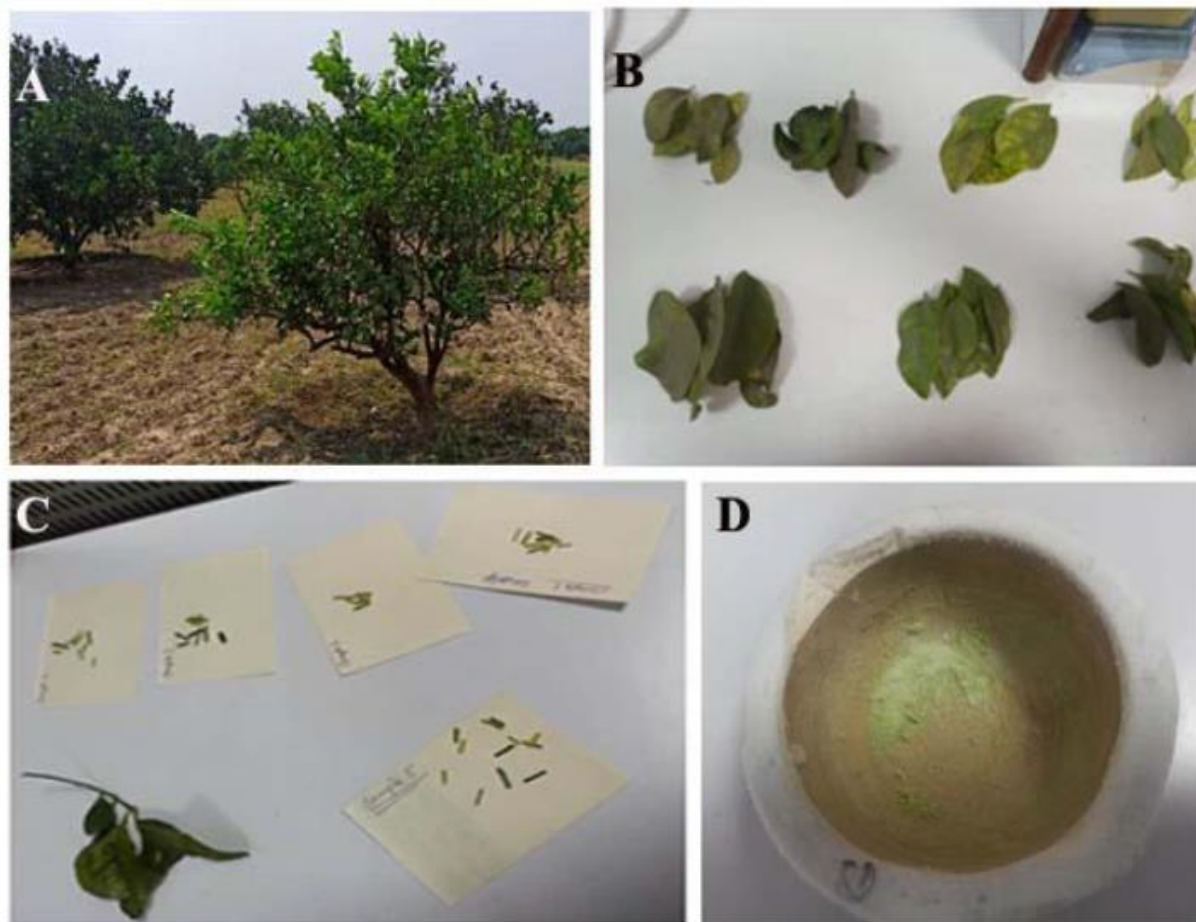
### **Ethics statement**

The research complied with protocols for plant protection and in controlled condition so that HLB disease should not infect the normal citrus plantation.

### **Sample sources and DNA preparation**

From 2020 to 2022, 120 citrus leaf samples (42 showed blotchy leaves citrus and 29 showed yellow shoots) were collected from 25 different citrus cultivars in Delhi/NCR that covered almost all citrus fields including Indian Agricultural Research Institute (IARI, New Delhi) 28.6377° N, 77.1571° E.

All samples were collected handpicked and stored in -40C (Fig 1A). Leaves were washed with running tap water and blotted dry with paper towels (Fig 1B). The midribs of leaves were extracted through cutting by surgical knives (Fig 1 C). Then, 100 mg of each sample were grinded in liquid nitrogen (Fig 1 D) and polyvinylpyrrolidone, and DNA was extracted using the CTAB method. The extracted DNA was dissolved in 50  $\mu$ l of SDW. The quality and concentration of DNA were checked by a NanoDrop One (ND-ONE-W Thermo Scientific).



**Figure 1:** (A) Samples were collected by handpicking from citrus fields of IARI, New Delhi, (B) Leaves were washed with running tap water and blotted dry with paper towels, (C) The midribs of leaves were extracted through cutting by surgical knives, (D) 100 mg of each sample were grinded in liquid nitrogen and polyvinylpyrrolidone for DNA extraction.

### Primers design

One set of primer were designed for the PCR to amplify the 3 larger and 2 smaller subunits of Multicopy *nrdB* gene (Accession No: CP010804.1). The primer sets were designed manually and verified through primer BLAST (NCBI primer designing tool) with the following criteria:  $T_m = 55 \pm 2^\circ\text{C}$  and primer length = 18–22 BP.

### Validation the specificity of designed PCR primers

To validate the PCR primer specificity, we firstly BLAST primer against *Candidatus Liberibacter asiaticus* genome sequences. To ensure that the designed primers were specific for Las, citrus greening disease positive sample were identified and separated from collected

samples of citrus. Objective genes were confirmed by electrophoresis in 1.6% agarose gels and sequencing PCR products and BLAST them online.

CGB positive samples were tested using the PCR primer *nrdB* L2F1/R1 in this study. PCR products were separated by electrophoresis in 1.6% agarose gels and detected after staining with ethidium bromide.

## Results

### Identification of multiple-copy regions in A4 genome

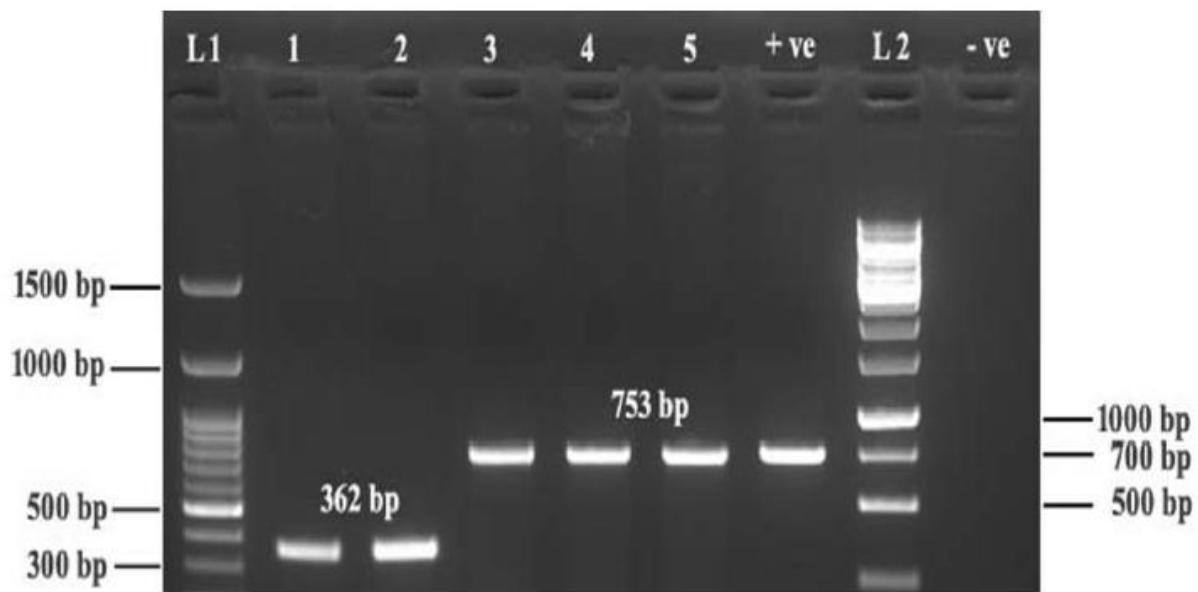
PCR primer *nrdBL2F1/R1* produced the target products without primer dimers. The amplification products are 362 and 753 bp in length (Fig 2).

### Specificity of *nrdBL2F1/R1* primer set

Primer set *nrdBL2F1/R1* was designed based on the 753 bp of *nrdB* gene in the CLas genome. BLASTn search using primer sequences in NCBI contained clas genome sequences returned hits strictly to the *nrdB* gene of CLas. PCR of DNA samples extracted from five CGB positive citrus leaves shows amplification around 753 bp in gel electrophoresis against 1Kb and 100 bp DNA ladder as marker and one CLas-free plant leaf reared in our laboratory showed no amplification with primer set *nrdBL2F1/R1* by PCR (Table 1).

**Table 1:** General information of primer sets of Multicopy *nrdB* gene of “*Candidatus Liberibacter asiaticus*”

| S.No. | NAME                | PRIMER               | Nucleotide (bp) | Annealing temperature |
|-------|---------------------|----------------------|-----------------|-----------------------|
| 1     | <i>nrdB</i><br>L2F1 | GCATTTAACCCACGAACCC  | 753bp           | 59°C                  |
|       | <i>nrdB</i><br>L2R1 | ATACGGATGGGCATGGGAAA |                 |                       |



**Figure 2:** The 1.6% agarose gel electrophoresis result of products of PCR of *Candidatus Liberibacter asiaticus* gene through *nrdB* gene primer.

### Discussion

Citrus Greening Disease is a complex, challenging, and devastating disease that threatens the major citrus crop despite intense management efforts throughout the world over the years. HLB-infected citrus trees exhibit scant foliage, severe twig or limb die-back, and eventually die in three to five years. Citrus with HLB infection has a productivity reduction of 30% to 100% and inferior fruit quality (Gottwald et al., 2008). Research on citrus greening disease over the past decade has involved scientists, growers, and industry representatives who have explored multiple facets of the disease and other environmental, horticultural, sociological, and economic factors that impact it. The development of PCR primers based on the multicopy gene *nrdB* helps to detect “*Ca. L. asiaticus*” at early stages and even in lower concentration. The primers designed in the present study provide a very useful supplement to the current approaches for CLas detection. This will help in controlling the spread of the disease in non-infected plants, and thus prevent citrus crop loss. The present study provides means to detect pathogen in early stages and subsequently stop further dissemination of pathogen thereby helping in the management of Citrus Greening Disease.

**References:**

1. Gottwald TR, da Graca JV, Bassanezi RB. (2007). Citrus Huanglongbing: The Pathogen and Its Impact. 8(1).
2. Warghane A, Pragati M, Dipak G, Shukla PK, Ghosh D. (2017). Diversity and characterization of Citrus tristeza virus and *Candidatus Liberibacter asiaticus* associated with citrus decline in India. Indian Phytopathology. 70. 359-367.
3. Hung TH, Hung SC, Chen CN, Hsu MH, Su HJ. (2004) Detection by PCR of *Candidatus Liberibacter asiaticus*, the bacterium causing citrus huanglongbing in vector psyllids: application to the study of vector–pathogen relationships. Plant Pathology, 53 (1), 96-102.
4. [4] Zheng Z, Xu M, Bao, M. *et al.* Unusual Five Copies and Dual Forms of *nrdB* in “*Candidatus Liberibacter asiaticus*”: Biological Implications and PCR Detection Application. *Sci Rep* 6, 39020 (2016).
5. Batool A, Iftikhar Y, Mughal SM, Khan MM, Jaskani MJ, Abbas M, and Khan IA. (2007). Citrus greening disease-a major cause of citrus decline in the world-a review. *Hort. Sci. (Prague)*, 34(4), 159-166.
6. Hong Y, Luo Y, Yi J, He L, Dai L, Yi T (2019) Screening nested-PCR primer for ‘*Candidatus Liberibacter asiaticus*’ associated with citrus Huanglongbing and application in Hunan, China. *PLoS ONE* 14(2): e0212020.
7. Bove J. Huanglongbing: a destructive, newly-emerging, century-old disease of citrus. *Plant Pathology*. 2006; 88: 7–37.

**Chapter: 7****Tenofovir induced nephrotoxicity****Aparna Matpathi****Pharma D Intern, CMR College of Pharmacy, Medchal-501401, Hyderabad****E-mail: [aparnamatpathi@gmail.com](mailto:aparnamatpathi@gmail.com)**

**Abstract:** Tenofovir is a widely used antiretroviral drug that has revolutionized the treatment of HIV infection. Despite its efficacy, tenofovir has been associated with the development of nephrotoxicity in some patients. The renal toxicity of tenofovir is primarily characterized by proximal tubular dysfunction and acute kidney injury. In severe cases, this can lead to chronic kidney disease and end-stage renal disease, which are associated with significant morbidity and mortality.

The pathophysiology of tenofovir-induced nephrotoxicity is multifactorial and is thought to involve multiple mechanisms, including mitochondrial toxicity, oxidative stress, and inflammation. These mechanisms can lead to cellular injury and death, resulting in the loss of renal function.

Early detection and management of tenofovir-induced nephrotoxicity are critical to prevent irreversible kidney damage. Patients receiving tenofovir therapy should undergo regular monitoring of renal function, including serum creatinine and estimated glomerular filtration rate. In some cases, it may be necessary to discontinue tenofovir therapy and switch to an alternative antiretroviral agent.

In conclusion, tenofovir-induced nephrotoxicity is an important complication of tenofovir therapy that can have significant clinical implications. A thorough understanding of the pathophysiology, clinical features, and management of this condition is essential for healthcare providers who care for patients receiving tenofovir therapy.

**Keywords:** Tenofovir, nephrotoxicity, mitochondria, proximal tubular cells, serum uric acid levels.

**Introduction:**

Tenofovir was the initial drug to be approved by the US Food and Drug Administration (FDA) in 2001, and it remains the only NtRTI drug that is authorized for the management of HIV infection.[1]. Due to its effectiveness and tolerability demonstrated in clinical trials, Tenofovir is currently a commonly prescribed element of antiretroviral treatment for both treatment-naïve and experienced patients.[1]. Nephrotoxicity is characterized by a sudden decline in kidney function resulting from the toxic effects of medications and chemicals [5]. Nephrotoxins are substances that exhibit the ability to cause nephrotoxicity [5]. Tenofovir is excreted unchanged in the urine through a process involving both glomerular filtration and proximal tubular secretion.[1]. The primary ways tenofovir-related kidney damage manifests in clinical settings are (a) proximal tubular impairment with normal kidney function, and (b) proximal tubular impairment along with reduced kidney function [1]. Chronic kidney disease (CKD) can show no noticeable symptoms until the Glomerular Filtration Rate (GFR) drops below 30 mL/min/1.73 m<sup>2</sup>. This means there is a significant possibility of not detecting nephrotoxicity since the level of serum creatinine may not go above the upper limit of normal until the GFR is below 60 mL/min/1.73 m<sup>2</sup>[1]. The nephrotoxicity of Tenofovir can affect cardiovascular health by reducing the Glomerular Filtration Rate (GFR) and hindering the activation of vitamin D in the proximal tubules. The decrease in GFR and deficiency of vitamin D are both linked to an elevated risk of cardiovascular disease.[1]. Tenofovir's cytotoxicity is mainly directed at mitochondria [1]. Consequently, impairment of mitochondrial function can impede the transport of molecules, the activation of vitamin D, and the urinary acidification process [1]. The negative effect of TDF on the function of the tubes in the kidneys results in a reduction in the conversion of vitamin D to its active form (1- $\alpha$  hydroxylation) and a decrease in the reabsorption of vitamin D-binding protein [2]. The nephrotoxicity caused by Tenofovir is associated with damage to the cells in the proximal tubules of the kidneys, which can lead to partial or complete Fanconi syndrome, acute kidney injury (AKI), or chronic kidney disease (CKD). The presence of nephrotoxicity can be determined by a straightforward blood test. The test involves measuring blood urea nitrogen (BUN), the concentration of serum creatinine, glomerular filtration rate, and creatinine clearance [3]. Kidney damage caused by IL-2 is usually temporary and can be treated by giving large amounts of fluids when the first signs of low urine output appear [4]. Apart from administering fluids, treating low urine output and low blood pressure caused by kidney damage may involve using vasopressors like dopamine at low to intermediate doses, which work by

interacting with adrenergic receptors [4]. Various cytokines, including interleukin (IL), interferon, and colony-stimulating factors, are significant in the damage and repair of renal tubules. Therefore, they are viewed as biomarkers for kidney damage resulting from drug-induced nephrotoxicity [5].

**Case presentation:** The tertiary care hospital admitted a 30-year-old male patient who presented with several chief complaints. He had been experiencing shortness of breath for 10 days, along with orthopnea and paroxysmal nocturnal dyspnea. The patient also had grade-4, pitting-type bilateral pedal edema that had been present for 10 days. In addition, he had abdominal distension, facial puffiness, and had been coughing up whitish mucus for four days. He reported decreased urine output and had a history of weight loss and decreased appetite. The individual had a history of chronic alcoholism.

During the examination, the patient was conscious, coherent, and afebrile. His blood pressure was 110/70 mmHg, and his heart rate was 96 beats per minute. The Jugular Venous Pressure (JVP) was elevated, and the patient had bilateral pitting edema.

**Laboratory findings:** The results of the patient's 2D echocardiogram revealed dilatation in all four chambers of the heart, with moderate left ventricular dysfunction and grade 2 diastolic dysfunction. Additionally, the patient was found to have severe tricuspid regurgitation and severe mitral regurgitation, along with moderate pulmonary arterial hypertension. The ejection fraction was found to be 49%. A chest X-ray was also performed, which revealed dilatation in both the right and left chambers of the heart and enlarged paratracheal nodes. Table- 1 depicts other diagnostic findings;

**Table-1:**

| Name of the test      | Abnormal values | Standard range      |
|-----------------------|-----------------|---------------------|
| Blood urea            | 33 mg/dl        | 7 and 20 mg/dL      |
| Serum creatinine      | 2.27 mg/dl      | 0.7 to 1.3 mg/dL    |
| Albumin               | 2.66 g/dl       | 3.4 to 5.4 g/dL     |
| Total serum proteins  | 7.22 g/dl       | 6.0 to 8.3 g/dl     |
| Direct bilirubin      | 0.19 mg/dl      | less than 0.3 mg/dL |
| Total serum bilirubin | 1.11 mg/dl      | 0.1 to 1.2 mg/dL    |

|                      |           |                  |
|----------------------|-----------|------------------|
| SGPT                 | 23 IU/L   | 29 and 33 IU/L   |
| SGOT                 | 47 IU/L   | 8 and 45 IU/L    |
| Alkaline phosphatase | 103 U/L   | 44 and 147 U/L   |
| Sodium               | 129 mEq/L | 135 to 145 mEq/L |
| Potassium            | 3.1 mEq/L | 3.5 to 5.2 mEq/L |
| Hemoglobin           | 9.6g/dl   | 14 to 18 g/dl    |

**Conformational diagnosis:** After a thorough examination and evaluation of the patient's laboratory data, it was determined that the patient was suffering from acute decompensated heart failure (ADHF) and Tenofovir-induced nephrotoxicity.

**Treatment:** The treatment regimen comprised of several medications including Furosemide, which was administered to rule out edema; Spironolactone was also given to prevent the development of CKD, while antibiotics such as Augmentin and Azithromycin were administered to the patient. Additionally, Thiamine was given as a preventive measure against renal failure. The detailed information regarding medications prescribed is mentioned in table- 2

**Table- 2:**

| Brand name        | Generic name   | Dose                | Route of administration | Frequency |
|-------------------|----------------|---------------------|-------------------------|-----------|
| Inj. Furosemide   | Furosemide     | 40 mg               | IV                      | BD        |
| T. Spironolactone | Spironolactone | 25 mg               | PO                      | BD        |
| Inj. Augmentin    | Augmentin      | 1.25 g              | IV                      | BD        |
| T. Azithromycin   | Azithromycin   | 500 mg              | PO                      | OD        |
| Inj. Pantoprazole | Pantoprazole   | 40 mg               | IV                      | OD        |
| Inj. Thiamine     | Vit- B1        | 1 unit in 100 mL NS | IV                      | OD        |

The administration of Tenofovir has been discontinued to prevent any further damage to the patient's kidneys.

**Discussion:** The primary site of tenofovir toxicity is the proximal tubular cell, which contains specific cell membrane transporters that promote the accumulation of tenofovir. They are responsible for the majority of molecule transportation in the tubules, absorbing more than 200 g

$\text{ClNa}^+$ , 1 kg glucose, and various other molecules from the lumen of the tubules daily. The energy required for this transportation process is supplied by a large number of mitochondria. Dysfunction of mitochondria can be attributed to three main causes: (a) missing or faulty mitochondrial genes, (b) missing or faulty nuclear genes that play a role in mitochondrial function, or (c) damage to normally functioning mitochondria, leading to their loss of function. As a result, damage to the mitochondria will hinder the transportation of molecules, activation of vitamin D, and the process of urinary acidification. [1] TDF has the potential to harm mitochondria, as evidenced by the presence of structural abnormalities in mitochondria associated with TDF-induced tubulopathy [2]. TDF in its original form is eliminated from the body through both glomerular filtration and tubular secretion into the urine [2]. If the concentration of TDF in the bloodstream rises or if the secretion of TDF into the tubules is blocked, the amount of TDF within cells also increases [2]. Due to a deficiency in the production of ATP, the cells in the tubules are unable to effectively carry out the process of reabsorbing certain ions and small molecules, such as potassium, glucose, phosphate, uric acid, amino acids, and  $\beta$ 2-microglobulin [2]. The primary treatment option is to discontinue the use of the drug [1]. Discontinuation of the drug typically leads to an improvement in the visible signs of kidney damage, although the improvement may only be partial [1]. Efforts to create new drugs with reduced toxicity are focused on making chemical changes that prevent the drugs from entering proximal cells [1]. The best way to treat tenofovir-induced kidney damage is by ceasing the use of tenofovir. Symptoms of kidney damage usually get better after discontinuing the medication [1]. Identifying drug-induced nephrotoxicity at an early stage would be beneficial in reducing the financial losses incurred during safety testing of new drugs [3].

**Conclusion:** In this case, the patient had been taking Tenofovir as a treatment for HIV. However, prolonged use of the medication resulted in nephrotoxicity. It was found that discontinuing the use of Tenofovir proved to be beneficial for the patient, who was subsequently treated with copious amounts of fluids, while a diuretic was used to reduce the edema. The patient's health condition improved significantly, and all their symptoms were relieved. Early diagnosis of the condition can help prevent renal toxicity in the long run.

**References:**

1. Fernandez-Fernandez, B., Montoya-Ferrer, A., Sanz, A. B., Sanchez-Niño, M. D., Izquierdo, M. C., Poveda, J., Sainz-Prestel, V., Ortiz-Martin, N., Parra-Rodriguez, A., Selgas, R., Ruiz-Ortega, M., Egido, J., & Ortiz, A. (2011). Tenofovir nephrotoxicity: 2011 update. *AIDS research and treatment*, 2011, 354908. <https://doi.org/10.1155/2011/354908>
2. Tourret, J., Deray, G., & Isnard-Bagnis, C. (2013). Tenofovir effect on the kidneys of HIV-infected patients: a double-edged sword?. *Journal of the American Society of Nephrology : JASN*, 24(10), 1519–1527. <https://doi.org/10.1681/ASN.2012080857>
3. Kim, S. Y., & Moon, A. (2012). Drug-induced nephrotoxicity and its biomarkers. *Biomolecules & therapeutics*, 20(3), 268–272. <https://doi.org/10.4062/biomolther.2012.20.3.268>
4. Chiruvella, V., Annamaraju, P., & Guddati, A. K. (2020). Management of nephrotoxicity of chemotherapy and targeted agents: 2020. *American journal of cancer research*, 10(12), 4151–4164.
5. Al-Naimi, M. S., Rasheed, H. A., Hussien, N. R., Al-Kuraishy, H. M., & Al-Gareeb, A. I. (2019). Nephrotoxicity: Role and significance of renal biomarkers in the early detection of acute renal injury. *Journal of advanced pharmaceutical technology & research*, 10(3), 95–99. [https://doi.org/10.4103/japtr.JAPTR\\_336\\_18](https://doi.org/10.4103/japtr.JAPTR_336_18)

**Chapter: 8****Use of E-learning & Face to Face learning strategies for Nursing students in relation to their some personal variables****Rumi Sen<sup>1</sup> and Dr. Ratna Chhaya Singh<sup>2</sup>****Associate Professor****Department of Nursing, Aliah University****E-mail-rumisen@yahoo.com**

**Abstract:** For effective teaching learning process and to cover the divergent need and aspiration of the Nursing students a number of strategies are adopted by the teachers. Among them E-learning and Face to Face learning are the two strategies which are very relevant in the present changing situation. Hence it is a very burning current research area.

This study aims to investigate use of E-learning and Face to Face learning strategies for Nursing students in relation to their parental educational variation, occupation and income.

Convenient sampling method was used to select 300 nursing students studying in different nursing colleges of Kolkata. A 5 likert scale questionnaire was used.

Result shows that obtained “t” value  $0.92 < \text{the tabular value at } 0.05 \text{ levels}$  so there exist no significant difference between the use of E-learning of nursing students in relation to parental education variation whereas there exist significant difference between the face-to-face learning of nursing students in relation to parental education variation as the obtained “t” value  $2.92 > \text{the tabular value at } 0.05 \text{ levels}$  so .

There exist significant difference between the use of E-learning and face to face learning of nursing students in relation to parental occupation variation as the obtained “t” value  $3.00 \text{ \& } 2.99$  respectively  $> \text{the tabular value at } 0.05 \text{ level}$  .

There exist significant difference between the use of E-learning and face to face learning of nursing students in relation to parental income variation as the obtained “t” value  $3.82 \text{ \& } 3.18$  respectively  $> \text{the tabular value at } 0.05 \text{ level}$  .

It is concluded that parental education have no relation with E-learning of nursing students but parental occupation and income have significance relation with E-learning and Face to Face learning strategies for Nursing students.

**Keywords:** E-learning, face-to-face learning, nursing, students

## **1. Introduction**

All of us have experienced traditional learning or face to face learning since the beginning of our education. Since ancient days this Face to Face learning is conducted by teachers gathering students in places such as classes, labs or seminars to study and learn about different subjects. This traditional method of learning has been practiced around the world in all levels of learning. In this type of Face to Face learning environment, teachers uses different teaching styles and techniques but the most conventional teaching style is teaching by speaking. With the evolution in information technology and Internet there is fast change in the way people started accessing the information.

E-learning is defined as learning that makes use of Information and Communication Technologies (ICTs). The incorporation of technological resources and innovative education strategies has transformed the teaching and learning processes. Various studies have shown various e-learning and online learning tools that are effective for teaching and learning in the fields of health profession. The knowledge gain and performance of the students as a result of E-learning were shown to be equivalent to that of face to face methods.

**Mpungose B.C.** Demarcated physical classrooms are not accessible in the case of challenges ranging from student protests to pandemic outbreaks. Face-to-face learning provides real-time contact with resources and others, takes place within a specified contact time, and provides prompt feedback to students (Waghid, 2018). That said, e-learning is education that takes place over the Internet is alternatively called online learning, and it is an umbrella term for any learning that takes place across distance and not in a face-to-face platform (Anderson, 2016; Mpungose, 2020a). Furthermore, Choudhury and Pattnaik (2020) affirm that, e-learning definition evolves with the evolution of Web from Web 0 to 4.0. Khoza (2019b) state that e-learning is capable of making course content available online, because of the widespread use of modern technologies such as hardware resources (computers, laptops, mobile phones and others), and software resources (learning management system, software applications, social media sites and others). This suggests that students have freedom to access course information/content

anytime and anywhere, irrespective of challenges such as the pandemic outbreak provided they have access to hardware and software resources.

So the advent of the Internet and related tools for digital communication and global connectivity has changed the way information is stored, communicated, and shared, removing the barriers of time and location. This new development has created a new urge for the fraternity of academicians to reconsider how courses could be taught, considering approaches that lessen barriers of time and energy and increase access for many potential students. E-learning allows a greater flexibility and convenience in timing and location for both the instructor and student. However, convenience and accessibility are only valuable if courses effectively facilitate student learning.

For effective teaching learning process and to cover the divergent need and aspiration of the Nursing students and to fulfill the demands of the changing situations; there are number of strategies which are used by the teachers due to teaching learning process of Nursing students. Among them E-learning and Face to Face learning are the two strategies which are very relevant for the Nursing students to fulfill their divergent need and aspiration during teaching learning process and also to fulfill their psychological and demand of the present changing situation. Hence it is a very burning current research area.

### **1.1 Significance of the Study**

In the present day when digital world have become so popular and advance, information's are shared from one part of the world to another part within seconds, e-learning is a valuable stepping stone to be up-to-date on nursing technology. Still adopting E-learning approach to teaching and learning in nursing program, is of slight concern and has been given to the pre-requisite personal and technical qualities required for academic achievement and satisfaction.

On the other hand Face to Face learning is the most traditional type of learning instruction where the learners are benefitted to a greater extent from the interaction with their fellow students as well. Face-to-face learning ensures a better understanding and recollection of lesson content and gives class members a chance to bond with one another. And from the review of related literature it is observed that in this region specially in our state of West Bengal not a single study conducted on the use of E-learning and Face to Face learning strategies for Nursing students in this pandemic situation as well as before that also. Thus the present study is unique and sincere steps for the investigator.

## 1.2 Statement of the Problem

In the context of present situation both E-learning & Face to Face learning played very important role considering the personal variable of the nursing student of Kolkata in the present context of parental educational qualification (literate/illiterate), employment of parents (service/nonservice) and income of family (below poverty line/above poverty line), hence the investigator stated her problem for study as mentioned below.

**“Use of E-learning & Face to Face learning strategies for Nursing students in relation to their some personal variables”**

## 1.3 Objectives of the Study

1. To find out use of E-learning and Face to Face learning strategies for Nursing students in relation to their parental educational.
2. To find out use of E-learning and Face to Face learning strategies for Nursing students in relation to the occupation of parents.
3. To find out use of E-learning and Face to Face learning strategies for Nursing students in relation to their parental income.

## 1.4 Hypothesis of the Study

Ho<sub>1</sub>: The scores of the E-learning and Face to Face strategy for Nursing students are not normally distributed in total and due to their intra variations/ intra variables wise.

Ho<sub>2</sub>: There does not exist any significant difference of the mean scores of E-learning strategy of Nursing students due to their parental educational variations.

Ho<sub>3</sub>: There does not exist any significant difference of the mean scores of E-learning strategy of Nursing students due to their parental occupation variations.

Ho<sub>4</sub>: There does not exist any significant difference of the mean scores of E-learning strategy of Nursing students due to their parental income variations.

Ho<sub>5</sub>: There does not exist any significant difference of the mean scores of Face to Face learning strategy of Nursing students due to their parental educational variations.

Ho<sub>6</sub>: There does not exist any significant difference of the mean scores of Face to Face learning strategy of Nursing students due to their parental occupation variations.

Ho<sub>7</sub>: There does not exist any significant difference of the mean scores of Face to Face learning strategy of Nursing students due to their parental income variations.

## **2.0 Methodology of the Study**

### **2.1 The Design of the Study**

The present research work is a mixed type of research work, where, Normative and correlational, survey type research design was used and it is a non-experimental survey design adopted to accomplish the objectives of the study.

### **2.2 The Population and Sample of the Study**

The study Population comprises of B.Sc. Nursing students, 300 students were taken by Non-probability convenience sampling technique from selected Nursing Institutes of Kolkata

### **2.3 The Tools Used**

Two self-made questioner's (five points liker scale) were prepared and used after validation by experts and reliability test.

### **2.4 The Procedure of the Study**

The following procedures were adopted for conducting the present study:

- i. Duplication of questionnaire
- ii. Selection sample
- iii. Administration of the Questionnaire
- iv. Scoring
- v. Preparation of the data sheet
- vi. Compilation of the data according to the variables
- vii. Presentation of data in tables
- viii. Assessment of the scores by the application of appropriate statistical procedures.
- ix. Reportin
- x. Compilation of references in APA style.
- xi. Submitting the thesis

## **3.0 The Results and Discussion**

This is done in accordance with the objectives and hypotheses formulated.

### **3.1. Parental Education differences on E-Learning score of nursing students**

One of the objectives of the study was to be found out if there exist any parental education

differences on use of E-learning of nursing students, therefore the null hypothesis was stated as “there is no significant difference in the use of E-learning of nursing students in relation to parental education variation”.

In order to find out differences if any of the scores on use of E-Learning of above graduate and below graduate parents, the test of significance of difference between the means of two sub samples was calculated and tested for significance. The result has been presented in the following table:

**Table 1: Summary of test of significance of differences between parental education variations of nursing students on the use of E-Learning**

n = 300

Critical value of ‘t’ with df (98) at 0.01=2.63 and 0.05=1.98

| Parental Education variation | n   | Mean  | S.D  | SE <sub>D</sub> | ‘t’  | Remarks         |
|------------------------------|-----|-------|------|-----------------|------|-----------------|
| Above Graduate               | 103 | 98.67 | 6.92 | 0.53            | 0.92 | Not-Significant |
| Below Graduate               | 197 | 99.16 | 5.7  |                 |      |                 |

The obtained value 0.92 is < tabular value at 0.05 levels 1.98 and at 0.01 level 2.63 so it is non-significant and the null hypothesis that states there exist no significant difference between the use of E-learning of nursing students in relation to parental education variation will be accepted.

### **3.2. Parental Occupation differences on E-Learning score of nursing students**

One of the objectives of the study was to be found out if there exist any parental occupation differences on the use of E-learning of nursing students, therefore the null hypothesis was stated as “there is no significant difference in the the use of E-learning of nursing students in relation to parental occupation variation ”.

**Table2: Summary of test of significance of differences between parental occupation variation of nursing students on the use of E-Learning.**

n = 300

| Parental Occupation variation | n   | Mean   | S. D | SE <sub>D</sub> | 't'  | Remarks     |
|-------------------------------|-----|--------|------|-----------------|------|-------------|
| Service                       | 96  | 100.53 | 6.25 | 0.54            | 3.00 | Significant |
| Non-Service                   | 204 | 102.15 | 6.84 |                 |      |             |

Critical value of 't' with df (98) at 0.01=2.63 and 0.05=1.98

The obtained value 3.00 > tabular value at 0.01 level which is 2.63 and at 0.05 level which is 1.98 so it is significant thus the null hypothesis was stated as there exist no significant difference between the use of E-learning of nursing students in relation to parental occupation variation will be rejected.

### 3.3. Parental Income differences on E-Learning score of nursing students

One of the objectives of the study was to be found out if there exist any parental income differences on the use of E-learning of nursing students, therefore the null hypothesis was stated as "there is no significant difference in the the use of E-learning of nursing students in relation to parental income variation".

**Table 3: Summary of test of significance of differences between parental income variations of nursing students on the use of E-Learning**

n = 300

| Parental Income variation | n | Mean | S. D | SE <sub>D</sub> | 't' | Remarks |
|---------------------------|---|------|------|-----------------|-----|---------|
|---------------------------|---|------|------|-----------------|-----|---------|

|                    |     |        |      |      |       |             |
|--------------------|-----|--------|------|------|-------|-------------|
| Above Poverty Line | 203 | 100.19 | 6.95 | 0.54 | 3. 82 | Significant |
| Below Poverty Line | 97  | 96.37  | 6.67 |      |       |             |

Critical value of 't' with df (98) at 0.01=2.63 and 0.05=1.98

The obtained value 3.82 > tabular value at 0.01 level which is 2.63 and at 0.05 level which is 1.98 so it is significant thus the null hypothesis was stated as there exist no significant difference between the use of E-learning of nursing students in relation to parental income variation will be rejected.

### 3.4. Parental Education differences on Face-to-Face Learning score of nursing students

One of the objectives of the study was to be found out if there exist any parental education differences on the face-to-face learning of nursing students, therefore the null hypothesis was stated as "there is no significant difference in the face-to-face learning of nursing students in relation to parental education variation".

In order to find out differences if any of the scores on face-to-face learning of above graduate and below graduate parents, the test of significance of difference between the means of two sub samples was calculated and tested for significance. The result has been presented in the following table:

**Table 4: Summary of test of significance of differences between parental education variations of nursing students on the Face-to-Face Learning**

n = 300

| Parental Education variation | n   | Mean  | S.D  | SE <sub>D</sub> | 't'  | Remarks     |
|------------------------------|-----|-------|------|-----------------|------|-------------|
| Above Graduate               | 103 | 96.56 | 5.81 | 1.42            | 2.92 | Significant |
| Below Graduate               | 197 | 97.08 | 4.65 |                 |      |             |

Critical value of 't' with df (98) at 0.01=2.63 and 0.05=1.98

The obtained value 2.92 > tabular value at 0.05 levels 1.98 and at 0.01 level 2.63 so it is significant and the null hypothesis that states there exist no significant difference between the face-to-face learning of nursing students in relation to parental education variation will be rejected.

### 3.5. Parental Occupation differences on Face-to-Face Learning score of nursing students

One of the objectives of the study was to be found out if there exist any parental occupation differences on the face-to-face learning of nursing students, therefore the null hypothesis was stated as “there is no significant difference in the face-to-face learning of nursing students in relation to parental occupation variation”.

**Table 5: Summary of test of significance of differences between parental occupation variations of nursing students on Face-to-Face Learning**

n = 300

| Occupation  | n   | Mean  | S. D | SE <sub>D</sub> | ‘t’  | Remarks     |
|-------------|-----|-------|------|-----------------|------|-------------|
| Service     | 96  | 96.42 | 6.34 | 1.34            | 2.99 | Significant |
| Non-Service | 204 | 98.10 | 7.12 |                 |      |             |

Critical value of t’ with df (98) at 0.01=2.63 and 0.05=1.98

The obtained value 2.99 > tabular value at 0.05 levels 1.98 and at 0.01 level 2.63 so it is significant and the null hypothesis that states there exist no significant difference between the face-to-face learning of nursing students in relation to parental occupation variation will be rejected.

### 3.6. Parental Income differences on Face-to-Face Learning score of nursing students

One of the objectives of the study was to be found out if there exist any parental income differences on the face-to-face learning of nursing students, therefore the null hypothesis was stated as “there is no significant difference in the face-to-face learning of nursing students in relation to parental income variation”.

**Table 6: Summary of test of significance of differences between parental income variation of**

**nursing students on Face-to-Face Learning**

n = 300

| Income             | n   | Mean  | S. D | S E <sub>D</sub> | 't'  | Remarks     |
|--------------------|-----|-------|------|------------------|------|-------------|
| Above Poverty Line | 203 | 98.18 | 7.15 | 1.35             | 3.18 | Significant |
| Below Poverty Line | 97  | 94.26 | 6.18 |                  |      |             |

Critical value of 't' with df (98) at 0.01=2.63 and 0.05=1.98

The obtained value 3.18 > tabular value at 0.05 levels 1.98 and at 0.01 level 2.63 so it is significant and the null hypothesis that states there exist no significant difference between the face-to-face learning of nursing students in relation to parental income variation will be rejected.

**Discussion**

The primary purpose of this study was to assess the role of E-learning & Face to Face learning strategies on the personal variable of the nursing student of Kolkata in the present context of parental educational qualification, employment of parents and income of family. There is a paucity of evidence from the literature documenting how students have responded to different learning strategies. However, we found three previous studies concerning this topic. Thapa P., Bhandari S. L., Pathak S. investigated nursing students' attitude on the practice of e-learning: A cross-sectional survey amid COVID-19 in Nepal consistent with our study, their finding revealed that there was no significant association of overall attitude regarding e-learning with selected socio-demographic variables. Present study result showed that obtained "t" value 0.92 is < tabular value at 0.05 levels 1.98 and at 0.01 level 2.63 so there exist no significant difference between the use of e-learning of nursing students in relation to parental education variation.

Mukasa J., Otim M., Monaco B., et al investigated in their study nursing students' perspectives and readiness to transition to e-learning during COVID-19 in the UAE: A cross-sectional study indicates that half of the participating students felt that E-learning was successful, and 66% reported that they were prepared for E-learning. This suggested that students were satisfied with their experiences of the new learning approach and the associated interactions. This could be

because students were able to participate in their learning in a more flexible and convenient manner than in traditional face-to-face. Although around half of the participants had access to the Internet, they were not comfortable communicating online with each other or with their instructors. This may be related to cultural perspectives and other issues from the students' perspectives, such as lack of access to the Internet and infrastructure. This result is in consistence with the present study result where the obtained "t" value of E-learning and face to face learning is 3.82 and 3.18 respectively which is > tabular value at 0.01 level which is 2.63 and at 0.05 level which is 1.98 so there exist significant difference between the use of E-learning and face to face Learning of nursing students in relation to parental income variation

### **Limitations**

The key limitation of this study was that a larger sample would have been desirable and more representative. The study was limited to Kolkata only, samples from other districts and states would have been more desirable. Another limitation was that there were no local and/or national studies to which to compare and contrast findings of the present study.

### **Conclusion**

Research on the use and advancement of E-learning in nursing education is relatively uncharted territory. This study therefore aimed to understand the experiences and challenges encountered by nursing students at Kolkata. The challenges of E-learning as reported by participants included economical problem to purchase devices such as android phone, computer/laptop and data, connection problems and difficulties in communication with instruction. The findings helped identify the significant challenges and adaptations necessary for future pedagogical approaches to teaching and learning and how students can best be supported. It generated significant insights into e-learning challenges in Kolkata may also inform further research which will build of similar kind.

## References

1. Ali Mohamed Gameel Wafaa. Nursing Students' Readiness for e-Learning Experience. *Gynecology & Obstetrics* [serial online] 2016 June; 6(6): [5screen]  
Available from URL:  
[https://www.researchgate.net/publication/305272004\\_Nursing\\_Students'\\_Readiness\\_for\\_e-Learning\\_Experience](https://www.researchgate.net/publication/305272004_Nursing_Students'_Readiness_for_e-Learning_Experience)
2. Amir R.L., Tanti I., et al Student perspective of classroom and distance learning during COVID-19 pandemic in the undergraduate dental study program Universitas Indonesia *BMC Medical Education* [serial online] 2020; 20: 392: [8 screen] Available from URL:  
<https://bmcmmededuc.biomedcentral.com/track/pdf/10.1186/s12909-020-02312-0.pdf>
3. AnnBerga K, Vadnais E, Nelson J, et al Blended learning versus face-to-face learning in an undergraduate nursing health assessment course: a quasi-experimental study, Volume 96 , 2021  
Available from URL:  
<https://www.sciencedirect.com/science/article/pii/S0260691720314726>
4. Gherhes V., Stoian E. C., Fărcasiu A. M. and Stanici M. E-Learning vs. Face-To-Face Learning: Analyzing Students' Preferences and Behaviors; 2021 April, 14; [15 screen]  
Available from URL; file:///C:/Users/User/Downloads/sustainability-13-04381-v2.pdf
5. Islam B & Laskar H J, Attitudes of the secondary student-teachers of B.ed. towards online teaching-learning; 2021. (Unpublished)
6. Li C and Lalani F, the Covid-19 pandemic had changed education forever. *World economic forum* April 29, 2020 Available from URL: <https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/>
7. **McCutcheon** Karen, **Halloran** O' Peter, **Lohan** Maria. Online learning versus blended learning of clinical supervisee skills with pre-registration nursing students: A randomised controlled trial. *Pubmed.gov* [serial online] 2018 Jun; 82: [10 screen]. Available from URL:  
<https://pubmed.ncbi.nlm.nih.gov/29574394/>
8. Mishra L, Gupta T, Shree A Online teaching learning in higher education during lockdown period of Covid-19 pandemic. *IJER open access* [serial online] 2020: 1 [8 screen] Available from URL: <https://www.sciencedirect.com/science/article/pii/S2666374020300121>
9. Morcillo Ramos Jesús Antonio, Costa Leal César, García Moral Enrique José, Martínez Ruzafa María. Experiences of Nursing Students during the Abrupt Change from Face-to-Face to e-Learning Education during the First Month of Confinement Due to COVID-19 in Spain *Int J Environ Res*

- Public Health [serial online]2020 Jul 30;17(15):5519. Available from URL: <https://pubmed.ncbi.nlm.nih.gov/32751660/>
10. Mpungose B.C. Emergent transition from face-to-face to online learning in a South African University in the context of the Coronavirus pandemic [serial online]2020 October(113) [9 screen] Available from URL; <https://www.nature.com/articles/s41599-020-00603-x.pdf>
  11. Mukasa J., Otim M., Monaco B., et al Nursing students' perspectives and readiness to transition to e-learning during COVID-19 in the UAE: A cross-sectional stud, *Advances in Medical Education and Practice* open access 2021 December 22; p1505–1512 Available from URL: chrome extension://efaidnbmnnnibpcajpcgglefindmkaj/<https://www.dovepress.com/getfile.php?fileID=77020>.
  12. Normative Point of View. Available from URL: <http://www2.uiah.fi/projekti/metodi/178.htm>
  13. Paul Jasmine, Jefferson Felicia A comparative Analysis of Student Performance in an Online vs. Face-to-Face Environmental Science Course. *Frontier in Computer Science* [serial online] 2019 November. Available from URL: <https://www.frontiersin.org/articles/10.3389/fcomp.2019.00007/full>
  14. Polit F. Denis and Bernadetta. Hungler B.P. *Nursing research principles, methods*, London: J.B. Lippincott company; 1987. P88-91.
  15. Singh A. Online education has emerged alternatively as Face to Face classes. *Financial Express* July13.2020 Available from URL:<https://www.financialexpress.com/education-2/online-learning-and-education-for-all-during-and-after-covid-19-pandemic/2021940/>
  16. Thapa P., Bhandari L. S., Pathak S. (2021) a descriptive web-based cross- sectional survey amid COVID-19 on Nursing students' attitude on the practice of e-learning, [serial online] June 24, 2021 Available from URL: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0253651>.

**Chapter: 9**

**Assess knowledge gap on morbidities, its preventive, control measures and practice of using preventive measures related to air pollution among Traffic police in W.B (Kolkata)**

**Snita Bhunia<sup>1</sup> and Dr. Ratna Chhaya Singh<sup>2</sup>**

<sup>1</sup>Senior Lecturer of college of Nursing, CNMCH, Kolkata

<sup>2</sup>Ph.D in Nursing, MGU, Bhopal

E-mail: etibhunias@gmail.com

**Abstract**

**Back ground:** Air pollution is a major problem of present scenario, which has serious toxicological impact on human health and environment Air pollution is considered as the major environmental risk factor in the incidence and progression of some diseases such as asthma, lung cancer. Traffic police by their profession are doing well for our society. They are vulnerable people to developed morbidities related air pollution.

**Aims and objectives:** To assess Knowledge gap of the traffic regarding morbidities, its preventive, control measures and practice of preventive and control measures related to air pollution among Traffic police in W.B (Kolkata) and to examine the association of knowledge gap with practice measures.

**Materials & Methods:** A descriptive study was conducted “Assess knowledge gap on morbidities, its preventive, control measures and practice of using preventive measures related to air pollution among Traffic police in W.B (Kolkata). Conceptual frame work of the study was based on Pender’s health promotional model. Study was done with 200 Traffic Police under different Kolkata traffic guard, W.B. sample selection was done by probability sampling technique through lottery method. Data regarding knowledge were collected through structured questionnaire.

**Results:** Descriptive and inferential statistics were used for data analysis. Study findings revealed that Maximum 47.5 % traffic police have good knowledge regarding morbidities, its preventive, and control measures related to air pollution. Mean of the knowledge score is 6.5, median 7, mode 15.375, SD 3. There is significant association between Knowledge level of traffic police & practice of using preventive measures for prevention of morbidities regarding

Air pollution among traffic police as at one degree of freedom calculated chi-square value (8.8551), yates correction (7.7944) is greater than p value at level 0.05.

**Conclusion:** It has implication on control and prevention of occupational health hazards. Based on the study findings information booklet to be developed for increase their knowledge and practice of preventive measures during their working period.

**Keywords:** Traffic Police, Knowledge, Morbidities, Prevent, Control, Air pollution, Information booklet.

### **Introduction:**

Air pollution is a major problem of present scenario, which has serious toxicological impact on human health and environment. Large volumes of emission from motor engines of automobiles and industrial activities causes air pollution. Air pollution is considered as the major environmental risk factor in the incidence and progression of some diseases such as asthma, lung cancer, ventricular hypertrophy, Alzheimer's and Parkinson's diseases, psychological complication, autism, retinopathy, Foetal growth and low birth weight. Traffic control systems are the very much important to control the road vehicular mobility. Traffic police by their profession doing well for our society. They are vulnerable people to developed morbidities related air pollution. So it is very much necessary for traffic police to look after their health and maintain safety and preventive and control measures so that they can safe their health and gives us productive services through their service period.

**An emission inventory of Kolkata control board** <sup>[2]</sup> checked Air quality in Kolkata through Air quality Index, 2019. Kolkata was shown to have a PM 2.5 reading of 59.8 as recorded in 2019, as a yearly average. This is shown directly in to unhealthy bracket rating, which requires a PM 2.5 reading of anywhere between 55.5 to 150.4  $\mu\text{g}/\text{m}^3$  to be classified. This reading got position of 61<sup>st</sup> most polluted city worldwide in 2019 and coming in at 28<sup>th</sup> place out of all cities ranked in India. This shows that Kolkata is much polluted and for certain months it was seen that was hazardous levels of pollution. In January, 176.1  $\mu\text{g}/\text{m}^3$  rating seen which may have a very large risk of adverse health effects, and few months are recorded in Kolkata was 19.7  $\mu\text{g}/\text{m}^3$ , it is nearly 9 times lower than the highest months reading.

**Dey A, Mishra T, sahu s. saha A(2021)** <sup>[3]</sup> studied on Evaluation of impact of ambient air pollution on respiratory health of traffic police in Kolkata, Air pollution is associated with a broad spectrum of an environmental health problem, caused by increased urbanization and population, globally. Emission of pollutants was strongly implicated in acute morbidity and mortality associated with severe pollution. Traffic cops are most vulnerable due to the nature of their job, continuously exposed to toxic pollutants. The study aimed to assess the physical and respiratory morbidities of traffic cops due to the effect of environmental pollutants. The result of this study shows that outdoor environmental exposure creates harmful effects on lung function parameters of traffic police among the three zones of Kolkata.

**Giriyanna Gowda, R thenambigal (14thJan 2020)** <sup>[4]</sup> studied on A study on respiratory morbidities and pulmonary functions among traffic policemen in Bengaluru city. Air pollution is a major public health problem in the present Indian cities. It more prone to develop respiratory problems such as asthma, chronic obstructive pulmonary disease, rhinitis, recurrent respiratory tract infections, and others. A total of 217 traffic policemen were included in the study.

**STATEMENT OF STUDY- “Assess knowledge gap on morbidities, its preventive, control measures and practice of using preventive measures related to air pollution among Traffic police in W.B (Kolkata).**

### **Objectives**

1. To assess Knowledge gap on morbidities, its preventive, control measures related to air pollution among Traffic police in W.B (Kolkata).
2. To assess practice of using preventive measures related to air pollution among Traffic police in W.B (Kolkata)
3. To examine the association of knowledge gap on morbidities, its preventive & control measures with practice of using preventive measures related to air pollution among traffic police, Kolkata.

### **Null Hypothesis (H0)**

H0<sub>1</sub> There is no association of knowledge gap on morbidities, its preventive & control measures with practice of using preventive measures of air pollution among traffic police at the 0.05 level of significance.

**Research Methodology**

Study type – Pre experimental study

Study design- one group pretest and posttest study design

Study area- selected Traffic guard for study

Study population- Traffic police those who are having occupational exposure of 2 years or more and they are working under road traffic control department of Govt. of west Bengal.

Target Population- Traffic police of west Bengal, Kolkata.

Accessible Population – Traffic Police of selected traffic Guard of West Bengal (Kolkata)

Sample /Sample size- 200 samples from traffic police of West Bengal Govt. Traffic control Department

Sampling technique – Cluster sampling technique

**Operational Definition-****Traffic police-**

In this study word means an official people working in road traffic control department of Govt. of west Bengal and having exposure in vehicular emission.

**Knowledge-**

In this study it means gained information on morbidities and its prevention related to air pollution are measure in terms of response given to the Knowledge questionnaire.

**Morbidities** – Disease arises in the body due to exposure in air pollution.

**Prevent** - stop the occurrence of morbidities related air pollution.

**Control-** Restriction of occurrence or limit the disease progression.

**Air pollution-** Pollutant present in the air which causes morbidities related air pollution among the traffic police.

**Information booklet** – Materiel prepared by the researcher to provide information regarding morbidities related air pollution and its preventive and control measures.

Tool for data collection-

Tool 1 – Structure questionnaire to assess demographic data

Tool II – Structured questionnaire to assess knowledge on morbidities and its preventive measures related to air pollution.

Tool III- Checklist to assess practice of using preventive measures related to air pollution.

### **Study tools**

**Questionnaire development:** questionnaire develops as a booklet in Bengali and English language with instructions was prepared based on WHO guidelines and research study result.

**Validity:** After initial preparation the questionnaire to be judged by a group of experts in the Department of Community Medicine of different Govt Medical College, Kolkata who will make necessary correction. This final corrected version was used for pre testing.

**Reliability of the tool:** Appropriate statistical methods used to check the reliability of the tools. Tool II Knowledge questionnaire the reliability was computed using Kuder Richardson formula. The reliability of the Knowledge questionnaire was  $r = .83$ , hence the questionnaire found to be reliable.

### **Plan for data collection procedure-**

- Ethical permission has been taken from Institutional Ethical committee.
- Formal administration permission obtained from the concerned authority.
- Sample had been selected as cluster sampling technique.
- Talked to each traffic guard Officer in-charge those who are selected for study.
- Self-introduction had been given to the participants and rapport had been established.
- Purpose of the study had been explained to each participant. And they have right to decide to be a participant in the study.
- Informed consent had been taken from each participant and they had given assurance of their confidentiality of their responses
- Data will be collected with structured questionnaire on demographic variables
- Knowledge questionnaire regarding morbidities and its prevention related air pollution
- Assess practice of using preventive measures related air pollution through checklist.

## RESULTS

### Section-1

**Knowledge of Traffic Police on morbidities & its preventive measures regarding air pollution.**

**Table 1: Frequency percentage distribution of knowledge scores of traffic police**

n = 200

| Obtained knowledge score range | Frequency (f) | Percentage (%) |
|--------------------------------|---------------|----------------|
| 1-4 (Fair)                     | 34            | 17             |
| 5-8(Average)                   | 68            | 34             |
| 9-12(good)                     | 85            | 47.5           |
| 13-16( very good)              | 13            | 6.5            |
| Total                          | 200           | 100            |

Maximum Score 16

Minimum score – 0

Table -1 shows that 68(34%) of the Traffic Police had average Knowledge Score and 85(47.5%) having good knowledge score.

**Table 2: Mean, Median and standard deviation of knowledge scores among Traffic Police**

| Variable  | Maximum possible score | Range | Mean | Median | Mode   | S.D |
|-----------|------------------------|-------|------|--------|--------|-----|
| Knowledge | 16                     | 1-16  | 6.5  | 7      | 15.375 | 3   |

Table 2 shows that Knowledge scores of Traffic Police ranged from (1-16) where maximum possible Score was 16. The mean knowledge score was (6.5), median (7), mode is 15.375 & SD is 3.

Total 200 samples were taken for study, data has collected through questionnaire, data has compiled and analysed. Result shown (34/200) 17 % traffic Police have fair knowledge (Score 1-4/16), (68/200) 34 % traffic police have average knowledge level (score, 5-8/16), (85/200) 47.5% traffic police have good knowledge level (score-9-12/16), (13/200) 6.5% traffic police have very good knowledge level (score 13-16/16). The mean knowledge score was (6.5), median (7), mode is 15.375 & SD is 3.

## Section II

### Assess practice of using preventive measures related to air pollution

**Table 3: Frequency percentage of different preventive measures for prevention of morbidities regarding air pollution among traffic police**

**n = 200**

| <b>S. No</b> | <b>Using Preventive measures</b>                                           | <b>Frequency (Out of Total sample 200)</b> | <b>Percentage%</b> |
|--------------|----------------------------------------------------------------------------|--------------------------------------------|--------------------|
| <b>1</b>     | Mask                                                                       | <b>136</b>                                 | <b>68</b>          |
| <b>2</b>     | Goggles                                                                    | <b>124</b>                                 | <b>62</b>          |
| <b>3</b>     | Umbrella                                                                   | <b>68</b>                                  | <b>34</b>          |
| <b>4</b>     | Drinking Plenty of water                                                   | <b>93</b>                                  | <b>46.5</b>        |
| <b>5</b>     | Deep breathing exercise                                                    | <b>28</b>                                  | <b>14</b>          |
| <b>6</b>     | Adequate rest & sleep                                                      | <b>42</b>                                  | <b>26</b>          |
| <b>7</b>     | Meditation                                                                 | <b>12</b>                                  | <b>6</b>           |
| <b>8</b>     | Taking Balanced diet                                                       | <b>24</b>                                  | <b>12</b>          |
| <b>9</b>     | Changing duty place most polluted area to less polluted area               | <b>10</b>                                  | <b>5</b>           |
| <b>10</b>    | Receiving update knowledge regarding harmful pollutant at own working area | <b>nil</b>                                 | <b>nil</b>         |

Table 3 shows that Maximum Traffic Police (136/200) 68% using Mask , Goggles (124/200) 62%, Umbrella (68/200) 34%, drinking plenty of water (93/200) 46.5%, Deep Breathing exercise (28/200) 14%, Adequate rest & sleep (42/200) 26%, meditation (12/200) 6%, taking balanced diet (24/200) 12%, Changing duty place most polluted area to less polluted area (10/200) 5%, and no one receiving update knowledge regarding harmful pollutant at working area.

### Section - III

**Table 4: Association between Knowledge of the Traffic police and Practice of using preventive and control measures**

**n = 200**

| S. No | Median               | Variables                 |                               | Chi-square                | df | t-value | At 0.05 level of significant |
|-------|----------------------|---------------------------|-------------------------------|---------------------------|----|---------|------------------------------|
| 1.    | Median &Below median | Using preventive measures | Not using preventive measures | 8.8551                    | 1  | 3.84    | significant                  |
|       |                      | 62                        | 24                            | Yates correction is7.7944 |    |         |                              |
|       | Above median         | 101                       | 13                            |                           |    |         |                              |

According to Table 3, At 1 degree of freedom, the table value of chi-square at 0.05 level of significant is 3.84 and calculated chi-square value of knowledge level is 8.8551 and Yates correction is 7.7944. So here null hypothesis is rejected research hypothesis is accepted. So there is association between Knowledge level of traffic police and practice of using preventive and control measures regarding air pollution.

## Discussion

**Kshitij Karki, Susmita K. C (Feb 2019)** <sup>[5]</sup>, studied on Prevention of respiratory problems among traffic police: A cross sectional study in Kathmandu valley exploring knowledge and practice. The objective of the study was to identify the knowledge and practice regarding prevention of respiratory problems among traffic police. The study result interpreted that one fourth participant traffic polices had knowledge but very few were practicing the preventive measures for respiratory problems. It is recommended to conduct awareness campaign to the traffic police and advocate the government to provide the protective measures.

This current studies also shows that 47.5 % traffic police have good Knowledge, but 68% traffic police are using Mask, 62% traffic police using goggles, 46.5% are taking plenty of water, 34 % taking adequate rest and sleep. According to Table 3, At 1 degree of freedom, the table value of chi-square at 0.05 level of significant is 3.84 and calculated chi-square value of knowledge level is 8.8551 and yates correction is 7.7944. So here null hypothesis is rejected research hypothesis is accepted. So there is association between Knowledge level of traffic police and practice of using preventive and control measures regarding air pollution. If traffic police gain their knowledge through, information booklet or periodically awareness programme so that they may increase their Knowledge as well as their practice to use preventive measures related to air pollution. As traffic polices are working in pollutant area, they must maintain always protective measures to prevent different morbidities related to air pollution.

## Conclusion-

Study results shown (34/200) 17 % traffic Police have fair knowledge (Score 1-4/16), (68/200) 34 % traffic police have average knowledge level (score, 5-8/16), (85/200) 47.5% traffic police have good knowledge level (score-9-12/16), (13/200) 6.5% traffic police have very good knowledge level (score 13-16/16). Maximum Traffic Polices (136/200) 68% using Mask, Goggles (124/200) 62%, Umbrella (68/200) 34%, drinking plenty of water (93/200) 46.5%, Deep Breathing exercise (28/200) 14%, Adequate rest & sleep (42/200) 26%, meditation (12/200) 6%, taking balanced diet (24/200) 12%, Changing duty place most polluted area to less polluted area (10/200) 5%, and no one receiving update knowledge regarding harmful pollutant at working area. As a health care personnel, our aim to motivate for practice to use different preventive measures to prevent different morbidities related air pollution. According to knowledge gap information booklet to be

prepared and distribute to traffic polices increase their knowledge and to Motivate for practice to use preventive measures to prevent different morbidities.

## References

1. Air pollution control board, Air pollution in different area of Kolkata, [internet] 2021 [cited on August 2021], **Available from:** <https://www.pollution-alert.com/en/india/pollution/geo-1252881/west-bengal.html>
2. An emission inventory of Kolkata control board [internet] 2019 [cited on August 2021],
3. Dey A, Mishra T, sahu s. saha A.Evaluation of impact of ambient air pollution on respiratory health of traffic police in Kolkata. University journal of Health Sciences BLDU.[internet] 2021[cited on 2021 Jun]; 6(1):35 available from: [researchgate.net/publication/350749431](https://researchgate.net/publication/350749431).
4. Gowda G, and Thenambigai R. A study on respiratory morbidities and pulmonary functions among traffic policemen in Bengaluru city, [internet] 14 th Jan 2020 [cited on 2021 Jun]; Indian J Community Med. Jan- March, 45(1):23-26. Available from: [Ncbi.nlm.gov/pmc/articles/PMC6985951](https://ncbi.nlm.gov/pmc/articles/PMC6985951).
5. Karki K, susmita K.C. Prevention of respiratory problems among traffic police: A cross sectional study in Kathmandu valley exploring knowledge and practice. [internet] 2019 [cited on 2021 Jun]; US National library of Medicine enlisted journal, Available from: [researchgate.net/publication/331088431-prevention-of-respiratory-problem](https://researchgate.net/publication/331088431-prevention-of-respiratory-problem).
6. Lippincott Williams & Wilkins, health impact of air pollution, [Internet] [cited on August 2021] Available on: <https://www.jstor.org/stable/3703461>. Vol. 14, No. 2 (Mar., 2003), pp. 228-239.

7. Mary E. Assessment of Respiratory Morbidities among Police Personnel in Kochi city,[internet] October 2013 [cited on 2021 April];Available from: [Ernakulam dspace.sctimst.ac.in/jspui/bitstream/123456789/2264/1/6](https://dspace.sctimst.ac.in/jspui/bitstream/123456789/2264/1/6).
8. National institute of environmental health science, Health effect of Air pollution [Internet][sep 2021][cited on Nov 2021]Available from: <https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm>
9. Pratama A R, Arliansyah Jand Agustien M, Analysis of air pollution due to vehicle exhaust emissions on the road networks of beringin janggut area. [internet] [ 2019] [cited august 2021]; Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4243514/>
10. Sasikumar S, Maheshkumari K, Dilara K, Padmavathi R,(2020) Assessment of pulmonary functions among traffic police personnel in Chennai city - A comparative cross-sectional study, [internet] 2020 [cited on 2021 Jun]; 9(7):p- 3356-60. Available from: [Jfmpc.com/article.asp issn](https://www.jfmpc.com/article.asp?issn=).
11. Zorana J. Andersen, Martin Hvidberg, Steen S. Jensen, Matthias Ketzel, Steffen Loft, Mette Sørensen, Anne Tjønneland, Kim Overvad, and Ole Raaschou-Nielsen Chronic Obstructive Pulmonary Disease and Long-Term Exposure to Traffic-related Air Pollution, A Cohort Study, American journal of respiratory and critical care medicine. [internet] 2010 [cited on August 2021 Available from: <https://www.atsjournals.org/doi/full/10.1164/rccm.201006-0937OC>
12. Ms Swagata Roy. Air pollution in India has caused losses of up to Rs 7 lakh crore annually[internet] [22 April 2021][cited on August 2021]: Available on <https://www.downtoearth.org.in/blog/air/air-pollution-in-india-has-caused-losses-of-up-to-rs-7-lakh-crore-annually-76616>.

**Chapter: 10****A Questionnaire based Survey on Student's Opinion on the Prevailing Methods in Medical Education during the COVID Pandemic****Dr. Monika Mishra****HOD & Sr. Professor, Department of Pharmacology****SMS Medical College, Jaipur**

**Abstract:** Covid pandemic has caused disruption in health care system worldwide including the medical education. Facing the challenges for the faculty to deliver the lectures safely while ensuring the integrity and continuity of medical education for students, we moved on to complete on-line teaching and learning methodology from the conventional class-room lectures, practicals, tutorials and group discussions. A questionnaire based study was planned for 150 medical students in SMS Medical college, Jaipur who were to appear in the University Examination. 19 questions were framed pertaining to the subject of Pharmacology, methodology of teaching, comparison with the traditional teaching, satisfactory level of teaching methods and also the assessment patterns and send to the students through online platform. They responded promptly and the results were then analyzed. Results showed that the new era students are no longer interested in attending monotonous theory based lectures but have keen interest in clinical application with reasoning skills through innovative methods of teaching like problem solving interactive clinical seminars and case studies to prepare them for medical practice and henceforth, the medical education system in India needs significant restructuring and reforms with emphasis on rational use of medicines.

**Keywords:** Pharmacology, Assessment, Clinical seminars, Medical education.

**Introduction**

Medical education and its tools have to adapt to meet the ever growing demands of the profession. The subject of pharmacology is the backbone of modern medicine, serving as the foundation stone for skilled and good clinical practice. The subject also prepares medical graduates as scientists with substantial knowledge of pharmacology and practical lab skills for research purpose.

**Aims & Objectives**

The global disruptions caused by the Covid Pandemic in the year 2020, lead us to a new perspective to find out an alternative teaching method to ensure the continuity of medical education. E-learning and on-line classes become the sole option for the faculty to deliver the lectures safely. The study was planned to ascertain the impact of on-line teaching method on understanding of the subject Pharmacology and to explore the feedback opinion of students on the various teaching methods.

### Method

During the Covid pandemic, as the e-classes were arranged instead of the conventional classroom, an on-line feedback from 150 students of second M.B.B.S. from SMS Medical College, Jaipur: who were appearing in the University examination, was taken in the form of a questionnaire. All possible questions regarding learning-teaching methods with regards to the subject of Pharmacology were framed and send personally to their (WhatsApp) mobile nos. They responded promptly and the results were then analysed.

**Table 1: Learning Based Data of Students**

| Learning Based Data                                                 | No. of students | Percentage |
|---------------------------------------------------------------------|-----------------|------------|
| Method of learning with lecture notes and text books                | 132             | 88         |
| Method of learning with their own notes                             | 18              | 12         |
| Regular studies                                                     | 105             | 70         |
| Studies during assessments                                          | 45              | 30         |
| Pattern of learning both mugging and understanding                  | 108             | 72         |
| Pattern of learning with only understanding (difficulty in mugging) | 42              | 28         |

**Table 2: Student's Opinion on Teaching Techniques**

| Opinion                        | No. of students | Percentage |
|--------------------------------|-----------------|------------|
| Case based interactive session | 150             | 100        |
| Case studies                   | 84              | 56         |
| Student seminars               | 57              | 38         |
| Experimental pharmacology      | 6               | 4          |

|                                                                       |     |    |
|-----------------------------------------------------------------------|-----|----|
| Pharmacy Practical                                                    | 3   | 2  |
| Theory lectures blackboard - chalk method in conventional class rooms | 105 | 70 |
| Theory Lectures - on line videos and PPT                              | 45  | 30 |
| Lectures to be - precise and overview                                 | 33  | 22 |
| Lectures to be - Elaborative with more details                        | 117 | 78 |
| More viva-voce/tutorials                                              | 120 | 80 |
| Frequent assessment to be a cause of stress                           | 30  | 20 |
| Vertical integrated teaching was opted by                             | 135 | 90 |
| Pharmacy to be taught as an orientation course during internship      | 75  | 50 |

**Table 3: Level of satisfaction of students**

| Level                                 | No. of students | Percentage |
|---------------------------------------|-----------------|------------|
| Satisfaction with teaching techniques | 100             | 66.67      |
| Satisfaction with assessment patterns | 120             | 80         |
| Satisfaction with teaching faculty    | 120             | 80         |
| Reforms suggested by                  | 42              | 28         |

**Reforms suggested by Students**

Horizontal integration with other second MBBS subjects was equally important to vertical integration. More emphasis on case-studies. More interactive sessions. Student seminars. Drug related demonstrations, Home assignments be given. Lectures to include more diagrams, flow charts, illustrations, and related with critical cases to make it more interesting. Mnemonics be added to help memorize. Doubt sessions be added. Q and A session based on clinical case after each lecture emphasizing on rational prescribing of the drug taught. For assessments, more tutorials, viva voce and MCQ pattern of objective questionnaire be added and students be also marked for student seminars. The teaching faculty to not just read out the ppt but must explain the slide clearly in simple words.

## Discussion

The curriculum in pharmacology is witnessing a change from emphasis on animal experiments and dispensing pharmacy based curriculum to an applied holistic approach. All students found the subject Pharmacology important for rational prescribing for future clinical practice. All the students opined that case based interactive session should be part of a regular teaching schedule. In small group learning, students were able to ask questions with confidence and get their doubts cleared besides developing personal rapport with the teacher. Students enjoyed tutorials as it involved active participation of all students. Problem based teach helped students to develop critical thinking skills for rational prescribing. Case studies with real life situations were the most interesting and liked by the students as they motivated them towards self-directed learning. Though the study reflected the student's reservation towards older conventional class room teaching, they did appreciate the case studies and problem based learning. The training of a tomorrow' doctor who enters medical practice should include a greater integration of basic and applied pharmacology for producing health care professionals with appropriate knowledge, attitude and skills for the rational use of drugs through - AN INNOVATIVE CURRICULUM REGIMEN. It is recommended to appoint curriculum managers and discipline champions who work together to ensure proper balance in various discipline. The application of Information and Communication Technology (ICT) in the teaching learning process is emphasized, which promotes evidence based medicine and is useful did in a Computerised Aided Lab (CAL) for variuos simulation exercises, as an alternative to animal models. ICT is a means of sharing of relevant information amongst peers, promoting team spirit. The latest chip technology, various in-silico methods and newer discipline like genomics, proteonomics and molecular pharmacology need to be accommodated to increase the knowledge base within the timeframe for training a medical graduate, to meet the global standards. Worldwide access to ICT facilitates in medical school would minimize global differences in Pharmacological standards. There is also a challenge of digital literacy which dictates the need for promoting computer literacy among faculty and students so that the benefits of ICT can be fully harnessed. In these challenging times, implementing newer methods of teaching would definitely raise the bar of medical education.

## Conclusion

Traditional Pharmacology teaching in India has been criticized for not preparing students for medical practice as also facing the challenge to catch up with researches growing at a fast pace internationally. The pharmacology component of medical curriculum needs to be clearly defined in terms of input and expected outcomes which must be reliably and validity assessed as a prerequisite for a medical graduate. Thus, the innovative integrated medical curriculum, training medical students with a holistic mindset at the very outset, along with developing skills such as a communication, team spirit aided with ICT with will enable the medical graduate to function effectively in clinical practice, academics and pharmaceutical industry.

## References

1. Woolliscroft Jo. Innovative in response to The Covid-19 Pandemic crisis. Academic Medicine: Journal of the Association of American Medical Colleges. 2020
2. Sklar DP. Covid-19: Lessons from the disaster that can improve health professionals education. Academic Medicine: Journal of the Association of American Medical Colleges. 2020.
3. Serilk Z, Marzhan A, Chandan Pal S. Integration of traditional and virtual Experiment in the process of teaching physics at NIS, Shymkent, Kazakhstan. IJHBR:2020
4. Organization WH. WHO director - General's Opening remarks at the Media briefing on Covid-19 11 March 2020. <https://www.who.int/dg/speeches/details/who-director-generals-s-opening-remarks-at-the-media-briefing-on-covid-19...11-March-2-20>. 2020
5. Mian A, Khan S. Medical education during pandemics: A UK Perspective. BMC Medicine 2020.
6. McCullough LB, Coverdale J, Chervenak FA. Teaching Professional Formation in Response to the Covid-19 Pandemic. Academic Medicine, 2020: Epub 04/15.

7. Chiodini J. Online Learning in the Time of Covid-19. Travel Medicine and Infectious Disease, 2020.
8. Chandra S, Laoteppitaks C, Mingioni N, Papanagnou D, Zooming-Out Covid : Virtual Clinical Experiences in an Emergency Medicine Clerkship. Medical education. 2020.
9. Badyal D. Practical Manual of Pharmacology. 2nd ed. New Delhi: Jaypee Brothers: 2018.
10. Kalra J, Singh S, Badya D, Barua P, Sharma T, Dhasmana DC, et al. Poetry in teaching pharmacology: Exploring the possibilities. Indian J Pharmacol. 2016; 48: 561-4.
11. The Journal of Clinical Pharmacology, Teaching Pharmacology in An Innovative Medical Curriculum: Challenges of Integration, Technology and Future Training. 07 March 2013.
12. The attitude of medical students of Tabriz University of Medical Sciences towards the necessity of clinical pharmacology. Future of Medi Edu J. 2012; 2(1): 32-.5.
13. Akat PB, Karande VB, Murthy MB, Burute SR. Interns Opinion on "bedside pharmacology clinics' and its incorporation in undergraduate curriculum. J Pharmacol Pharmacother. 2012; 3(1): 56.
14. Badyal DK, Bala S, Kathuria P. Student evaluation of teaching and assessment methods in pharmacology. Indian J Pharmacol 2010; 42: 87-9.
15. World Bank, HNPSTATS: The World Bank's Health, Nutrition and Pollution Data Platform. Available at (<http://devdata.worldbank.org/hnpstats/hnpsummary/countrydata/getshowdata.asp?sctry>>Ind.india>) accessed august 3, 2006.
16. Barrows HS, Tamblyn RN. Problem based learning: an approach to medical education. New York: Springer publishing company: 1980.

**Chapter: 11****Therapeutic potential of Ayurveda management in atrial fibrillation with special reference to paroxysmal and Lone AF****Dr Mini V G<sup>1\*</sup> and Dr Giri P V<sup>2</sup>****<sup>1</sup>PhD Scholar, Department of Kayachikitsa, Vaidyaratnam Ayurveda College  
Ollur, Trissur, Kerala, 680306****<sup>2</sup>Professor and HOD, Department of Kayachikitsa, Vaidyaratnam Ayurveda College  
Ollur, Trissur, Kerala, 680306  
E-mail: mini.tinku@gmail.com**

**Abstract:** Atrial fibrillation (AF) is an increasingly prevalent cardiovascular pandemic encountered in clinical practice. Disorders in electrical wavefront propagation mainly caused by structural and molecular abnormalities which can be measured non-invasively by surface electrocardiogram. Management of Atrial fibrillation related electro-pathology to maintain sinus rhythm includes lifestyle changes, pharmaceutical and nutraceutical therapies. Geriatric population with Atrial fibrillation is at increased risk for both stroke and bleeding with AF anticoagulation. Hence anticoagulation must be tightly monitored in these conditions with a goal of maintaining the INR at 2. Proper evaluation and diagnosis describe the management strategies such as anticoagulation, rate control medication, rhythm control medication, interventional cardiac procedures etc. Identifying the complex pathophysiology of Atrial fibrillation in individual cases is difficult and assessment of the efficacy of current therapies is suboptimal. Therefore, unravelling the electro-pathology and underlying molecular mechanism is expected to develop an innovative personalized diagnostic tools and treatment modalities. As per Ayurveda classics “*Hridroga*” i.e., disease pertaining to “*Hridaya*” are very well explained along with management using classical Ayurveda formulations. According to Ayurveda principles all movements including rhythmic atrioventricular contractions are regulated by the functions of *vata* dosha particularly *vyana vayu*. The management of rhythm abnormality can be classified mainly in to two stages i.e., during the episodes of atrial fibrillation with symptoms and asymptomatic phase. In paroxysmal and lone AF management, Ayurveda formulations along with *rasayana* therapy beneficial to prevent the thrombogenic stroke and cardiogenic ischaemia. In the asymptomatic stage regular internal medications indicated in *Hridroga chikitsa* along with external therapies and administration of *rasayana* can be beneficial to prevent recurrence of

rhythm abnormalities. This paper is a sincere effort to understand atrial fibrillation in terms of Ayurveda parlance and explain the inter professional strategies, which will be beneficial for improving the Quality of Life as well as preventive aspects in AF.

**Keywords:** Atrial fibrillation, *Rasayana therapy*, *Hridroga*, Quality of Life, paroxysmal AF, Lone AF

### Introduction

Atrial fibrillation (AF) is the most common type of cardiac arrhythmia, an ectopic focus has taken over pace making function from the Sino-atrial node. Disorders of rhythm can be classified clinically in to Iregular rhythm, tachycardias and bradycardias. tachycardias may be sinus, supraventricular( including AF and flutter) or ventricular. Atrial fibrillation, atrial flutter and atrial tachycardia are common arrhythmias associated with a variety of cardiac conditions. In atrial fibrillation, contractions of atrial cardiomyocytes are completely irregular, rapid, un-coordinated and functionless<sup>1</sup>. Atrial fibrillation may occur by itself or with other arrhythmias, notably atrial flutter. Comparing with atrial fibrillations, atrial flutter is more organized involving regular atrial activation which in turn produces a characteristic saw tooth pattern on ECG<sup>2</sup>. The most common persistent cardiac arrhythmia, atrial fibrillation may be associated with deterioration of haemodynamic functions resulting significant morbidity and mortality<sup>3</sup>. Due to rhythm irregularity blood flow through the heart becomes turbulent, getting chances of clot formation and accelerating the manifestation of stroke. Symptoms may vary from asymptomatic to symptoms such as chest pain, palpitations, fast heart rate, shortness of breath, nausea, dizziness, diaphoresis and generalised fatigue. As life span is increasing world-wide, the steep rise in the prevalence of atrial fibrillation in the general population is becoming an urgent public health issue. AF might significantly affect patient's quality of life as it is associated with serious complications<sup>4</sup>.

The major goal of rhythm management is to improve patient's symptom burden and Quality of life, which is becoming an increasingly important clinical outcome measure in AF. In some cases paroxysmal AF will become permanent as the underlying electro-pathological condition progresses. As per Ayurveda classics disease pertaining to heart and its management along with *rasayana* administration are detailed under the heading *Hridroga* treatment<sup>5</sup>. When AF persists for a period of months, electrical remodelling occurs with atrial fibrosis. Early intervention in

curative as well as preventive aspect with clinically proven treatment modalities are beneficial in the management of AF particularly in lone AF and paroxysmal patterns.

### **Epidemiology**

Atrial fibrillation is the most common sustained cardiac arrhythmia. The prevalence of atrial fibrillation has been increasing worldwide. It has been estimated that the number of individuals with atrial fibrillation will double or triple by the year 2050. The global burden of atrial fibrillation is unknown because of inability to compare the epidemiology of Atrial fibrillation in different countries and ethnicities has been limited by study design issues. The overall prevalence in the general population is estimated to be 0.4%. the incidence and prevalence of Atrial fibrillation steadily increase with age, such that this arrhythmia occurs in <0.5% of the population <50 years of age and increases to approximately 2% at ages 60-69 years. The age adjusted 'prevalence of atrial fibrillation is higher for men than women and higher for whites than blacks.

### **Pathophysiology**

Paroxysms of atrial fibrillation are caused by spontaneous depolarizations of atrial tissue outside the sinoatrial node at rates faster than the sinus rhythm. Ectopic activities commonly originate from the pulmonary veins. Progression from paroxysmal to persistent AF reflects the progression from arrhythmogenic trigger mediated initiation of AF to an electro-pathology-mediated arrhythmia indicates the structural impairment of atrial tissues. Major Sustained structural damage in atrial cardiomyocytes is breakdown of the mitochondrial, cytoskeletal and sarcometric networks accompanied by autophagic protein degradation and changes in chromatin composition. In long standing persistent atrial fibrillation extensive conduction abnormalities are also noted along the lateral boundaries of the atrial musculature. Multiple lines of intra-atrial conduction block result an increase in the number of fibrillation waves. Quantification of electrophysiological parameters such as the amount of conduction block and the number focal fibrillation waves can be utilized to stage the severity of atrial fibrillation and determines the effectiveness of anti-arrhythmic therapy. Along with findings of electrophysiological irregularities, identification of the underlying molecular defects can be beneficial in the development of mechanism based, potentially more effective atrial fibrillation therapies. Molecular pathways involved in these structural changes include defective proteostasis,

activation of stress signalling, genome instability and inflammatory signalling. Elucidating the key modulators associated with molecular mechanisms, electrical and contractile impairment underlying atrial fibrillation is the first step in developing novel diagnostic tools (patient tailored) for screening, prevention and management at various stages.

### **Etiological factors and triggers**

The exact cause of atrial fibrillation is unknown, but it is usually associated with clinical diagnosis of Hypertension and coronary artery diseases. Any condition that leads to inflammation, stress, damage, or ischemia alters the electrophysiology and sustained structural integrity of atrial cardiomyocytes can result in the manifestation of atrial fibrillation. In developing countries, the presence of congestive heartfailure markedly increases the risk AF. The commonly encountered causes that shares strong association with AF include advanced age, congenital heart disease, underlying heart disease (valvular disease, coronary artery disease, structural heart disease) etc.

### **Patterns and staging**

Clinically, Atrial fibrillation is classified as paroxysmal, persistent or permanent- the three P<sup>S6</sup>

### **Patterns of atrial fibrillation**

| S.NO | Pattern    | Features                                                                                                                                                                                                                                                                                                     |
|------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.   | Paroxysmal | <ol style="list-style-type: none"> <li>1. Characterized by self-terminating episodes that generally lasts &lt; 7days.</li> <li>2. Most cases occur in patients with evidence of structural heart disease, but there may be no evidence of concomitant disease.</li> </ol>                                    |
| 2.   | persistent | <ol style="list-style-type: none"> <li>1. Generally, lasts &gt;7 days and often requires electrical or pharmacologic cardioversion.</li> </ol>                                                                                                                                                               |
| 3.   | permanent  | <ol style="list-style-type: none"> <li>1. &gt; 80% of patients with permanent AF have an identifiable underlying cause.</li> <li>2. AF is classified as permanent when it has failed cardioversion.</li> </ol>                                                                                               |
| 4.   | Lone AF    | <ol style="list-style-type: none"> <li>1. Atrial fibrillation occurring in the absence of cardiac disease or other known etiological factors</li> <li>2. About 50% of patients with paroxysmal AF and 20% with persistent or permanent AF have structurally normal hearts, known as Lone AF-DAVID</li> </ol> |

|  |                                                   |
|--|---------------------------------------------------|
|  | 3. Commonly seen in individuals <60 years of age. |
|--|---------------------------------------------------|

**CHA2DS2-VASc Score:** for risk stratification recommended for non valvular AF.

#### Current guidelines

|    |                                                                                        |                                                              |
|----|----------------------------------------------------------------------------------------|--------------------------------------------------------------|
| 1. | AF patients with CHA2DS2-VASc score 2 or more                                          | Oral anticoagulation is recommended                          |
| 2. | Females: absence of risk factors<br>Males: CHA2DS2-VASc score 1 or 0                   | low stroke risk                                              |
| 3. | In all patients with AF                                                                | Recommended CHA2DS2-VASc score for assessment of stroke risk |
| 4. | Low CHA2DS2-VASc Score                                                                 | Aspirin not recommended                                      |
| 5. | Patients with low ejection fraction                                                    | Recommended catheter ablation                                |
| 6. | Obese patients with AF                                                                 | Recommended weight loss                                      |
| 7. | AF patients with a risk of stroke and contra indication of long- term anti-coagulation | Percutaneous left atrial appendage occlusion                 |

#### Clinical examination and diagnosis

Initial clinical evaluation by proper history taking and physical examination are curcial for diagnosis and risk stratification. Main focus is on confirming the diagnosis, classifying the type of AF, establishing the risk of thromboembolism and defining the most effective treatment strategy<sup>7</sup>. A complete history should focus on symptoms such as palpitations, chest pain, shortness of breath, increased lower extremity swelling, dyspnea on exertion, and dizziness. History taking is imperative in identifying signs and symptoms along with risk factors. On general physical examination, patients may be tachycardiac with an irregularly irregular pulse<sup>8</sup>. The heart rate usually ranges from 110/mt to 140/mt. Extremities should be evaluated for edema, peripheral pulses in both upper and lower extremities, and integumentary signs of peripheral vascular disease (PVD) such as hair loss and skin breakdown.

Laboratory investigations required to evaluate for the cause of atrial fibrillation. The standard blood tests that are recommended by the ACC/AHA are thyroid function tests, measurement of

serum electrolytes and haematocrit. A complete blood count (for infection), basic metabolic panel for electrolyte abnormalities, thyroid function test to evaluate for hyperthyroidism. Recent studies have reported that elevated biomarkers such as C- reactive protein (CRP) and B-type natriuretic peptide concentration also predict an increased risk<sup>9</sup>. Patients who developed AF had significantly increased levels of D-dimer. Other recommended studies include chest radiography, ECG and transthoracic echocardiography to exclude mitral stenosis and LA and LV enlargement<sup>10</sup>.

In AF, different presentations on electrocardiography are a cornerstone in establishing the etiology of AF. ECG shows typical narrow complex irregularly irregular pattern with no distinguishable p waves. Fibrillatory waves may be seen in older patients<sup>11</sup>. AF may not be associated with a rapid ventricular rate and often asymptomatic which can be identified using ECG. Residual atrial activity of Coarse AF is generally best seen in lead V1 with the absence of P wave like activity in other leads. Several cardiac diseases

### **Signs and symptoms**

The clinical presentation of AF may vary from asymptomatic to catastrophic complications such as cardiogenic shock and ischaemic stroke<sup>12</sup>. AF frequently leads to reduced functional capacity, dyspnoea, palpitations, fatigue, tachycardia, heart failure and leads to significant morbidity and mortality

### **Differential Diagnosis**

Patients with atrial fibrillation may be able to describe the chaotic irregularity of heart, has a distinctive irregularly irregular rhythm with absent p waves<sup>13</sup>. Whereas atrial flutter has a regularly irregular rhythm with absent P-waves. Enquiry as to the mode of- termination of a palpitation is particularly important in taking a history<sup>14</sup>. By definition, all palpitations start suddenly when the patient is first aware of the symptom. However the nature of the termination may provide some diagnostic clues as to the underlying heart rhythm. If the patient describes sudden termination, this is suggestive of some form of paroxysmal arrhythmia which has suddenly reverted to normal. If by contrast, the palpitation subsides gradually, this would be more consistent with a sinus tachycardia which has gradually slowed down to normal. Differential diagnosis includes atrial flutter, atrial tachycardia, WPW syndrome and Atrioventricular nodal re-entry tachycardia.

### Complications and risk factors

The most devastating complications of AF are thromboembolism, tachycardia induced cardiomyopathy and haemorrhagic stroke<sup>15</sup>. Due to irregularity of the atrial contractions, blood flow becomes turbulent resulting thrombus formation and embolize to the brain significantly impairing quality of life.

### Management

The management strategies requires confirmation of the arrhythmia followed by characterisation of patients using the 4S, -AF scheme, which includes stroke risk, symptom severity, severity of AF burden and substrate severity<sup>16</sup>. There are four aspects to the treatment of AF. The control of ventricular rate, the restoration of sinus rhythm, the maintenance of sinus rhythm and prevention of embolism<sup>17</sup>. Careful assessment, risk stratification and therapy can markedly improve prognosis<sup>18</sup>. Administration of all anticoagulant drugs, comorbid conditions that may be complicated by bleeding such as peptic ulcer, uncontrolled hypertension, alcohol misuse, frequent falls, poor drug compliance and potential drug interactions, are all relative contraindications. In warfarin treated patients, anticoagulation can be reversed by administering vitamin K or clotting factors, but there are no current antidotes for the direct thrombin inhibitors<sup>19</sup>.

As per Ayurveda classics, management strategies can be explained on the basis of *samprapti*(aetiopathogenesis) of *Hridroga*<sup>20</sup>. According to the principles of Ayurveda all structural and functional activities are regulated by *Vata*, *Pitta* and *Kapha*. In Atrial fibrillation, irregularities in cardiac rhythm are mainly due to impaired functions of these body constituents. *Vyana vayu*, *Sadhaka Pitta* and *Avalambaka Kapha* are involved in the pathogenesis<sup>21</sup>. Hence treatment strategy should be focussed to maintain the normal function of these basic body constituents particularly the functions of *Vyana Vayu*<sup>22</sup>. Many patients with symptomatic AF also have asymptomatic episodes<sup>23</sup>. In AF, treatment modalities are different in symptomatic and asymptomatic phase. Therapeutic formulations indicated in *Vataroga*, *Hridroga*, *Hridgata Vata*, *Swasa-Kasa roga* can be incorporated in the management of AF considering the digestive capacity, strength of patients, associated comorbidities, and severity of the symptom. The main objective is preventing the progression, electric and molecular pathological remodelling and atrial fibrotic changes. Internal administration of *Vidaryadi* decoction<sup>24</sup>, *Maharasnadi*<sup>25</sup>

decoction, and various *Arishta-Asava* formulations indicated in *Hridroga* treatment can be beneficial. Clinically proven Rasayana prayogas like *Brhma Rasayana*<sup>26</sup>, internal administration of *Bala thyla*<sup>27</sup> etc can be given according to the condition of the patient in asymptomatic phase for the prevention and progression of Paroxysmal and lone AF.

### Conclusion

Deeper understanding of molecular and electro-pathological abnormalities driving AF in terms of Ayurveda principles is needed to develop a standard protocol in the management of AF. Like AF innovation platform in Netherlands (AFIP) co-creation platforms are essential for clinical trials and research works. These observation calls for the development of patient-tailored diagnostic testing and treatment strategies. Financial support from Government and private funding agencies are needed to support these translational studies from bench to bedside.

**References:**

1. Aubrey Leatham et.al. (1986), lecture notes on cardiology, third edition, Chapter 8.
2. David C Dale and Daniel D Federman, ACP Medicine, Volume 1, 3rd Edition, American college of Physicians, chapter 19, Page.No.238
3. Atrial fibrillation - statpearls - NCBI bookshelf (no date). Available at: <https://www.ncbi.nlm.nih.gov/books/NBK526072/> (Accessed: April 14, 2023).
4. Prof. K. R Srikantha Murthy, Vagbhatas Astanga Hrdayam, Published by Chowkhamba Krishnadas Academy, volume II, chapter no-6, p.no 277.
5. Valentin Fuster et.al, THE HEART, Volume 1, 13th Edition, published by The McGraw-Hill companies, Chapter40, Page.no-963
6. David C Dale and Daniel D Federman, ACP Medicine, Volume 1, 3rd Edition, American college of Physicians, chapter 19, Page.No.238,239.
7. Valentin Fuster et.al, THE HEART, Volume 1, 13th Edition, published by The McGraw-Hill companies, Chapter2, Page.no-28, 29
8. David C Dale and Daniel D Federman, ACP Medicine, Volume 1, 3rd Edition, American college of Physicians, chapter 19, Page.No.238.
9. Brain R Walker et.al, Davidsons Principles and Practice of Medicine, 22nd Edition, Churchill Livingstone, Chapter18, Page.No-565.
10. David C Dale and Daniel D Federman, ACP Medicine, Volume 1, 3rd Edition, American college of Physicians, chapter 19, Page.No.238
11. Desmond G Julian et.al, Cardiology, eighth edition, published by Elsevier, chapter 2, Page.No-21.
12. Valentin Fuster et.al, THE HEART, Volume 1, 13th Edition, published by The McGraw-Hill companies, Chapter40, Page.no-966
13. Atrial fibrillation (2022) Nature News. Nature Publishing Group. Available at: <https://www.nature.com/articles/s41572-022-00354-w> (Accessed: April 14, 2023).
14. Desmond G Julian et.al, Cardiology, eighth edition, published by Elsevier, chapter 9, Page.No-171.
15. Brain R Walker et.al, Davidsons Principles and Practice of Medicine, 22nd Edition, Churchill Livingstone, Chapter18, Page.No-565.
16. Prof. K.R Srikantha Murthy, Susrutha Samhita, published by Chaukhambha orientalia, Vol.II, Uttarathantra, chapter 43, Page.No. 281.

17. Dr T Sreekumar, Ashtanga Hridaya, published by Harisree Hospital, Part-1, Chapter-12, page.No-308, Ref.No-6-7.
18. Dr T Sreekumar, Ashtanga Hridaya, published by Harisree Hospital, Part-1, Chapter-12, page.No-308.
19. Valentin Fuster et.al, THE HEART, Volume 1, 13th Edition, published by The McGraw-Hill companies, Chapter40, Page.no-978, reference no-52, 53.
20. Dr T Sreekumar, Ashtanga Hridaya, Published by Harisree Hospital, part-1, chapter-14, Page.No-376, reference no-9-10.
21. Dr.G Prabhakara Rao, editor. Sahasrayoga, Chaukhambha publications, New Delhi, first edition on2016, Chapter-3, Kasaya yoga prakaranam, page-151
22. Prof. K R Srikantha Murthy, Vagbhatas Astanga Hridayam, Published By Chowkhamba Krishnadas Academy, Vol. III ( Uttara Sthana), 39th Chapter, ref.No- 15-23
23. Dr Kanchiv Lochan, translator and Editor, Ashtanga Hridaya of Vagbhata, Sarira Sthana, published by Chaukhambha, New Delhi, 1st Edition, 2012, chapter 2, versus 47-52.

**Chapter: 12****Occlusal Wear of CAD-CAM fabricated restorations – A Review of Current Literature**

**Dr. Yogesh S. Ingole<sup>1</sup>, Dr. Ranu S. Ingole<sup>2</sup>, Dr. Sattyam Wankhade<sup>3</sup>, Dr. Brajesh Dammani<sup>4</sup> and Dr. Usha Radke<sup>5</sup>**

<sup>1</sup>Assistant Professor, Department of Prosthodontics and Crown & Bridge, Government Dental College and Hospital, Nagpur

<sup>2</sup>Associate Professor, Department of Oral Medicine and Radiology, Government Dental College and Hospital, Nagpur

<sup>3</sup>Associate Professor, Department of Prosthodontics and Crown & Bridge, Government Dental College and Hospital, Nagpur

<sup>4</sup>Professor, Department of Prosthodontics and Crown & Bridge, V.Y.W.S. Dental College and Hospital, Amravati

<sup>5</sup>Dean, Professor & Head, Department of Prosthodontics and Crown & Bridge, V.S.P.M.'s Dental College and Research Centre, Nagpur.

E-mail: dr.ysingole@gmail.com

**Abstract:**

**Background:** The computer-aided design computer-aided manufacturing (CAD-CAM) systems have been advanced dramatically over the last two decades. Recently, technological developments in CAD-CAM systems have enabled clinicians and dental laboratories to manufacture various kinds of restorations using different materials. Wear of tooth structure is a natural unavoidable process which occurs when tooth and tooth, or tooth and restoration are in contact and slide against each other. However, this natural process may be accelerated by the introduction of restorations whose properties of wear differ from those of the tooth structure that they slide against. So, this review evaluates the wear of different CAD-CAM fabricated crowns and their antagonists; which may influence the occlusal contact areas between these occluding surfaces.

**Methodology:** This is a traditional or narrative type of review.

**Discussion:** The review includes the articles involving various CAD-CAM fabricated crowns like Zirconia, Lithium Disilicate, Resin matrix ceramic, PEEK, Zirconia-reinforced Lithium Silicate materials exhibiting their own wear, as well as the wear of opposing natural teeth over a long-term period.

**Summary:** Contrary to the general belief, CAD-CAM Zirconia crowns caused comparatively less occlusal wear of the opposing natural teeth as compared to Lithium Disilicate and Zirconia-reinforced Lithium Silicate.

**Conclusion:** The CAD-CAM based restorations as well as their opposing natural teeth both showed significant occlusal wear over a long-term period which does have an influence on the occlusal contact areas between these occluding surfaces.

**Keywords:** Occlusal wear, CAD-CAM crowns, tooth surface loss, attrition.

### **Introduction:**

The computer-aided design/computer-aided manufacturing (CAD/CAM) systems have been advanced dramatically over the last decades. Recently, technological developments in CAD/CAM systems have enabled clinicians and dental laboratories to manufacture various kinds of restorations using different materials. Preservation of tooth structure using conservative treatments results in the longevity of restored teeth over time.<sup>1</sup>

Contemporary computer-aided design and manufacturing (CAD-CAM) systems involve use of advanced restorative materials like Zirconia veneered with ceramics, Glass-Ceramics, monolithic Zirconia, Zirconia-reinforced Lithium Silicate (ZLS), Graphene, PEEK and so on. The design of a single crown restoration should be in a functionally and anatomically harmonic relationship with the adjacent and antagonist teeth. The occlusal surface of a single crown should offer functional stability in maximum intercuspation (MICP) and no interference during eccentric movements.<sup>2</sup>

Wear of tooth structure is a natural unavoidable process which occurs when tooth and tooth, or tooth and restoration are in contact and slide against each other. However, this natural process may be accelerated by the introduction of restorations whose properties of wear differ from those of the tooth structure that they slide against. It has been shown that enamel may be subject to accelerated wear when opposed by ceramic. Therefore and despite the truth that a constant wear of the entire dentition is possible independent of dental restorations, it is desirable that wear behaviour of restorative materials is similar to natural enamel, because excessive wear could lead to clinical problems such as damage of teeth occluding surfaces, loss of vertical dimension of

occlusion, poor masticatory function associated with temporomandibular joint remodelling, dentine hypersensitivity or death of the tooth and at least may lead to esthetic impairment.<sup>3</sup>

In order to observe and assess wear, it is necessary to understand tooth wear mechanisms and how it can be measured and evaluated, both clinically and in the laboratory. The terms abrasion, attrition and even corrosion were often used to identify the same thing which is the tooth wear caused mostly by alimentation and utilities use. Contrary, nowadays there is an agreement that the terms, abrasion, attrition and erosion describe different mechanisms. The observation of in vivo and in vitro studies show that individual wear mechanisms rarely act alone but interact with each other so that tooth wear is the result of three processes: abrasion, attrition and erosion.<sup>3</sup>

**Wear** is defined as a progressive loss of material from the contacting surfaces of a body caused by relative motion at the surface.

**Tooth surface loss (TSL) or tooth wear (TW)** is an irreversible loss of hard tooth structure caused by factors other than those responsible for dental caries.

Tooth hypersensitivity and function impairment, and may lead to change in the morphology of the affected tooth. A sound clinical approach by the dentist & patient awareness can prevent and manage tooth wear. When tooth to tooth or tooth and restoration are in contact, they slide against each other and unavoidable changes occur in natural enamel. Differences in composition and physical properties of tooth and restorative materials causes differential wear with time. This results in either excessive wear of the restorative material or the opposing dentition which can lead to tooth sensitivity, or loss of esthetics & occlusal destabilization<sup>3</sup>. This review article highlights the important qualitative and quantitative analyses of wear available in the current literature.

#### **Classification of tooth wear (Pindborg)<sup>4</sup>**

- **Attrition:** The gradual loss of hard tooth substance as a result of **chewing activity**.
- **Abrasion:** Pathologic tooth wear caused by **friction from a foreign body**, independent of occlusion between the teeth.
- **Erosion:** The loss of hard tooth substance due to a **chemical process** not involving bacteria.

- **Abfraction:** The Pathologic loss of hard tooth substance caused by **biomechanical loading forces**; such loss is thought to be the result of flexure and chemical fatigue degradation of enamel and/or dentin at some location distant from the actual point of loading.”

#### Mechanisms of wear<sup>4</sup>

- **Tribology:** the science of interacting surfaces in relative motion, or simply ‘the study of rubbing’.
- **Adhesive wear:** Formation and rupture of interfacial adhesive bonds (e.g. ‘cold-welded’ junctions).
- **Abrasion:** Removal of material by microcutting (ploughing).
- **Surface fatigue:** Fatigue and crack formation in the subsurface layers by tribologic stress cycles resulting in the separation of material (spalling).
- **Tribochemical reaction:** Development of reaction products as the result of chemical reactions taking place between the wear couple and the interfacial medium.

#### Factors affecting the wear process in oral cavity<sup>4</sup>

The following factors affect the wear process in the oral cavity-

|                                        |                               |
|----------------------------------------|-------------------------------|
| Time/Age                               | Gender                        |
| Occlusal conditions                    | Muscle hyperfunction          |
| Parafunction                           | Gastrointestinal disturbances |
| Environmental conditions               | Saliva                        |
| Properties of the contacting materials | Type of movement & Velocity   |
| Load and duration of tooth contact     | Diet                          |
| The wear mechanism involved            | Temperature                   |

There is both a clinical and a scientific need to be able to measure tooth wear, and the literature abounds with many methods which can be broadly divided into quantitative and qualitative in nature. Quantitative and qualitative methods typically utilise grading or scoring systems designed to identify increasing severity or progression of a condition; these are described as indices and are usually numerical. An ideal index should be simple to understand and use, clear

in its scoring criteria and be demonstrably reproducible. Its application should be useful for research into the aetiology, prevention and monitoring of a condition, essentially being an epidemiological and clinical tool<sup>4</sup>.

### **Qualitative analysis of wear:**

Qualitative methods, which rely on clinical descriptions, can be more subjective if appropriate training and calibration are not carried out but which, with correct safeguards, can be valuable epidemiological tools. The earliest indices shared common, arbitrary criteria, relying on descriptive terms such as slight, mild, moderate, severe and extensive. Eccles originally classified lesions broadly as early, small and advanced, with no strict criteria definitions, thus allowing wide interpretation. Later, the index was refined and expanded, with greater emphasis on the descriptive criteria (Table 1).

### **Eccles Index for dental erosion of non-industrial origin<sup>5</sup>**

| Class      | Surface         | Criteria                                                                                                                                                                                                                                         |
|------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Class I    |                 | Early stages of erosion, absence of developmental ridges, smooth, surfaces of maxillary incisors and canines.                                                                                                                                    |
| Class II   | Facial          | Dentine involved for less than one third surface; two types<br>Type 1(commonest): ovoid-crescentic in outline, concave in cross differentiate from wedge shaped abrasion lesions<br>Type 2: irregular lesion entirely within crown. Punched out. |
| Class IIIa | Facial          | More extensive destruction of dentine, affecting anterior teeth part of the surface, but some are localised and hollowed out.                                                                                                                    |
| Class IIIb | Lingual/Palatal | Dentine eroded for more than one third of the surface area. Gingival white, etched appearance. Incisal edges translucent due to loss of is flat or hollowed out, often extending into secondary dentine                                          |

|            |                  |                                                                                                                                     |
|------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Class IIIc | Incisal/Occlusal | Surfaces involved into dentine, appearing flattened or with cupping. Under-mined enamel; restorations are raised above surrounding. |
| Class IIId | All              | Severely affected teeth, where both labial and lingual surfaces are may be affected; teeth are shortened                            |

**Table 1: Eccles Index for dental erosion of non-industrial origin**

Smith and Knight took Eccles' ideas a stage further, producing the tooth wear index (TWI), a comprehensive system whereby all four visible surfaces (buccal, cervical, lingual and occlusal–incisal) of all teeth present are scored for wear, irrespective of how it occurred (Table 2).

**Smith and Knight Tooth wear index<sup>5</sup>**

| Score | Surface         | Criteria                                                                                                                                                                                       |
|-------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | B/L/O/I<br>C    | No loss of enamel surface characteristics.<br>No loss of contour.                                                                                                                              |
| 1     | B/L/O/I<br>C    | Loss of enamel surface characteristics.<br>Minimal loss of contour.                                                                                                                            |
| 2     | B/L/O<br>I<br>C | Loss of enamel exposing dentine for less than one third of surface.<br>Loss of enamel just exposing dentine.<br>Defect less than 1 mm deep                                                     |
| 3     | B/L/O<br>I<br>C | Loss of enamel exposing dentine for more than one third of surface.<br>Loss of enamel and substantial loss of dentine.<br>Defect less than 1-2 mm deep.                                        |
| 4     | B/L/O<br>I<br>C | Complete enamel loss - pulp exposure - secondary dentin exposure.<br>Pulp exposure or exposure of secondary dentine.<br>Defect more than 2mm deep - pulp exposure - secondary dentine exposure |

B: buccal; L: lingual; O: occlusal; I: incisal; C: cervical

**Table 2: Smith and Knight tooth wear index****Simplified scoring criteria for tooth wear index<sup>5</sup>**

Bardsley et al pioneered a new, simplified version of Tooth Wear Index when carrying out epidemiological studies on large numbers of adolescents in North West England (Table 3).

| Score | Criteria                                                     |
|-------|--------------------------------------------------------------|
| 0     | No wear into dentine.                                        |
| 1     | Dentine just visible (including cupping) or dentine exposed. |
| 2     | Dentine exposure greater than 1/3 of surface.                |
| 3     | Exposure of pulp or secondary dentine.                       |

**Table 3: Simplified scoring criteria for tooth wear****U.S. Public Health Service Criteria<sup>6</sup>**

For the evaluation of the single crowns at the baseline and the recall appointments, the US Public Health Service (USPHS) criteria were used (Table 4). All parameters were rated Alpha (A) in case of no problem, Bravo (B) in case of minor extent of the complication, and Charlie (C) if the complication was major or if the restoration had to be removed due to the complication.

| Parameters  | Alpha (A)                                                                                                      | Bravo (B)                                                                                                                                                                                                                                                                       | Charlie (C)                                                                                                                                                                                           |
|-------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Color Match | The restoration appears to match the shade and the translucency of adjacent tooth tissues. (visual inspection) | The restoration does not match the shade and the translucency of adjacent tooth tissues, but the mismatch is within the normal range of the tooth shades. (within normal range: Similar to silicate cement restorations for which dentist did not quite succeed in the matching | The restoration does not match the shade and the translucency of the adjacent tooth structure, and the mismatch is outside the normal range of the tooth shades and translucency. (visual inspection) |

|                                    |                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                           |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                    |                                                                                                                                                                                                                                                                                                                     | tooth color by his choice among available silicate cement shades). (visual inspection)                                                                                                                                                                          |                                                                                                                                                                                                           |
| Anatomic contour                   | <p>The restoration is a continuation of existing anatomic form or is slightly flattened. It may be overcontoured. When the side of the explorer is placed tangentially across the restoration, it does not touch two opposing cavosurface line angles at the same time.</p> <p>(visual inspection and explorer)</p> | <p>A surface concavity is evident. When the side of the explorer is placed tangentially across the restoration, it does not touch two opposing cavosurface line angles at the time, but the dentin or base is not exposed. (visual inspection and explorer)</p> | <p>There is a loss of restorative substance such that a surface concavity is evident and the base and/or dentin is exposed. (visual inspection and explorer)</p>                                          |
| Cavosurface marginal discoloration | <p>There is no visual evidence of marginal discoloration different from the color of the restorative material and from the color of the adjacement.(visual inspection)</p>                                                                                                                                          | <p>There is visual evidence of marginal discoloration at the junction of the tooth structure and the restoration, but the discoloration has not penetrated along the restoration in a pulpal direction. (visual inspection)</p>                                 | <p>There is visual evidence of marginal discoloration at the junction of the tooth structure and the restoration that has penetrated along the restoration in a pulpal direction. (visual inspection)</p> |
| Parameters                         | Alpha (A)                                                                                                                                                                                                                                                                                                           | Bravo (B)                                                                                                                                                                                                                                                       | Charlie (C)                                                                                                                                                                                               |

|                    |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                             |                                                                                                                         |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Marginal Integrity | The explorer does not catch when drawn across the surface of the restoration toward the tooth, or, if the explorer does not catch, there is no visible crevice along the periphery of the restoration. (visual inspection and explorer) | The explorer catches and there is visible evidence of the crevice, which the explorer penetrates, indicating that the edge of the restoration does not adapt closely to the tooth structure. The dentin and/or the base is not exposed, and the restoration is not mobile. (visual inspection and explorer) | The explorer penetrates crevice defect extended to the dento enamel junction. (explorer).                               |
| Secondary Caries   | The restoration is a continuation of existing anatomic form adjacent to the restoration. (visual inspection)                                                                                                                            | There is visual evidence of the dark keep discoloration adjacent to the restoration (but not directly associated with cavosurface margins). (visual inspection and explorer)                                                                                                                                |                                                                                                                         |
| Surface Texture    | Surface texture similar to polished enamel as determined by means of a sharp explorer. (explorer)                                                                                                                                       | Surface texture gritty or similar to a surface subjects to a white stone or similar to a composite containing supramicron-sized particles. (explorer)                                                                                                                                                       | Surface pitting is sufficiently coarse to inhibit the continuous movement of an explorer across the surface. (explorer) |
| Gross Fracture     | Restoration is intact and fully retained.                                                                                                                                                                                               | Restoration is partially retained with some portion of the restoration still intact.                                                                                                                                                                                                                        | Restoration is completely missing.                                                                                      |

Table 4: U.S. Public Health Service Criteria

Modified California Dental Association (CDA) guidelines<sup>7</sup>

Modified California Dental Association (CDA) guidelines (Table 5) were used to evaluate the quality of restorations regarding shade match, marginal gap, fracture, loss of retention, and hypersensitivity.<sup>7</sup>

|                          | Alpha                                                                                                   | Bravo                                                                                                | Charlie                    | Delta                                                                              |
|--------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|----------------------------|------------------------------------------------------------------------------------|
| <b>Shade match</b>       | No mismatch                                                                                             | Slight mismatch                                                                                      | Gross mismatch             | Color falls outside the scale                                                      |
| <b>Marginal gap</b>      | No probe catch                                                                                          | Slight probe catch but no gap                                                                        | Gap with exposure of tooth | Restoration is mobile, fractured, or missing                                       |
| <b>Fracture</b>          | No fracture                                                                                             | Chipping of porcelain that does not impair esthetics or function and does not expose tooth structure | -                          | Chipping of porcelain impairing esthetics and function or exposing tooth structure |
| <b>Loss of retention</b> | No debonding                                                                                            | Debonding, may be re-cemented                                                                        | -                          | Debonding, cannot be re-cemented                                                   |
| <b>Hypersensitivity</b>  | No hypersensitivity when an air-syringe is activated for 2 s at distance of 2.5 cm from the restoration | Hypersensitivity disappearing after removal of the stimulus                                          | -                          | Spontaneous pain or the pain does not disappear after removal of the stimulus      |

**Table 5: Evaluation criteria based on the modified California Dental Association guidelines**

#### **Quantitative analysis of wear:**

Quantitative methods tend to rely on objective physical measurements, such as depth of groove, area of facet or height of crown.

**Rupawala A. et al (2017)<sup>8</sup>** clinically evaluated and compared the wear behaviour of human tooth enamel opposing monolithic zirconia and other different ceramic restorative materials and to observe the tetragonal to monoclinic phase transformation in zirconia-based ceramics that may occur while simulating wear occurring at room temperature in a wet environment (Fig. 1). They concluded that, the mechanically polished zirconia showed the least amount of enamel wear followed by porcelain fused to metal and glazed monolithic lithium disilicate, whereas glazed monolithic zirconia showed the highest enamel wear (Graph 1).

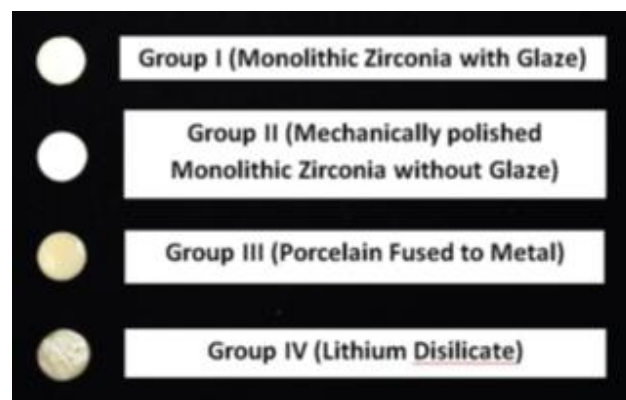
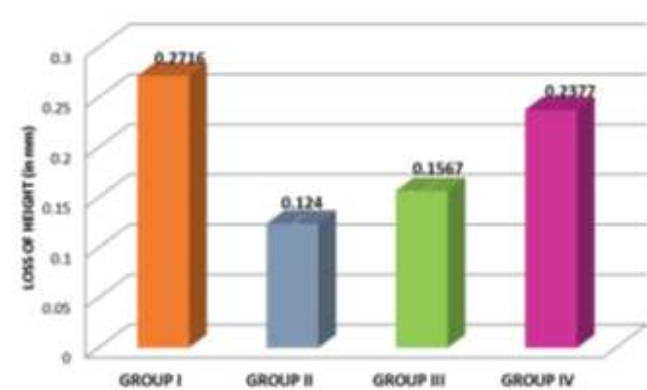


Figure 1: The ceramic discs Groups I, II, III, and IV



Graph 1: Mean loss of height in all the study groups

Nazirkar G. et al (2020)<sup>9</sup> compared the wear of natural teeth against polished yttrium tetragonalzirconia and polished lithium disilicate crowns in thirty patients. Patients were recalled after 1year and impression were recorded with opposing arch and baseline and final casts were scanned and superimposed using 3-D scanner (Fig.2). The enamel wear measured in  $\mu\text{m}$  (Fig.3,4). They concluded that polished lithium disilicate showed better clinical outcome than polished yttrium tetragonal zirconia, though the evaluated data was statistically non-significant (Fig.5).

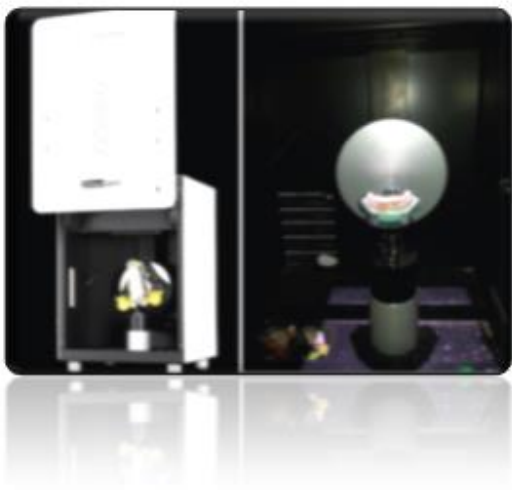


Figure 2: White Light Scanner



Figure 3: Superimposition of scanned images

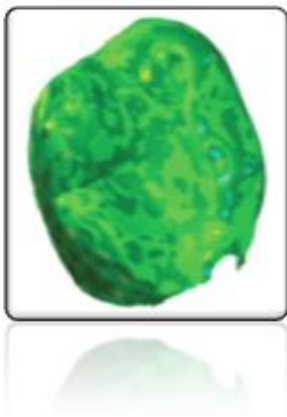


Figure 4: Analysis of scanned images using Polywork Software

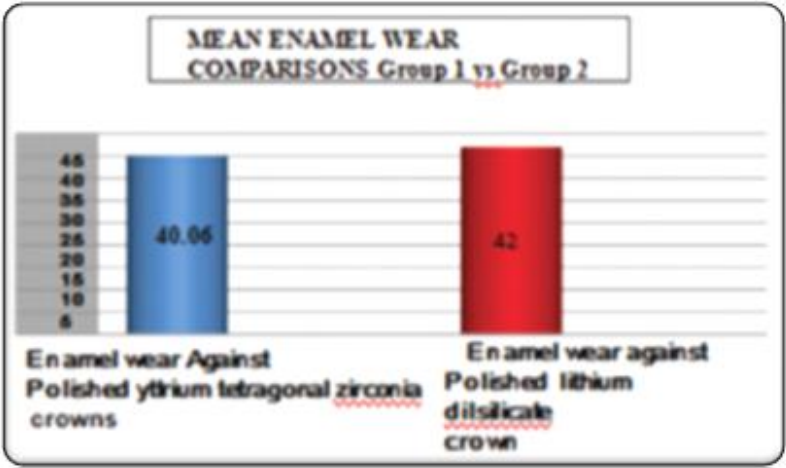


Figure 5: Comparison of Polished Yttrium Tetragonal Zirconia (Group 1) versus Polished Lithium Disilicate

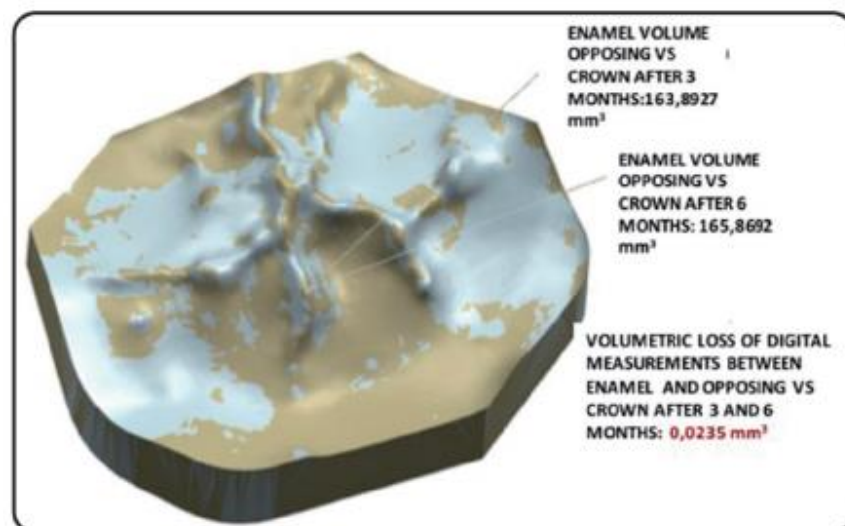
Aladag et al (2019)<sup>10</sup> determined the wear amount of single molar crowns, made from four different restoratives, and opposing natural teeth through computerized fabrication techniques using 3D image alignment in 24 patients for 6 months using lithium disilicate (IPS E-max CAD), lithium silicate and zirconia based (Vita Suprinity CAD), resin matrix ceramic material (Cerasmart, GC), and dual matrix (Vita Enamic CAD) materials (Fig.6). They concluded that

Glass matrix materials showed less wear both on their own and opposing enamel surfaces than resin matrix ceramic materials (Fig.7).

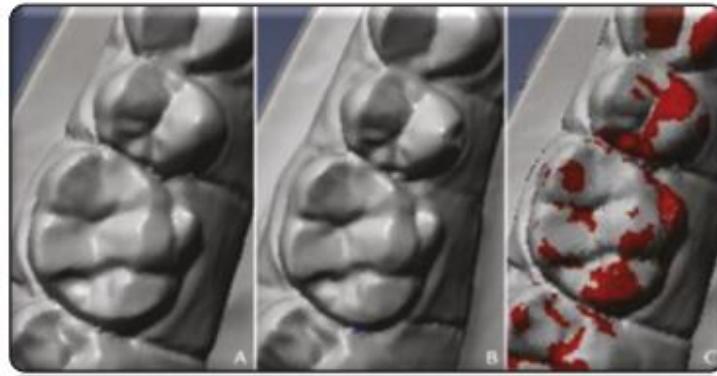


**Figure 6:** (A) The cropped images in the laserscanner programme (B) superimposed occlusal images

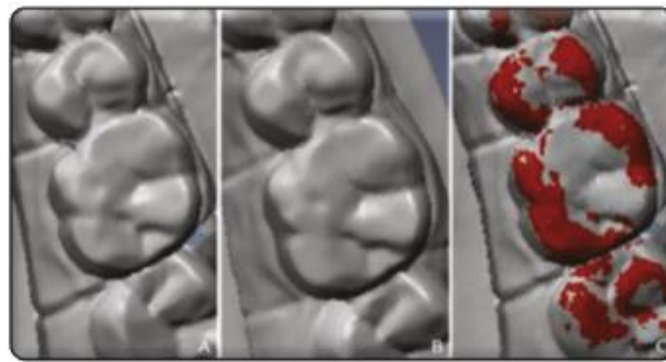
**Mundhe et al (2015)<sup>11</sup>** Clinically evaluated and compared the wear of enamel opposing natural enamel, zirconia, and metal ceramic crowns after 1 year (Fig. 8,9). They found that Zirconia crowns led to less wear of antagonist enamel than metal ceramic crowns, but more than natural enamel (Fig. 10).



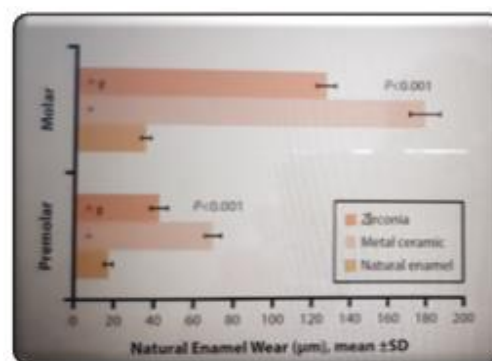
**Figure 7:** Volumetric loss calculations by Siemens Unigraphics NX 10 software.



**Figure 8:** A, Scanned 3-dimensional (3D) images of natural enamel of maxillary premolar and first molar opposing zirconia crown at baseline. B, Scanned 3D images of natural enamel of maxillary premolar and first molar opposing zirconia crown after 1 year. C, Superimposed image of natural enamel of maxillary premolar and first molar opposing zirconia crown. Red areas represent enamel wear on buccal and lingual cusps after 1 year of function.

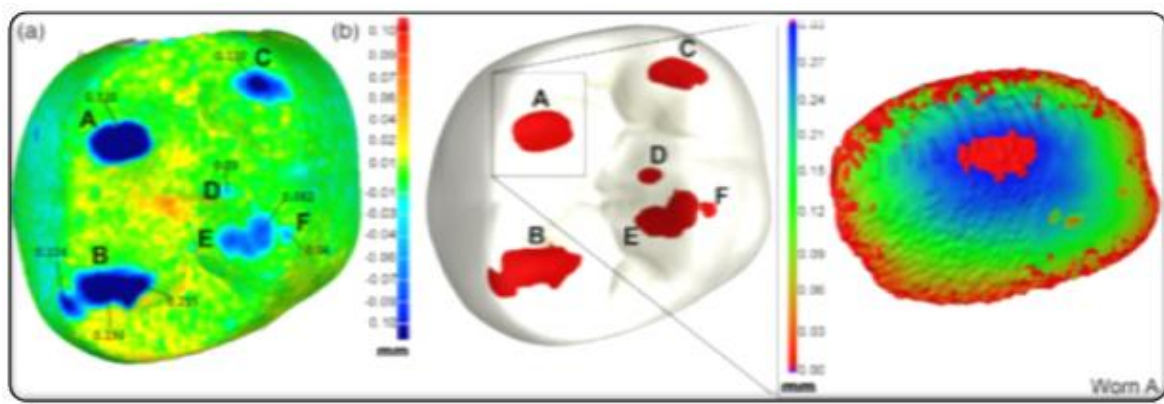


**Figure 9:** A, Scanned 3-dimensional (3D) images of natural enamel of maxillary premolar and first molar opposing metal ceramic crown at baseline. B, Scanned 3D images of natural enamel of maxillary premolar and first molar opposing metal ceramic crown at baseline at 1 year. C, Superimposed images. Red areas represent enamel wear on buccal and lingual cusps after 1 year of function.

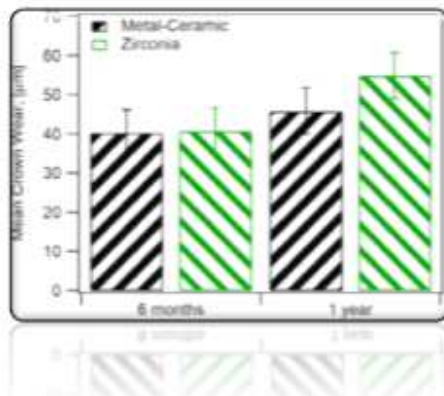


**Figure 10:** Wear of natural enamel opposing natural enamel, metal ceramic crowns, or zirconia crowns after 1 year of follow-up. \* Group Metal Ceramic or Group Zirconia is significantly different from Group Natural Enamel; # Group Zirconia is significantly different from Group Metal Ceramic.

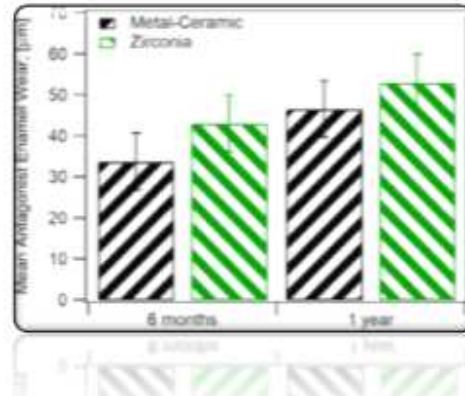
**Esquivel-Upshaw et al (2020)<sup>12</sup>** tested the hypothesis that (a) the chairside/handheld dental scanner combined with a metrology software will measure clinical wear in vivo in agreement with measurements from X-ray computed microtomography and; (b) polished monolithic zirconia does not cause accelerated wear of opposing enamel in 30 single crowns for one year period (Fig. 11). They concluded that, Intraoral scanning combined with a matching software can accurately quantify clinical wear to verify that monolithic zirconia exhibited comparable wear of enamel compared with metal-ceramic crowns and control enamel (Graph 2,3). Agreement between the intraoral scanner and the micro-CT was 99.8%.



**Figure 11:** (a) Top view of superimposed baseline scan and worn scan from **intraoral scanner using metrology software**. Blue areas show areas of wear according to color scale on the right of the image; (b) Top view of a Dentoform model showing wear facets (red) obtained using micro-CT measurements and representative wall thickness analysis obtained using VGStudio Max 3.0 for worn area A.



**Graph 2:** Comparison of wear between metal-ceramic (MC) and monolithic zirconia crowns at 6 months and 1 year using two different methods



**Graph 3:** Comparison of antagonist enamel wear between metal ceramic and monolithic zirconia crowns at 6 months and 1 year using

### Conclusion:

From the above qualitative and quantitative analyses, the following conclusions can be drawn:

- Mechanically polished zirconia showed less amount of wear of enamel as compared to glazed monolithic zirconia thus suggesting that polishing the monolithic zirconia surface might be the best treatment to reduce surface roughness and antagonistic wear of enamel<sup>8</sup>.
- Glazed porcelain fused to metal caused greater wear of the antagonistic tooth enamel than polished unglazed zirconia<sup>12</sup>.
- The wear mechanism of CAD-CAM ceramics & monolithic zirconia crown on natural teeth are mainly abrasive and fatigue wear<sup>11</sup>.
- The wear of all-ceramic, metal-ceramic and monolithic zirconia is comparable and there are no significant differences noted between the enamel antagonist wear and control enamel wear of these materials<sup>9</sup>.

### Future Scope:

- The occlusal contact area for the entire mouth should be 3-4 mm<sup>2</sup>. But, due to wear facets, the occlusal contact area could reach 2-4 mm<sup>2</sup> per tooth.

- So, there is an urgent need to study the changes in effective occlusal contact area of restorations and their antagonists which gets altered in due course of time due to wear mechanism.

**References:**

1. **Torbjorner A. FranssonB.** Biomechanical aspects of prosthetic treatment of structurally compromised teeth. *Int J Prosthodont* 2004; 17:135-41.
2. **Ye-Chan Lee et al.** Comparison between Occlusal Errors of Single Posterior Crowns Adjusted Using Patient Specific Motion or Conventional Methods. *Appl. Sci.* 2020, 10, 9140; doi:10.3390/app10249140
3. **Rim Hmaidouch and Paul Weigl.** Tooth wear against ceramic crowns in posterior region: a systematic literature review *International Journal of Oral Science* (2013) 5, 183–190.
4. **Morozova SY et al.** Tooth Wear- Fundamental Mechanisms And Diagnosis. *IOSR Journal of Dental and Medical Sciences* (IOSR-JDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861. Volume 15, Issue 5 Ver. VIII (May. 2016), PP 84-91.
5. **Penny Fleur Bardsley.** The evolution of tooth wears indices. *Clin Oral Invest* (2008) 12 (Suppl 1):S15–S19.
6. **Ioannis Konstantinidis et al:** Clinical Outcomes of Monolithic Zirconia Crowns with CAD/CAM Technology. A 1-Year Follow-Up Prospective Clinical Study of 65 Patients. *Int. J. Environ. Res. Public Health* 2018, 15, 2523; doi: 10.3390/ijerph15112523.
7. **Nejatidanesh F et al:** Five year clinical outcomes and survival of chairside CAD/CAM ceramic laminate veneers a retrospective study. *Journal of Prosthodontic Research* Accepted 17 May 2018 (2018).
8. **Rupawala, et al.:** A study on the wear of enamel caused by monolithic zirconia and the subsequent phase transformation compared to two other ceramic systems. *J Indian Prosthodont soc* 2017;17:8-14.
9. **Nazirkar et al:** Comparative evaluation of natural enamel wears against polished yttrium tetragonal zirconia and polished lithium disilicate – An *in vivo* study. *J Indian Prosthodont Soc* 2020;20:83-9.
10. **Akin Aladag et al.** *In vivo* wear determination of novel CAD/CAM ceramic crowns by using 3D alignment: *J Adv Prosthodont* 2019; 11:120-7.
11. **Kailas Mundhe et al.** Clinical study to evaluate the wear of natural enamel antagonist to zirconia and metal ceramic crowns: *J Prosthet Dent* 2015; 114:358-363.
12. **Esquivel-Upshaw et al.** Novel methodology for measuring intraoral wear in enamel and dental restorative materials. *Clin exp dent res.* 2020;6:677–685

**Chapter: 13**  
**Covid-19: Neurological and Psychological Effects (A Review Study)**

**Dr. Anita Kumari**

Assistant Professor, Department of Zoology  
Digvijai Nath PG College, Gorakhpur UP,  
E-mail: anita.kumari239@gmail.com

**Abstract:** COVID-19 is a zoonotic viral pandemic that started in Wuhan city of China and spread all over the world. It is caused by SARS-Cov-2 which belongs to the genus Betacoronavirus and subgenus Sarbecovirus of coronaviruses. These viruses are reported to cause severe acute respiratory syndrome. SARS-Cov-2 shares 80% sequence homology with SARS-Cov and 88% with bats SARS-like corona virus while genetically distant from the SARS and MERS viruses. SARS-Cov-2 is a novel form of coronaviruses. It is ellipsoidal in shape with characteristic crown-shaped appearance. Spike proteins provide characteristics appearance to SARS-Cov-2. The copy number of spike protein is 10 times higher than that of the influenza virus. It is RNA virus. Here RNA is present together with ribonucleoproteins in the lumen. Human gets infection from infected animals like bats and pangolins. After entering human body, it becomes contagious as infection spreads from human to human via respiratory droplets. It is initially a respiratory tract infection transmitted via air droplets. Subsequently, it spreads to majority of organs due to virus binding to angiotensin-converting enzyme 2 (ACE2) receptors located on several different human cells. The SARS-Cov-2 virus has caused a worldwide pandemic with a major impact on health care systems and economies. Pathophysiology is associated with majority of the organs. On an average one third of infected patients develop a broad spectrum of neurological symptoms followed by psychological effect. Effects produced by COVID-19 on the central nervous system are headache, delirium, cerebrovascular attacks, seizures, encephalopathy, meningitis, dysexecutive syndrome. Moreover, effects produced on peripheral nervous system are dysosmia, anosmia, dysgeusia, ageusia, acute myelitis, Guillain-Barre syndrome, Miller Fisher syndrome, and polyneuritis cranialis. Psychological effects of COVID-19 include uncontrolled fears related to infection, pervasive anxiety, disabling loneliness, frustration and boredom. This review study is expected to improve the management of COVID-19.

**Keywords:** COVID-19, CNS, Neurological, Psychological, Encephalopathy, Cerebrovascular.

## **Introduction**

Coronavirus disease 2019 (COVID-19) pandemic has taken heavy toll in all walks of our daily lives. It has changed the way of doing business including job-profile and skills required in performance of different job-roles. Long period of lockdown caused human isolation resulting into many mental as well physical health related problems. COVID-19 started from the Wuhan city of China in the late 2019 (Huang C et al, 2020). It is caused by virus SARS-Cov2 (severe acute respiratory syndrome- coronavirus 2) that belongs to the genus Betacoronavirus and subgenus Sarbecovirus of coronaviruses. It has 88% sequence homology with SARS-like coronavirus and 80% sequence homology with SARS-Cov but genetically distant from the SARS and MERS viruses. It is zoonotic disease and is transmitted to human from infected bats and pangolins. It becomes contagious and spreads by respiratory droplets (Koralnik and Tyler, 2020; Ren Li et al, 2020; Lovato and de Filippis, 2020). It is ellipsoidal shaped RNA virus with characteristic crown shaped appearance. COVID-19 is a single-stranded RNA virus with four key proteins. These four proteins are a spike (S) protein, an envelope (E) protein, membrane (M) and nucleocapsid (N). Its RNA is packed with ribonucleoprotein and encodes various structural proteins and several non-structural proteins involved in viral replication and transcription such as RNA-dependent RNA polymerase. Its spike proteins copy number is ten times more than that of influenza viruses (Khan M et al, 2021). It utilizes angiotensin 2 (ACE2) receptor binding site present in the membrane of numerous and distinct host cells. It produces fatal symptoms in the respiratory system such as acute respiratory distress syndrome (ARDS) following cytokine storm and pneumonia. Besides, infection spreads to the gastrointestinal system, urinary system, skin, and central nervous system (CNS) and causes some other severe symptoms (Gavriatopoulou M et al, 2020).

## **COVID-19 and CNS:**

Route of entry into the human brain and its assault is multipronged. When virus causes damage to neurons and surrounding tissue resulting into inflammatory changes called viral encephalitis. Symptoms seen during this condition are headaches, fever, vomiting, convulsions and changes in consciousness (Ellul and Solomon, 2018). Studies showed the cases of acute cerebrovascular disease in COVID-19 infection. In this case high D dimer level and low platelets have been

detected (Wang Y et al, 2020). Cerebrovascular disease may be also precipitated by cytokine storm widely observed during COVID-19 infection (Mehta P et al, 2020; Chen C et al, 2020) .

Moreover, astrocytes, microglia and macrophages are also infected by viruses. There is positive correlation between severity of COVID-19 and interleukin 6 (IL-6) level (Wan S et al, 2010). It was revealed that glial cells when infected with CoV, can secrete large amounts of inflammatory markers such as IL-6, IL-12, IL-15, and TNF-a (Bohmwald K et al, 2020).

ACE-2 enzyme is targeted by COVID-19 similar to Cov and influenza viruses (Turner AJ et al, 2004; Wrapp D et al, 2020; Yang P et al, 2014). This can lead to increase in blood pressure and cerebral vascular accidents. SARS-CoV-2 also binds to ACE2 present in capillary endothelium which leads to damage of the blood-brain barrier and entrance into the CNS (Baig AM et al, 2020). Toll-like receptors (TLRs) are also involved in the pathogenesis of COVID-19 (Khanmohammadi and Rezaei, 2021). There are ten identified members (TLR1-TLR10) of TLRs in case of humans (Onofrio L et al 2020) which are important for the activation of innate immunity, cytokine regulation and identification of pathogen-associated molecular patterns on bacteria, viruses and other parasites (Onofrio L et al 2020; Birra D et al, 2020; Debnath M et al, 2020; Hedayat M et al, 2011). TLR 7 and TLR 8 get activated by single-stranded RNA viruses such as COVID-19 (Khanmohammadi and Rezaei, 2021; Onofrio L et al 2020) and release of IL-1, IL-6, TNF-alpha, monocyte chemoattractant protein-1 (MCP-1), macrophage-inflammatory protein 1 alpha (MIP-1 A) and interferon-gamma IFN-gamma takes place (Jansen E et al, 2011). Further, Cytokine storm augmented cytokine release causes ARDS (Ware and Matthay, 2000) and multiple organ dysfunction syndrome (MODS) (Wang Y, 2020). Thus, TLR 7 and TLR 8 can be targeted for the development of new therapeutics (Khanmohammadi and Rezaei, 2021; Onofrio L et al, 2020; Patra R et al, 2021). Cov can lead to persistent neuropsychiatric diseases and systemic inflammation warranting continued monitoring and management.

Alternatively, it enters the CNS through axonal transport systems to infect peripheral neurons. Its entry into the CNS takes place by hematogenous or neuronal retrograde spread. Besides, matrix metalloproteases and the host proteases may involve in COVID-19 neuroinvasion (Bongetta et al., 2020, Vavougiou, 2020a). There is retrograde movement of virus from lungs to the neuronal synapse and thus infiltrate the brain stem. These are the other probable ways by which COVID-19 causes cardiovascular and pulmonary complications from brainstem (Bridwell R et al, 2020).

### **Neurological effects of COVID-19 infection**

Neurological effects of COVID-19 infection may be simple, temporary. It may be severe and permanent disorders in some cases. In a few cases, it may appear later and lead to permanent problems. Its effect may be acute as well as chronic also. There are reports where it is shown that COVID-19 also facilitates the development of Guillain-Barre syndrome, a form of paralysis in which the body's immune system attacks the nerves. COVID-19 has been studied to be involved in multiple sclerosis. (Bridwell R et al, 2020).

### **Chemosensory effects**

The nasal cavity and olfactory bulb play crucial role in the transmission of viruses. Thus the chemosensory impairment takes place which results in number of conditions such as anosmia and dysgeusia (van Riel D et al, 2015).

### **Encephalopathy**

Encephalopathy, an inflammation of the brain parenchyma, has been observed in severe cases of COVID-19, comorbid other chronic diseases, organ failure as a result of hypoxia, renal and hepatic dysfunction, and those with high systemic inflammation markers. Encephalopathy is due to severe inflammation caused by virus via activation of glial cells, increased tumor necrosis factor-alpha together with IL-6, IL-12, IL-15. There are reports which showed encephalitis and presence of SARS-Cov-2 in cerebrospinal fluid (Bridwell R et al, 2020; Avula A et al, 2020).

### **Stroke**

There are reports which showed the involvement of COVID-19 with increased risk of stroke. Increased risk of stroke may be due to cytokine storm, hemorrhagic cerebrovascular events, inflammation and hypoxia. The stroke cases were comorbid with hypertension, diabetes, and prior stroke history. Elevated inflammatory markers such as c-reactive protein has been reported. Reports showed increase of cerebrovascular problems such as cerebral hemorrhage in case of COVID-19. Several studies showed that the severity of COVID-19 was 2.5 times higher in patients with a history of cerebrovascular disease (Aggarwal G et al, 2020).

### **Epileptic seizures**

A number of studies have shown that the neurological damages caused by COVID-19 may increase the susceptibility to epilepsy (Zimmermann KM et al, 2021; Fasano A, 2020; Mahammedi A et al, 2020).

**Headache and migraine**

Mild or moderate headache has been observed in the beginning of the disease in patients diagnosed with COVID-19 followed by severe headache in some cases. This may be attributed to the effect of the virus on the cerebrovascular system. (Wang S-C et al, 2021; Gentile E et al 2021).

**Other neurological effects**

The other neurological effects of COVID-19 includes inflammatory neuropathy, facial palsy, neuroleptic malignant syndrome, post-infectious acute transverse myelitis, neuromuscular dysfunction or demyelinating process (Kajani R et al, 2020; Munz M et al, 2020; Boziki MK et al, 2020; d'Orsi G et al, 2021; Finsterer J).

**Behavioral effects of COVID-19****Changes in Daily Habits**

COVID-19 pandemic has produced deep impact on daily habits of people. As majority of the population remained indoor, spent maximum time on watching television, mobile, laptops and other similar electronic gadgets. So, they faced the problems of sleep disturbance. Reports showed that sleep disturbance is a critical factor associated with anxiety, depression and suicidal behaviour (Sher, 2020a). Besides sleep disturbance causes short temperament which in turn complicates family cohabitation (Islam et al., 2020).

**Increase in fear and uncertainty**

COVID-19 caused constant panicked state of mind and environment of fear of loss of lives. Besides, there had been impending threat of loss of jobs for a large population. Also, there remained constant fear for shortage of essential commodities. Limitation caused by social isolation, economic crisis and constant fear of death have caused chronic stress. Reports showed that in chronic stress condition, there is continuous cortisol release due to stimulation of the hypothalamo-pituitary axis in both experimental animals and human (Koprdoval R et al, 2016; Fiksdal A et al, 2019). The continuous release of cortisol in chronic stress condition is one of the major reasons of anxiety, depression, sleep disorders and post-traumatic stress disorder. These neurological conditions augment the risk of suicide as well. COVID-19 has also enhanced

schizophrenia symptoms and suicidal behavior in non- COVID-19 positive individuals (Valdés-Florido MJ et al, 2021).

### **Delirium**

Several studies have shown that there is delirium and impairment of consciousness in COVID-19 patients. This may be due to encephalopathy and encephalitis. Besides, long term hospital care and social isolation of the elderly people may increase the incidence of delirium (Kennedy M et al, 2020).

### **Increase in emotional disturbances**

COVID-19 pandemic has caused a significant enhancement in feelings of functional impairment, frustration, anger, worry, boredom (Ahmadi and Ramezani, 2020; Brooks et al., 2020).

### **Increase in Domestic Violence**

Prolonged period of lockdown during pandemic period resulted into forced proximity, along with economic stress. A number of studies showed that forced proximity with economic stress is risk factors for aggression and domestic violence (Bavel et al., 2020; Usher et al., 2020). There are enormous reports regarding the spurt of domestic violence in various countries such as United Kingdom, Australia, France and US (Bradbury-Jones and Isham, 2020; Usher et al., 2020).

### **Post-COVID-19 Neuropsychiatric problems**

A number of neuropsychiatric problems have been experienced by people who recovered from acute COVID-19 (Dinakaran D et al, 2020; Mazza MG et al, 2020). The common symptoms include fatigue, dyspnea, anxiety, depression and impaired attention, concentration and memory. Emotional distress including anxiety, depression and insomnia has been also reported in post-COVID-19 patient. There are reports regarding the disturbances in mood and cognitive functions in post- COVID-19 period. The possible cause may be due to abnormal or excessive autoimmune and inflammatory response. Limbic brain regions such as hippocampus and basal ganglia are affected in case of COVID-19 infection. There are reports which showed that COVID-19 causes neuroinflammation in the limbic system of the brain. In case of chronic hypoxia, attention and executive functions are affected (Almeira M et al, 2020). There are reports which showed that

the mental problems caused due to COVID-19 such as post-traumatic stress disorder, insomnia, severe anxiety and depression may also increase the risk of suicide. (Sher L, 2021). Headache, altered smell and taste, cough, asthenia, and myalgia are the other common symptoms in case of mild to moderate infections. The common symptoms in severe illness are encephalopathies, encephalitis, seizures, neuromuscular disorders, Guillain-Barre' syndrome, and other neuropathies have been observed in about 36% of patients (Dinakaran D et al, 2020; Mazza MG et al, 2020).

### **COVID 19 and its long term impacts**

There are reports on the long term symptoms of COVID-19. Also, COVID-19 has been identified as a multiorgan viral infection (Nalbandian A et al, 2021). These include both physical and mental health symptoms. According to the National Institute of Health, these are termed as a post-acute sequel of SARS-Cov-2 infection (PASC). PASC is a multiorgan condition. It is combination of poorly regulated immune response, inflammation, microvascular thrombosis and cell damage. It is manifested as a group of symptoms that range in severity (Greenhalgh T et al 2020). These symptoms are dyspnea, cough, racing heartbeat, fatigue, weakness, pain, dizziness, difficulty thinking and memory problems, sleep disturbance, depression, anxiety, PTSD (Greenhalgh T et al 2020). There is a report which showed that one in three patients who recovered from COVID-19 later presented with neurologic or psychiatric conditions within six months of the infection. Anxiety and depression are the most common amongst the neurologic or psychiatric condition (Taquet M et al, 2021). One study showed that people with higher mental resilience developed less mental distress in the pandemic period in comparison to people with lower resilience (Riehm KE et al, 2020). Epigenetic modifications such as DNA methylation, acetylation and histone changes play crucial changes in DNA gene expression which are in turn causes psychiatric vulnerability (Dudley KJ et al, 2011). There is urgent need of the time to integrate a medical and psychiatric approach to the care of patients with PASC. A plethora of studies showed the long-term implications of COVID-19 and the requirement for continued monitoring of this patient population. The pandemic is still ongoing and more people are getting infected with COVID-19. There is requirement of long-term care; attention has to be given for the treatment of patients with PASC. When patients are confirmed to have COVID-19, it is essential to examine for probable neuropathologic processes that have been seen with this virus,

such as delirium, cerebrovascular events, encephalitis or encephalopathy, mental status changes and new neurologic symptoms.

Therefore, it is essential to develop multidisciplinary approach for the management of the psychiatric and behavioral disturbances that may arise from neuropsychiatric manifestations of COVID-19 (Saeed et al. 2022).

### **Conclusion**

COVID-19 pandemic has presented new challenges to the whole world. It has caused serious damage to the neurological and psychological health of those who suffered from this infection in addition to causing mortality amongst comorbid patients. There are many unexplored areas related to human health which are being witnessed gradually and so it needs to clinically investigate into. Symptoms of COVID-19 infection have been multidimensional and therefore its clinical investigation and treatment require a long term inter specialist approach.

### **References**

1. Huang C, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*. Feb. 2020; 395(10223):497–506. doi:[https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5).
2. Korolnik IJ, Tyler KL. Covid-19: a global threat to the nervous system. *Ann Neurol*. 2020; 88: 1-11.
3. Ren Li, Wang Y, Wu Z, Xiang ZC, Guo Li, Xu T, Jiang YZ, Xiong Y, Li YJ, Li XW, Li H, Fan GH, Gu X-Y, Xiao Y, Gao H, Xu JY, Yang F, Wang XM, Wu C, Chen L, Liu YW, Liu B, Yang J, Wang XR, Dong J, Li L, Huang CL, Zhao JP, Hu Y, Cheng ZS, Liu LL, Qian ZH, Qin C, Jin Q, Cao B, Wang JW. Identification of a novel coronavirus causing severe pneumonia in human: a descriptive study. *Chin Med J*. 2020; 133: 1015-1024.
4. Lovato A, de Filippis C. Clinical presentation of COVID-19: A systematic review focusing on upper airway symptoms. *Ear Nose Throat J*. 2020; 99: 569-576.
5. Khan M, Adil SF, Alkhatlan H, Tahir MN, Saif S, Khan M, Khan ST. Covid-19: A global challenge with old history, epidemiology and progress so far. *Molecules*. 2021; 26: 39.
6. Gavriatopoulou M, Korompoki E, Fotiou D, Ntanasios-Stathopoulos I, Psaltopoulou T, Kastiris E, Terpos E, Dimopoulos MA. Organ-specific manifestations of COVID-19 infection. *Clin Exp Med*. 2020; 20: 493-506.
7. Onofrio L, Caraglia M, Facchini G, Margherita V, Placido SD, Buonerba C. “Toll-like receptors and COVID-19: a two-faced story with an exciting ending,” *Future Sci. OA*, vol. 6, no. 8, p. FSO605, doi: <https://doi.org/10.2144/fsoa-2020-0091>.
8. Ellul M, Solomon T. Acute encephalitis - diagnosis and management. *Clin Med Lond Engl*. Mar. 2018; 18(2):155–9. doi:<https://doi.org/10.7861/clinmedicine.18-2-155>.
9. Wang Y, Wang Y, Chen Y, Qin Q, “Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia (COVID-19) implicate special control measures,” *J. Med. Virol.*, vol. 92, no. 6, pp. 568–576, Jun. 2020, doi: <https://doi.org/10.1002/jmv.25748>.
10. Mehta P, et al. COVID-19: consider cytokine storm syndromes and immunosuppression. *Lancet Lond Engl*. Mar. 2020; 395(10229):1033–4. doi:[https://doi.org/10.1016/S0140-6736\(20\)30628-0](https://doi.org/10.1016/S0140-6736(20)30628-0).
11. Chen C, Zhang XR, Ju ZY, He WF, “[Advances in the research of mechanism and related immunotherapy on the cytokine storm induced by coronavirus disease 2019],” *Zhonghua Shao Shang Za Zhi Zhonghua Shaoshang Zazhi Chin. J. Burns*, vol. 36, no. 6, pp. 471–475, Jun. 2020, doi: <https://doi.org/10.3760/cma.j.cn501120-20200224-00088>.

12. Wan S, et al. Characteristics of lymphocyte subsets and cytokines in peripheral blood of 123 hospitalized patients with 2019 novel coronavirus pneumonia (NCP). Feb. 2020. doi:<https://doi.org/10.1101/2020.02.10.20021832>.
13. Bohmwald K, Gálvez NMS, Ríos M, Kalergis AM. Neurologic Alterations Due to Respiratory Virus Infections. *Front Cell Neurosci.* 2018; 12:386. doi:<https://doi.org/10.3389/fncel.2018.00386>.
14. Turner AJ, Hiscox JA, Hooper NM. ACE2: from vasopeptidase to SARS virus receptor. *Trends Pharmacol Sci.* Jun. 2004; 25(6):291–4. doi:<https://doi.org/10.1016/j.tips.2004.04.001>.
15. Wrapp D, et al., “Cryo-EM structure of the 2019-nCoV spike in the prefusion conformation,” *Science*, vol. 367, no. 6483, pp. 1260–1263, Mar. 2020, doi: <https://doi.org/10.1126/science.abb2507>.
16. Yang P, et al. Angiotensin-converting enzyme 2 (ACE2) mediates influenza H7N9 virus-induced acute lung injury. *Sci Rep.* Nov. 2014; 4:7027. doi:<https://doi.org/10.1038/srep07027>.
17. Baig AM, Khaleeq A, Ali U, Syeda H, “Evidence of the COVID-19 Virus Targeting the CNS: Tissue Distribution, Host-Virus Interaction, and Proposed Neurotropic Mechanisms,” *ACS Chem. Neurosci.*, vol. 11, no. 7, pp. 995–998, Apr. 2020, doi: <https://doi.org/10.1021/acscchemneuro.0c00122>.
18. Khanmohammadi S, Rezaei N. Role of Toll-like receptors in the pathogenesis of COVID-19. *J Med Virol.* May 2021; 93(5):2735–9. doi:<https://doi.org/10.1002/jmv.26826>.
19. Onofrio L, Caraglia M, Facchini G, Margherita V, Placido SD, Buonerba C. “Toll-like receptors and COVID-19: a two-faced story with an exciting ending,” *Future Sci. OA*, vol. 6, no. 8, p. FSO605, doi: <https://doi.org/10.2144/fsoa-2020-0091>.
20. Birra D, et al. COVID 19: a clue from innate immunity. *Immunol Res.* Jun. 2020; 68(3): 161–8. doi:<https://doi.org/10.1007/s12026-020-09137-5>.
21. Debnath M, Banerjee M, Berk M, “Genetic gateways to COVID-19 infection: Implications for risk, severity, and outcomes,” *FASEB J. Off. Publ. Fed. Am. Soc. Exp. Biol.*, vol. 34, no. 7, pp. 8787–8795, Jul. 2020, doi: <https://doi.org/10.1096/fj.202001115R>.
22. Hedayat M, Netea MG, Rezaei N. Targeting of Toll-like receptors: a decade of progress in combating infectious diseases. *Lancet Infect Dis.* Sep. 2011; 11(9):702–12. doi:[https://doi.org/10.1016/S1473-3099\(11\)70099-8](https://doi.org/10.1016/S1473-3099(11)70099-8).
23. Jansen E, van Vuren SF, Steyn CB, Brink M, Möller FP, Viljoen, Harvey BH. The neuropsychiatric manifestations of COVID-19: Interactions with psychiatric illness and pharmacological treatment. *Biomed Pharmacother Biomedecine Pharmacother.* Mar. 2021; 135:111200. doi:<https://doi.org/10.1016/j.biopha.2020.111200>.

24. Ware LB, Matthay MA. The acute respiratory distress syndrome. *N Engl J Med*. May 2000; 342:18, pp. 1334–49. doi:<https://doi.org/10.1056/NEJM200005043421806>.
25. Patra R, Das NC, Mukherjee S, “Targeting human TLRs to combat COVID-19: A solution?,” *J. Med. Virol.*, vol. 93, no. 2, pp. 615–617, Feb. 2021, doi: <https://doi.org/10.1002/jmv.26387>.
26. Wang Y, Wang Y, Chen Y, Qin Q, “Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia (COVID-19) implicate special control measures,” *J. Med. Virol.*, vol. 92, no. 6, pp. 568–576, Jun. 2020, doi: <https://doi.org/10.1002/jmv.25748>.
27. Bridwell R, Long B, Gottlieb M. Neurologic complications of Covid-19. *Am J Emerg Med*. 2020; 38(7): 1549.e3-1549.e7.
28. van Riel D, Verdijk R, Kuiken T. The olfactory nerve: a shortcut for influenza and other viral diseases into the central nervous system. *J Pathol*. 2015; 235: 277-287.
29. Avula A, Nalleballe K, Narula N, Sapozhnikov S, Dandu V, Toom S, Glaser A, Elsayegh D. Covid-19 presenting as stroke. *Brain Behav Immun*. 2020; 87: 115-119.
30. Aggarwal G, Lippi G, Michael Henry B. Cerebrovascular disease is associated with an increased disease severity in patients with Coronavirus Disease 2019 (COVID-19): A pooled analysis of published literature. *Int J Stroke*. 2020; 15: 385-389.
31. Zimmermann KM, Harmel J, Wojtecki L. CORE-myoelonus syndrome: A proposed neurological initial manifestation of Covid-19. *Mov Disord Clin Pract*. 2021; 8: 637-638.
32. Fasano A, Cavallieri F, Canali E, Valzania F. First motor seizure as presenting symptom of SARS-CoV-2 infection. *Neurol Sci*. 2020; 41: 1651-1653.
33. Mahammedi A, Saba L, Vagal A, Leali M, Rossi A, Gaskill M, Sengupta S, Zhang B, Carrierio A, Bachir S, Crivelli P, Paschè A, Premi E, Padovani A, Gasparotti R. Imaging of neurologic disease in hospitalized patients with COVID-19: An Italian multicenter retrospective observational study. *Radiology*. 2020; 297(2): E270-E273.
34. Wang S-C, Su P-K, Pariante CM. The three frontlines against Covid-19: *Brain Behav Immun*. 2021; 93: 409-414.
35. Gentile E, Delussi M, Abagnale C, Caponnetto V, De Cesaris F, Frattale I, Guaschino E, Marcinnò A, Ornello R, Pistoia F, Putortì A, Candida G, Roveta F, Lupi C, Coppola G, Prudeniano AMP, Rainero I, Sances G, Roca ME, Trojano M, Pierelli F, Geppetti P, Sacco S, de Tommaso M. Migraine during COVID-19: Data from Second Wave Pandemic in an Italian Cohort. *Brain Sci*. 2021; 11(4): 482.
36. Kajani R, Apramian A, Vega A, Ubhayakar N, Xu P, Liu A. Neuroleptic malignant syndrome in a COVID-19 patient. *Brain Behav Immun*. 2020; 88: 28-29.

37. Munz M, Wessendorf S, Koretsis G, Tewald F, Baegi R, Krämer S, Geissler M, Reinhard M. Acute transverse myelitis after COVID-19 pneumonia. *J Neurol.* 2020; 267: 2196-2197.
38. Boziki MK, Mentis AA, Shumilina M, Makshakov G, Evdoshenko E, Grigoriadis N. COVID-19 immunopathology and the central nervous system: Implication for multiple sclerosis and other autoimmune diseases with associated demyelination. *Brain Sci.* 2020; 10(6): 345.
39. d'Orsi G, Sica S, Maiorano A, Melchionda D, Lalla A, Montemurro L, Sabetta A, Goffredo R, Lecce B, Fiore JR, Santantonio T, Avolio C. Guillain-Barre syndrome as only manifestation of COVID-19 infection. *Clin Neurol Neurosurg.* 2021; 207: 106775.
40. Finsterer J, Scorza FA, Scorza CA, Fiorini AC. Attributing increased prevalence of facial palsy to SARS-CoV-2 requires evidence. *Brain Behav.* 2021; 11(2): e01996.
41. Sher, L. (2020a). COVID-19, anxiety, sleep disturbances and suicide. *Sleep Med.* 70:124. doi: 10.1016/j.sleep.2020.04.019.
42. Islam, S. M. D.-U., Bodrud-Doza, M., Khan, R. M., Haque, M. A., and Mamun, M. A. (2020). Exploring COVID-19 stress and its factors in Bangladesh: a perception-based study. *Heliyon* 6:e04399. doi: 10.1016/j.heliyon.2020.e04399.
43. Koprdoва R, Bögi E, Belovičová K, Sedláčková N, Okuliarová M, Ujházy E, Mach M. Chronic unpredictable mild stress paradigm in male Wistar rats: effect on anxiety- and depressive-like behavior. *Neuro Endocrinol Lett.* 2016; 37(Suppl1): 103-110.
44. Fiksdal A, Hanlin L, Kuras Y, Gianferante D, Chen X, Thoma MV, Rohleder N. Associations between symptoms of depression and anxiety and cortisol responses to and recovery from acute stress. *Psychoneuroendocrinology.* 2019; 102: 44-52.
45. Valdés-Flrido MJ, López-Díaz Á, Palermo-Zeballos FJ, Garrido-Torres N, Álvarez-Gil P, Martínez-Molina I, Martín-Gil VE, Ruiz-Ruiz E, Mota-Molina M, Algarín-Moriana MP, Guzmán-Del Castillo AH, Ruiz-Arcos Á, Gómez-Coronado R, Galiano-Rus S, Rosa-Ruiz A, Prados-Ojeda JL, Gutierrez-Rojas L, Crespo-Facorro B, Ruiz-Veguilla M. Clinical characterization of brief psychotic disorders triggered by the COVID-19 pandemic: a multicenter observational study. *Eur Arch Psychiatry Clin Neurosci.* 2021; 3: 1-11.
46. Kennedy M, Helfand BKI, Gou RY, Gartaganis SL, Webb M, Moccia JM, Bruursema SN, Dokic B, McCulloch B, Ring H, Margolin JD, Zhang E, Anderson R, Babine RL, Hshieh T, Wong AH, Taylor RA, Davenport K, Teresi B, Fong TG, Inouye SK. Delirium in older patients with COVID-19 presenting to the emergency department. *JAMA Netw Open.* 2020; 3(11): e2029540.
47. Ahmadi, K., and Ramezani, M. A. (2020). Iranian emotional experience and expression during the COVID-19 Crisis. *Asia Pac. J. Public Health* 32, 285–286. doi: 10.1177/1010539520937097.

48. Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., et al. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 395, 912–920. doi: 10.1016/S0140-6736(20)30460-8.
49. Bavel, J. J. V., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., et al. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nat. Hum. Behav.* 4, 460–471. doi: 10.1038/s41562-020-0884-z.
50. Usher, K., Bhullar, N., Durkin, J., Gyamfi, N., and Jackson, D. (2020). Family violence and COVID-19: increased vulnerability and reduced options for support. *Int. J. Ment. Health Nurs.* 29, 549–552. doi: 10.1111/inm.12735.
51. Bradbury-Jones, C., and Isham, L. (2020). The pandemic paradox: the consequences of COVID-19 on domestic violence. *J. Clin. Nurs.* 29, 2047–2049. doi: 10.1111/jocn.15296.
52. Dinakaran D, Manjunatha N, Kumar CN, Suresh BM. Neuropsychiatric aspects of COVID-19 pandemic: A selective review. *Asian J Psychiatry.* Oct. 2020; 53:102188. doi:<https://doi.org/10.1016/j.ajp.2020.102188>.
53. Mazza MG, et al. Anxiety and depression in COVID-19 survivors: Role of inflammatory and clinical predictors. *Brain Behav Immun.* Oct. 2020; 89:594–600. doi:<https://doi.org/10.1016/j.bbi.2020.07.037>.
54. Almeida M, Cejudo JC, Sotoca J, Deus J, Krupinski J. Cognitive profile following Covid-19 infection: Clinical predictors leading to neuropsychological impairment. *Brain Behav Immun Health.* 2020; 9: 100163.
55. Sher L. Post-Covid syndrome and suicide risk. *QJM.* 2021; 114: 95-98.
56. Dinakaran D, Manjunatha N, Kumar CN, Suresh BM. Neuropsychiatric aspects of COVID-19 pandemic: A selective review. *Asian J Psychiatry.* Oct. 2020; 53:102188. doi:<https://doi.org/10.1016/j.ajp.2020.102188>.
57. Mazza MG, et al. Anxiety and depression in COVID-19 survivors: Role of inflammatory and clinical predictors. *Brain Behav Immun.* Oct. 2020; 89:594–600. doi:<https://doi.org/10.1016/j.bbi.2020.07.037>.
58. Nalbandian A, et al. Post-acute COVID-19 syndrome. *Nat Med.* Apr. 2021; 27(4):601–15. doi: <https://doi.org/10.1038/s41591-021-01283-z>.
59. “COVID-19 long haulers explained.” <https://health.ucdavis.edu/coronavirus/covid-19-information/covid-19-long-haulers.html> (accessed Sep. 20, 2021).
60. “NIH launches new initiative to study. ‘Long COVID,’” *National Institutes of Health (NIH)*, Feb. 23, 2021. <https://www.nih.gov/about-nih/who-we-are/nih-director/statements/nih-launches-new-initiative-study-long-covid> (accessed Sep. 20, 2021).

61. Greenhalgh T, Knight M, A’Court C, Buxton M, Husain L. Management of post-acute covid-19 in primary care. *BMJ*. Aug. 2020; 370:m3026. doi:<https://doi.org/10.1136/bmj.m3026>.
62. Taquet M, Luciano S, Geddes JR, Harrison PJ, “Bidirectional associations between COVID-19 and psychiatric disorder: retrospective cohort studies of 62 354 COVID-19 cases in the USA,” *Lancet Psychiatry*, vol. 8, no. 2, pp. 130–140, Feb. 2021, doi: [https://doi.org/10.1016/S2215-0366\(20\)30462-4](https://doi.org/10.1016/S2215-0366(20)30462-4).
63. Riehm KE, et al., “Association between psychological resilience and changes in mental distress during the COVID-19 pandemic,” *J. Affect. Disord.*, vol. 282, pp. 381–385, Mar. 2021, doi: <https://doi.org/10.1016/j.jad.2020.12.071>.
64. Dudley KJ, Li X, Kobor MS, Kippin TE, Bredy TW, “Epigenetic mechanisms mediating vulnerability and resilience to psychiatric disorders,” *Neurosci. Biobehav. Rev.*, vol. 35, no. 7, pp. 1544–1551, Jun. 2011, doi: <https://doi.org/10.1016/j.neubiorev.2010.12.016>.
65. Saeed et al.2022, COVID-19 and its impact on the brain and Mind- A conceptual model and supporting evidence *Psychiatric Quarterly* (2022) 93:271–284, <https://doi.org/10.1007/s11126-022-09980-9>.

**Chapter: 14****Hepato and Nephro Protective Potential of *Saraca indica* Methanolic Extract against Lead Acetate Induced Toxicity in Rats****Brijesh Shivhare<sup>1\*</sup>, Maneesha Pandey<sup>1</sup> and Ramesh Kumar<sup>2</sup>**<sup>1</sup>Discipline of Biochemistry, School of Sciences, IGNOU, New Delhi, India- 110068<sup>2</sup>Department of Biochemistry, Bundelkhand University, Jhansi, UP, India- 284128

E-mail: brijeshshivhare143@gmail.com

**Abstract:** *Saraca indica* has been used medicinally for several diseases and ailments and exhibits many pharmacological effects. The current study aims to evaluate the protective effect of *Saraca indica* methanolic extract (SIME) on lead acetate (PbAc<sub>2</sub>) induced hepatotoxicity and nephrotoxicity in adult Wistar rats. Methanolic extract from *S. indica* was tested for its hepato-reno-protective effects against rat liver and kidney damage induced by lead acetate at 60 mg/kg. The reno-protective property of the ethanol extract (500 -2000 mg/kg) was assessed by the assessment of liver and kidney function parameters, antioxidant enzymes, and histopathology. N-Acetylcysteine (NAC) was utilized as a positive control at 100 mg/kg. PbAc injection caused a significant elevation in the liver and kidney function parameters as compared with normal rats. The concomitant decline in the glutathione content, catalase and SOD was observed as compared with the control. The SIME-treated rats showed a protective effect against lead-induced toxicity. The findings of this study show that SIME can protect liver and kidney damage induced by PbAc<sub>2</sub>, possibly as a result of the antioxidant activity of its ingredients. Thus, it may be used to explore the active lead molecule for the management of liver and kidney diseases.

**Keywords:** *Saraca indica*, Lead acetate, Antioxidant, Hepatoprotective, Nephroprotective

**Introduction**

Lead (Pb) is a hazardous contaminant, and occupational and environmental exposures to it continue to be a problem for global health. Chronic Pb exposure, even at low concentrations, has been shown to increase the risk of hepatotoxicity, nephrotoxicity, reproductive dysfunction, and behavioural abnormalities [1, 2]. The liver and kidney are the two organs most frequently damaged by Pb poisoning, respectively [3, 4]. Alterations in liver functions were discovered in earlier investigations on Pb-induced hepatotoxicity [5, 6]. As evidence for the importance of oxidative stress in lead hepatotoxicity, Pb has repeatedly been reported to undermine the antioxidant defence system by interfering with the metals required for antioxidant enzyme

activity [7, 8]. The Caesalpinaceae family plant *Saraca asoca* (Roxb.) Wilde or *Saraca indica*, also referred to as Sita Ashoka or Ashoka, is used for therapeutic purposes [9, 10]. Suppressing oxidative stress-induced membrane lipid, nuclear DNA, and protein oxidation shields hepatocytes from carbon tetrachloride-induced hepatotoxicity [11].

Moreover, it is believed that all plant parts, including the bark, leaves, and flowers, have therapeutic potential [12]. It was formerly prescribed to treat a number of ailments, such as uterine fibroids, leucorrhea, piles, diarrhoea, and wound healing [13]. The bark, leaves, flowers, fruits, seeds, and roots of the *S. indica* plant are all useful medicinally. Ashoka bark is used by women to treat menstruation, uterine, and menorrhagia issues [14, 15, 16]. In the leaves of this plant, alkaloids, steroids, flavonoids, tannins, saponins, terpenoids, polyphenolic, glycosides, and carbohydrates have all been identified [17]. According to this plant, dried flower buds possess antibacterial qualities [18]. *S. indica* flower aqueous suspension exhibits antiulcer efficacy in albino rats [19]. According to studies [20, 21], seeds include fatty acids, steroids, flavonoids, and saracin. To the best of our knowledge, similar studies have been done on the protective effects of *Saraca indica* bark methanolic extract on Doxorubicin-induced liver and kidney damage in rats [23] and the preventative effects of melatonin on Pb-induced liver and kidney damage in rats [22]. the goal of the current study was to determine whether *S. indica* methanolic extract (SIME), when given along with lead acetate treatment, can reduce oxidative stress-related liver and kidney damage.

## Materials and Methods

### Plant material

*Saraca indica* fresh leaves bark, and flowers were collected from Jhansi district. The collected plant materials were brought to the laboratory on the same day and it was identified, from the Department of Botany, University of Delhi, New Delhi and the specimen was submitted in the Delhi University Herbarium.

### Preparation of the extract

The plant samples had a pre-wash with tap water, followed by a second wash with distilled water, and were then allowed to air-dry for 7 to 10 days at room temperature. It was then retained for oven drying at 40°C to get rid of any remaining moisture. Bark, leaves, and flowers were used to make powder, which was then placed in an airtight container for later use. Soxhlet

extraction was carried out using methanol. The Soxhlet technique was used to extract the materials [24, 25]. The extract was then condensed to get a dry mass under vacuum using a rotatory vacuum evaporator after being filtered through Whatman grade 1 filter paper.

### **Animals**

Male Wistar rats that were six weeks old and weighed 150-170 g were used for this experiment. The animals were procured from a breeder in Kolkata that was authorised by the West Bengal government (India). Under conventional laboratory circumstances (12 hours of light/dark cycle; 25 °C), the animals were let to live in wire polypropylene cages in a room. One week before the trial, the rats were given free access to water and an animal standard meal while also being given time to acclimatise. The Institutional Animal Ethics Committee (IAEC) authorised all experimental techniques in accordance with national regulations for animal care, which were followed in accordance with the NIH Guidelines for the Care and The Institutional Animal Ethics Committee (IAEC), Bundelkhand University, Jhansi (India), IAEC No. BU/Pharm/IAEC/A/21/13, approved the use of laboratory animals and the IAEC's guidelines for animal care before the study could begin. The Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), New Delhi, India, provided approval to the protocol.

### **Experimental design**

Before tests, animals were checked for hunger, thirst, and body temperature. If a 30% weight loss was noticed within a week of the experiment, the use of the animals was stopped.

### **Evaluation of hepatic and renal protection**

The hepato and renal protective examination was separated into three main groups, namely: (i) Three-week pilot study (ii) Sub-chronic for three weeks (iii) Chronic study for five weeks. There were five animals (n = 5) in each study group. Lead acetate was delivered subcutaneously at a dose of 60 mg/kg for the induction of toxicity [26] and *Saraca indica* methanolic extract (SIME) was utilized orally at four different doses, i.e. 500, 1000, 1500, and 2000 mg/kg for the evaluation of protective effect [27]. NAC was administered subcutaneously at a dosage of 100 mg/kg [28].

The animals were placed into seven groups for the pilot study. Food and water were given to Group 1 (Control). Lead acetate was administered subcutaneously to Groups 2 with a dose of 60

mg/kg b. wt. for 2 weeks and NAC (100 mg/kg b. wt.) for 3 weeks, respectively. SIME was given orally to Groups 4, 5, 6, and 7 for 3 weeks at doses of 500, 1000, 1500, and 2000 mg/kg b.wt./d, respectively.

The prophylactic efficacy (sub chronic study) of the *S. indica* methanolic extract optimal dose against lead acetate-induced toxicity was carried out after dose fixation. In this study, the groups were split into three. For three weeks, group 1 (Control) received food and water. Group 2 received Lead acetate was administered subcutaneously (s.c.) for two weeks while Group 3 received NAC was administered subcutaneously (s.c.) for three weeks, respectively (500/kg b.wt./d.). Following a sub-chronic research, a chronic study was conducted to determine the best dose for treating lead acetate-induced toxicity. Group 1, known as the Control, received food and water for three weeks. Lead acetate (60 mg/kg b.wt. /d) was injected subcutaneously (s.c.) for two weeks before NAC (100 mg/kg b.wt. /d) and SIME (500 mg/kg b.wt.) was administered orally for three weeks to Group 2 and Group 3, respectively.

After 24 hours from the last treatment, the animals were sacrificed while under a light anesthesia. To conduct biochemical analysis and histological examinations, the blood from each animal's liver, kidney, and retro-orbital puncture (used to extract serum) was collected and stored at -20°C [29]. The amount of total protein in the homogenized liver and kidney was calculated using the method of Lowry et al. [30] using bovine serum albumin as a standard.

#### **Oxidative markers enzymes**

Alkaline phosphatase (ALP) and transaminases [Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST)] were calculated in the serum using the Reitman and Frankel technique [31]. Using commercial kits obtained from ERBA diagnostics Mannheim GmbH, the serum's triglycerides (TG), total cholesterol (TC), LDH, total bilirubin, creatinine, uric acid, and urea were measured using the Schmidt and Eisenburg technique [32].

#### **Antioxidant markers**

Malondialdehyde (MDA) formation was measured and used to express the amount of lipid peroxidation (LPO) in the liver homogenate [33]. Superoxide Dismutase (SOD) and Catalase (CAT) activity has been measured and represented in units [34]. The method of Dubey et al., 2015 [35] was used to quantify the levels of glutathione (GSH), glutathione-S-transferases (GSTs), and glutathione peroxidase (GPx) activity.

#### **Histopathological investigations**

The liver and kidney were prepared for paraffin sections after being fixed in 10% neutral buffered formalin for 24 hours, dehydrated in ethyl alcohol, and cleaned in xylene. For examination under a light microscope, sections of 3–4  $\mu\text{m}$  were cut from the prepared blocks and stained with hematoxylin–eosin [36].

### Statistical analysis

The results of the experiment on animals are presented as mean  $\pm$  SEM. The comparisons between the various groups were made using one-way analysis of variance (ANOVA), then Dunnett's t-test. With the use of the statistical analysis programme Graph Pad Prism 7, data were generated. At  $P < 0.05$ , values are considered statistically significant.

### Results

The effectiveness of *Saraca indica* methanolic extract (SIME) against lead acetate-induced toxicity was assessed by looking at general behaviour, body weight, liver weight, kidney weight, hepatic and renal biomarkers enzymes, and antioxidants for tissue homogenates, liver and kidney histology.

#### Effect of SIE on liver and kidney weights:

Lead-induced animals experienced hair loss, scratching, and minor bleeding problems during the experiment. The NAC and SIME treated groups, however, saw the least amount of these alterations. When compared to normal rats, lead acetate therapy considerably ( $p < 0.05$ ) reduces body weight while increasing the liver and kidney weight to body ratio. The body, liver, and kidney weights showed the protective effects of SIME treatment against lead acetate induced hepato- and nephro-toxicity (Table 1).

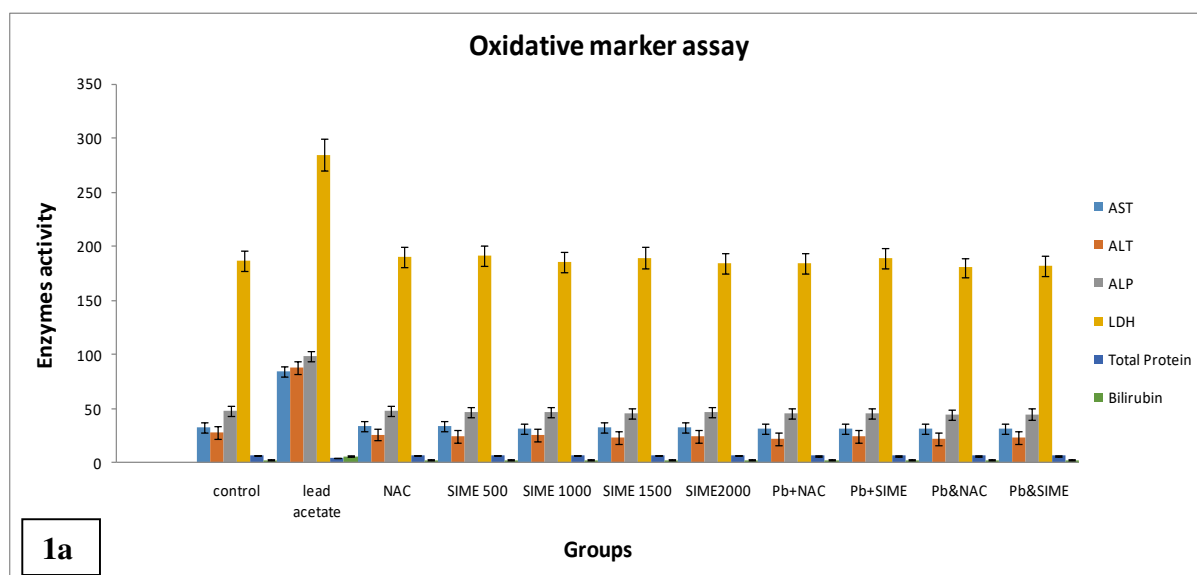
**Table 1:** Effect of SIME treatment against lead acetate induced hepato and nephro toxicity on rats body, liver and kidney weight.

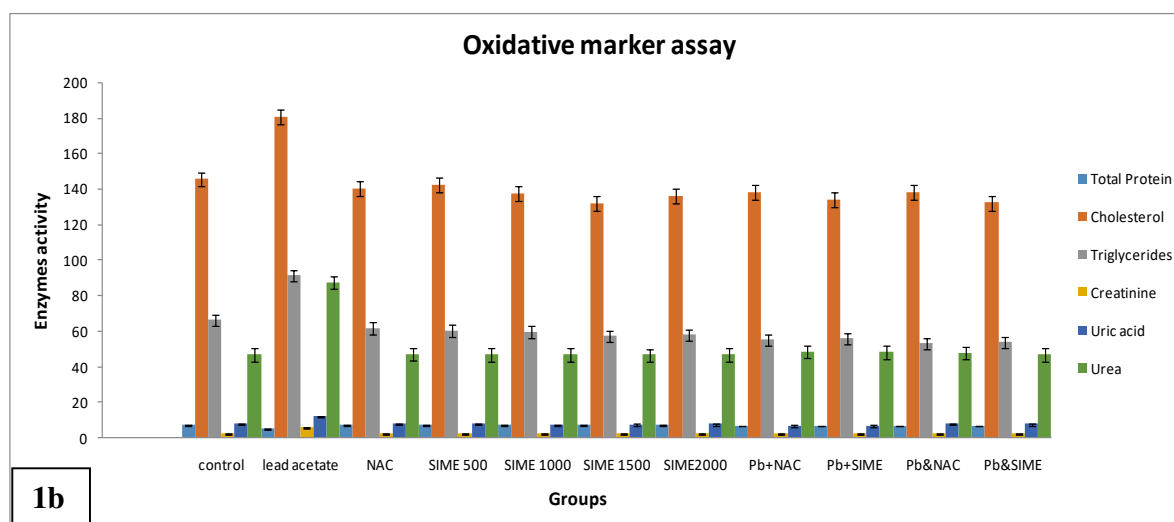
| Study Groups    | Experimental Groups | Weight (in gms) |                |                |                 |                 |
|-----------------|---------------------|-----------------|----------------|----------------|-----------------|-----------------|
|                 |                     | Body (day 0)    | Body (3/5 wks) | Liver          | Kidney          |                 |
| Study 1 (3 wks) | Control             | 125 $\pm$ 20    | 130 $\pm$ 20   | 4.9 $\pm$ 0.8  | 0.48 $\pm$ 0.15 | 0.49 $\pm$ 0.15 |
|                 | Lead (Pb)           | 105 $\pm$ 10    | 73 $\pm$ 15    | 2.8 $\pm$ 0.8  | 0.38 $\pm$ 0.02 | 0.40 $\pm$ 0.02 |
|                 | NAC                 | 135 $\pm$ 20    | 148 $\pm$ 15   | 5.13 $\pm$ 0.3 | 0.58 $\pm$ 0.05 | 0.57 $\pm$ 0.06 |
|                 | SIME 500            | 120 $\pm$ 15    | 130 $\pm$ 20   | 6.4 $\pm$ 0.6  | 0.62 $\pm$ 0.06 | 0.64 $\pm$ 0.06 |
|                 | SIME 1000           | 125 $\pm$ 25    | 135 $\pm$ 25   | 6.6 $\pm$ 0.7  | 0.60 $\pm$ 0.08 | 0.56 $\pm$ 0.03 |
|                 | SIME 1500           | 120 $\pm$ 25    | 140 $\pm$ 20   | 6.6 $\pm$ 0.3  | 0.65 $\pm$ 0.06 | 0.62 $\pm$ 0.05 |
|                 | SIME 2000           | 130 $\pm$ 20    | 145 $\pm$ 10   | 6.52 $\pm$ 0.8 | 0.68 $\pm$ 0.05 | 0.65 $\pm$ 0.04 |
| Study 2         | Control             | 165 $\pm$ 15    | 165 $\pm$ 10   | 6.5 $\pm$ 0.6  | 0.75 $\pm$ 0.05 | 0.78 $\pm$ 0.02 |

|                    |         |          |          |           |             |             |
|--------------------|---------|----------|----------|-----------|-------------|-------------|
| (3 wks)            | Pb+NAC  | 145 ± 20 | 148 ± 15 | 6.1 ± 0.5 | 0.57 ± 0.09 | 0.59 ± 0.06 |
|                    | Pb+SIME | 150 ± 20 | 155 ± 20 | 5.5 ± 0.4 | 0.68 ± 0.03 | 0.63 ± 0.03 |
| Study 3<br>(5 wks) | Control | 170 ± 15 | 180 ± 10 | 5.6 ± 0.6 | 0.48 ± 0.04 | 0.49 ± 0.05 |
|                    | Pb&NAC  | 175 ± 10 | 180 ± 10 | 9.3 ± 0.8 | 0.72 ± 0.07 | 0.76 ± 0.07 |
|                    | Pb&SIME | 180 ± 20 | 185 ± 15 | 7.2 ± 0.8 | 0.68 ± 0.4  | 0.70 ± 0.05 |

### Effect of SIME on liver/kidney function parameters in rats with lead acetate induced Liver/Kidney injury:

When compared to control, it was discovered that giving rats lead acetate resulted in significant ( $p < 0.05$ ) elevations in the levels of the enzymes AST, ALT, and ALP. Also high were LDH, cholesterol, triglycerides, bilirubin, creatinine, uric acid, and urea. SIME-treated rats have significantly lower levels of AST, ALT, ALP, and LDH than PbAc<sub>2</sub>-treated rats ( $p < 0.05$  for the 500, 1000, 1500, and 2000 mg/kg doses) (Figure 1a). Also, when compared to rats treated with PbAc<sub>2</sub>, rats given 500 mg/kg of SIME had considerably lower levels of triglycerides and cholesterol (Figure 1b).

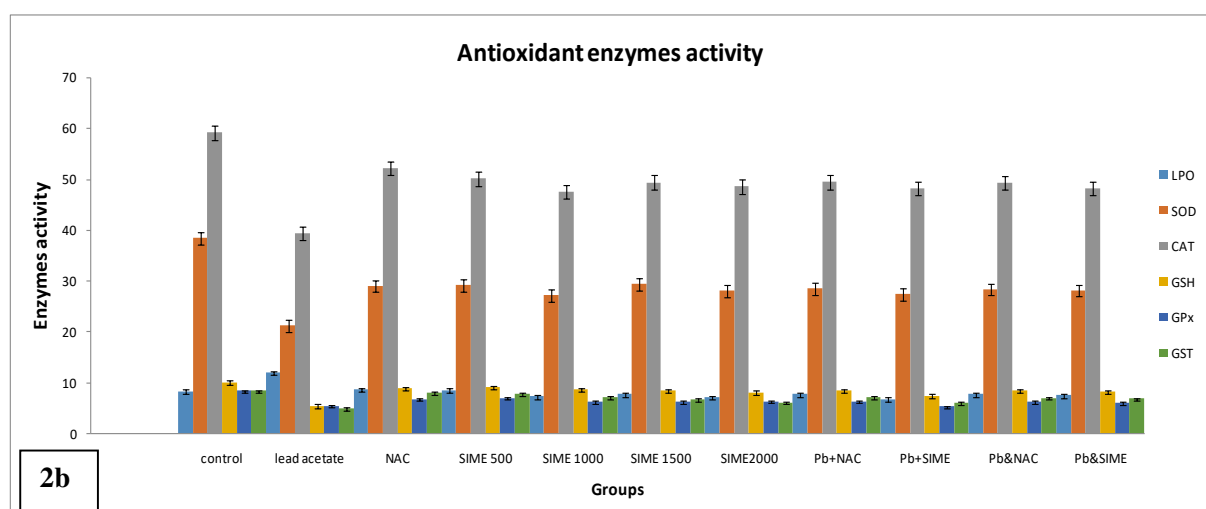
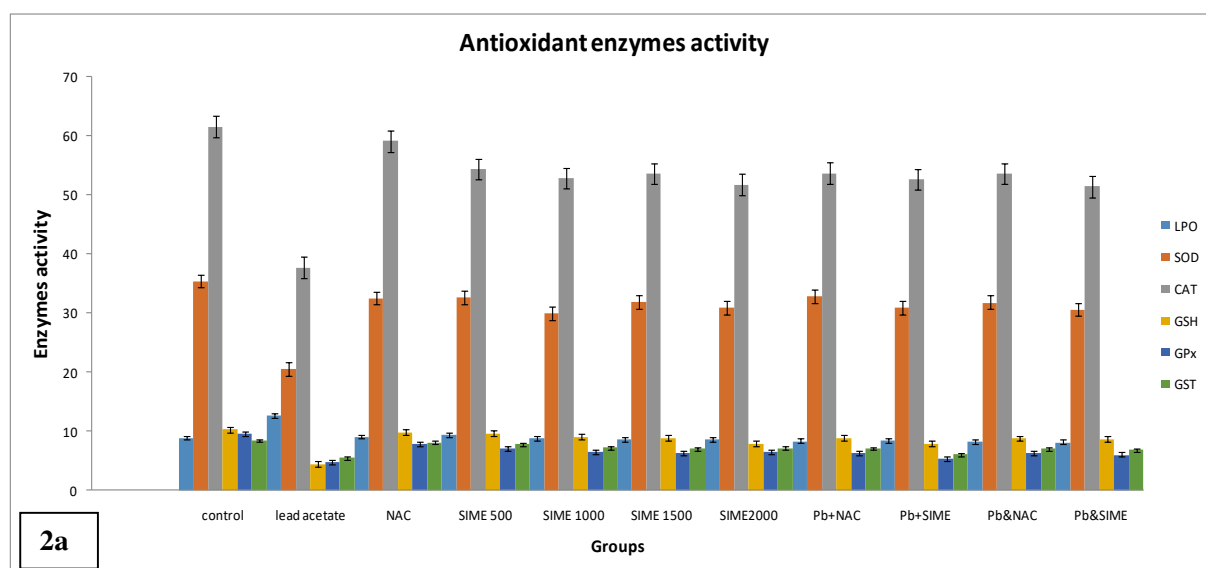




**Figure 1:** Effect of *Saraca indica* methanolic extract (SIME) on oxidative marker enzymes AST, ALT, ALP, LDH, Total protein and Bilirubin for Liver (Figure 1a) and Total protein, Total Cholesterol, Triglycerides, Creatinine, Uric acid and Urea for Kidney (Figure 1b). All the data represented as Mean  $\pm$  SEM.

#### Effect of SIME on liver and kidney antioxidant enzymes:

Rats treated with Pb had significantly higher levels of MDA than untreated control rats ( $p < 0.05$ ). In comparison to the Pb-treated group, rats given methanolic SIME at doses of 500 mg/kg, 1000 mg/kg, 1500 mg/kg, and 2000 mg/kg significantly reduced the degree of lipid peroxidation (LPO). Rats given PbAc<sub>2</sub> showed a significant ( $p < 0.01$ ) reduction in the levels of non-enzymatic antioxidants reduced glutathione (GSH), catalase (CAT), superoxide dismutase (SOD), glutathione-S-transferases (GSTs), and glutathione peroxidase (GPx) in liver (Figure 2a) and kidney (Figure 2b) tissue homogenate. In comparison to Pb-treated animals, treatment with 500 mg/kg of ethanolic SIME ( $p < 0.05$ ) significantly increased the levels of GSH, catalase (CAT), and superoxide dismutase (SOD).

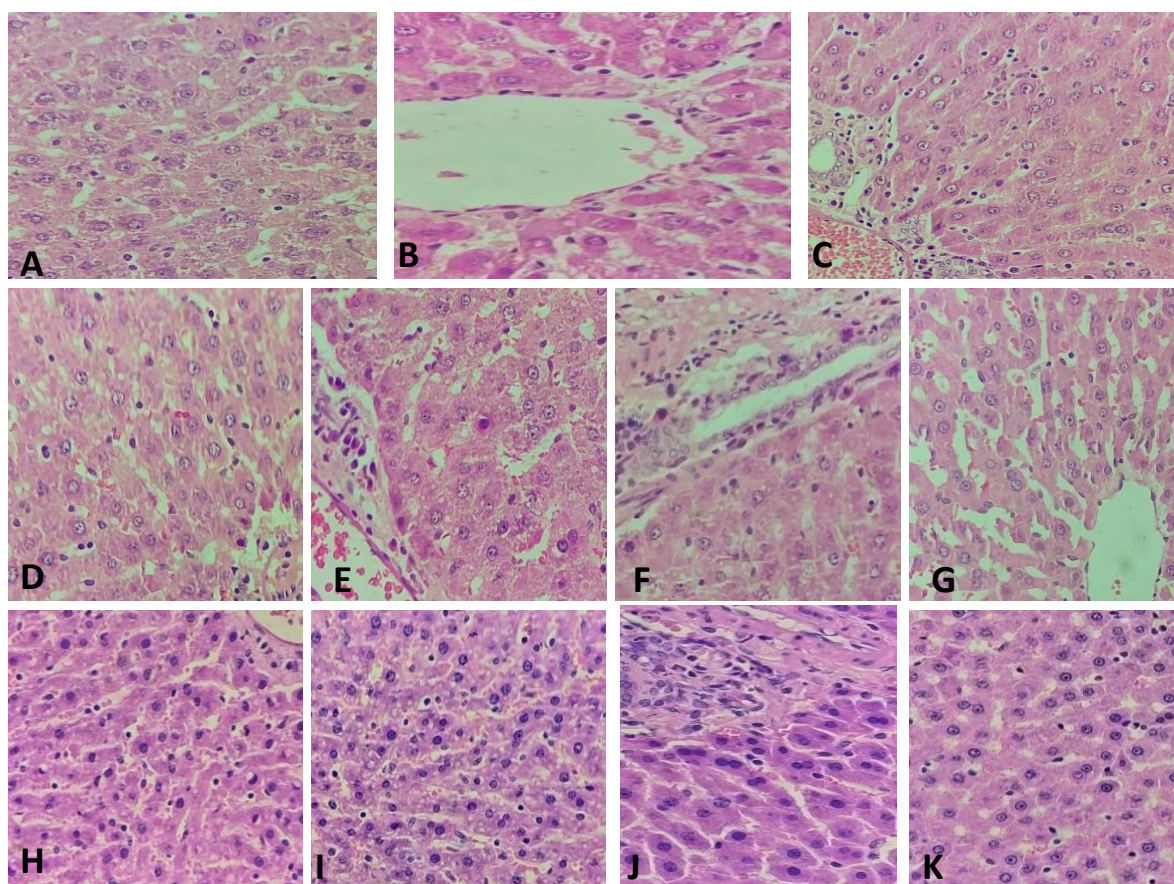


**Figure 2:** Effect of *Saraca indica* methanolic extract (SIME) on liver homogenate (figure 2a) and kidney homogenate (figure 2b) LPO, SOD, CAT, GSH, GST and GPx in control and treatment groups. Lead acetate ( $\text{PbAc}_2$ ), (60mg/kg b.wt./day), NAC (100mg/kg b.wt./day), SIME (500, 1000, 1500 and 2000 mg/kg b.wt. /d), Pb+NAC, Pb+SIME, Pb&NAC and Pb&SIME treated groups. All the data represented as Mean  $\pm$  SEM.

### Effect of SIME on liver histology in rats with lead acetate-induced liver injury:

Histopathological analysis of the control group's liver sections revealed normal cellular structure with distinct hepatic cells, sinusoidal gaps, and a central vein (Figure 3A). The structure in the lead acetate group was significantly distorted, and there were isolated necrosis, mild portal

inflammation, and increased gaps between hepatocyte plates that contain haemorrhage (Figure 3B). Rats given SIME showed evidence of protection in their liver sections, including mild inflammation, reduced vascular congestion and degeneration, and reduced cellular degeneration, necrosis, and vacuoles (Figure 3K). Rats given NAC (100 mg/kg) demonstrated substantial protection, a lack of necrosis, and no inflammation (Figure 3H & J).

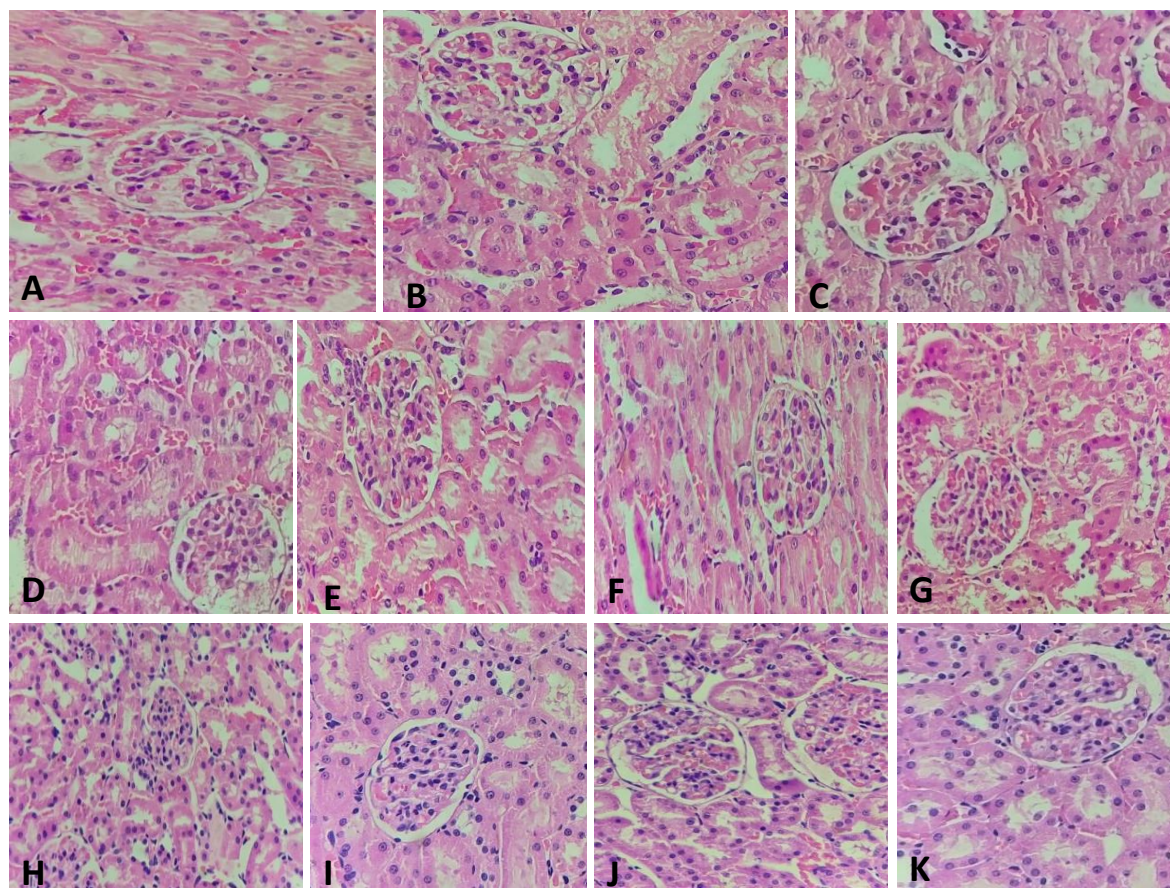


**Figure 3:** Histopathological evaluation of liver tissue in (A) Normal (B) Lead acetate (60mg/kg)treated (C) NAC (100mg/kg) treated (D) SIME (500 mg/kg) treated (E) SIME (1000 mg/kg) treated (F) SIME (1500 mg/kg) treated (G) SIME (2000 mg/kg) treated (H) Pb+ NAC (100 mg/kg) treated (I) Pb+ SIME (500 mg/kg) treated (J) Pb& NAC (100 mg/kg) treated and (K) Pb& SIME (500 mg/kg )treated rats. A section of a liver of lead acetate treated rat showing necrosis and cytoplasmic vacuolization. Hepatic section of a lead acetate treated rat that received SIME demonstrating that the hepatocytes and central veins as well as the hepatic sinusoids exhibited the normal appearance (H& E 400×).

### **Effect of SIME on kidney histology in rats with lead acetate-induced kidney injury:**

The histological pattern of the healthy kidney showed maintained structure, healthy glomeruli, healthy tubules, healthy interstitial cells, and a healthy Bowman's capsule (Figure 4A). As a result of lead acetate treatments, the structure was severely deformed, the glomeruli and tubules

were only mildly damaged, the interstitial blood vessels were thrombosed to engorged and inflamed, and the interfollicular stroma had significantly engorged blood vessels and hemorrhagic regions (Figure 4B). After SIME administration, rats showed maintained structure with normal glomeruli and tubules, a modest inflammatory response, and thrombosed to congested interstitial blood vessels (Figure 4D-G & I). Intact architecture, normal tubules, glomeruli, and blocked interstitial blood vessels were visible in rats fed NAC (Figure 4C).



**Figure 4:** Histopathological evaluation of kidney tissue in (A) Normal (B) Lead acetate (60mg/kg) treated (C) NAC (100mg/kg) treated (D) SIME (500 mg/kg) treated (E) SIME (1000 mg/kg) treated (F) SIME (1500 mg/kg) treated (G) SIME (2000 mg/kg) treated (H) Pb+ NAC (100 mg/kg) treated (I) Pb+ SIME (500 mg/kg) treated (J) Pb& NAC (100 mg/kg) treated and (K) Pb& SIME (500 mg/kg ) treated rats. A section of a kidney of lead acetate treated rat showing degeneration with some apparently necrotic cells and solid structures in the tubules of the cortex. A section of a kidney of lead acetate treated rat that given SIME demonstrating a near normal structure of the tubules. (H& E 400×).

## Discussion

*Saraca indica* has been utilized as a source of medicine for a very long time and consistently [37]. In conclusion, this work offers crucial information on the toxicity profile of *S. indica* when administered orally to rats in both acute and sub-acute doses [38]. In order to assess the effectiveness of lead acetate alone and in combination with *Saraca indica* methanolic extract (SIME) against lead-induced hepatotoxicity and nephrotoxicity. Body weight changes are a marker of a drug's or chemical's side effects, and they are substantial if they result in a loss of more than 10% of initial weight [39]. The control group of animals' body weight and organ weight did not differ significantly from each other (Table 1). The preventive impact of SIME for preserving normal measured parameters against lead-induced alterations is presumably complex [40]. With the exception of the lead acetate group, there were no significant differences between experimental groups and control group animals in the serum biochemical measures linked to kidney function, including urea, uric acid, creatinine, bilirubin, cholesterol, and total protein. Several biochemical measures for hepatic function, including total protein, AST, ALT, ALP, and normal control animal group and SIME treated animal group, did not significantly differ from each other (Figure 2). In the current investigation, co-treatment with *Saraca indica* methanolic extract dramatically reduced LPO levels, boosted SOD and CAT activity, increased GSH, GST, and GPx levels, and reversed the histological abnormalities in the liver and kidneys. Proteins in membranes affect membrane structure and function, and lead is known to harm thiol proteins [41, 42, 43]. Consequently, the current experiment demonstrates that lead produces severe hepato and renal toxicity and that *Saraca indica* methanolic extracts can mitigate the harm produced by lead.

## Conclusion

Important information on the sub-chronic and chronic oral toxicity profile of *S. indica* is provided by this study. Both sub-chronic and chronic oral treatments of the *S. indica* methanolic extract to rats are safe. The findings of this study add to the mounting evidence for the ability of *S. indica* extract to safeguard the liver and kidneys by inhibiting LPO and enhancing endogenous antioxidant defences. The SIME has hepato and nephro protective qualities since lead damages the liver and kidneys. To fully understand the safety and protective qualities in the clinical trials, it is also necessary to determine the effect of this plant extract.

## Acknowledgments

The authors are very much thankful to Institute of Pharmacy, Bundelkhand University, Jhansi (UP), India for providing animal facilities to carry out this research work.

## References

1. Jia Q, Ha X, Yang Z, Hui L, Yang X. Oxidative stress: a possible mechanism for lead-induced apoptosis and nephrotoxicity. *Toxicol Mech Methods*. 2012; 22(9):705–10.
2. El-Nekeety AA, El-Kady AA, Soliman MS, Hassan NS, Abdel-Wahhab MA. Protective effect of *Aquilegia vulgaris* (L.) against lead acetate-induced oxidative stress in rats. *Food Chem Toxicol*. 2009; 47 (9):2209–15.
3. Mudipalli A. Lead hepatotoxicity & potential health effects. *Indian J Med Res*. 2007; 126(6):518–27.
4. El-Tantawy WH. Antioxidant effects of Spirulina supplement against lead acetate-induced hepatic injury in rats. *J Tradit Complement Med*. 2015.
5. Abdel Moneim AE, Dkhil MA, Al-Quraishy S. The redox status in rats treated with flaxseed oil and lead induced hepatotoxicity. *Biol Trace Elem Res*. 2011; 143(1):457–67
6. Oyagbemi A, Saba A, Omobowale T, Akinrinde A, Ogunpolu B, Daramola O. Lack of reversal from lead acetate-induced hepatotoxicity, free radical generation and oxidative stress in Wistar rats (1139.17).
7. Aykin-Burns N, Laegeler A, Kellogg G, Ercal N. Oxidative effects of lead in young and adult Fisher 344 rats. *Arch Environ Contam Toxicol*. 2003; 44(3):417–20.
8. Boroker, A.A. and Pansare, T.A. Plant profile, phytochemistry and pharmacology of Ashoka (*Saraca asoca* (Roxb.) D. Wild- A comprehensive Review. *International Journal of Ayurvedic and Herbal Medicine*, 2017; 7(2), 2524-2541.
9. Mohamed OI, El-Nahas AF, El-Sayed YS, Ashry KM. Ginger extract modulates Pb-induced hepatic oxidative stress and expression of antioxidant gene transcripts in rat liver. *Pharm Biol*. 2015:1–9.
10. Mishra SB, Vijayakumar M (2014) Anti-Hyperglycemic and Antioxidant Effect of *Saraca asoca* (Roxb. De Wilde) Flowers in Streptozotocin- Nicotinamide Induced Diabetic Rats: A Therapeutic Study. *J Bioanal Biomed* S12: 003. doi:10.4172/1948-593X.S12-003
11. Sharif A, Ahmed E, Malik A, Riaz N, Afza N, Nawaz SA, et al. Lipxygenase inhibitory constituents from *Indigofera oblongifolia*. *Arch Pharm Res*. 2005; 28(7):761–4.
12. Divya, KR, Anjali, AR and Rajesh, T. Phytochemical screening of *Saraca asoca* (Roxb.), De. Wild. *Journal of Pharmacognosy and Phytochemistry*, 2017; 6(3), 518-521.

13. Prathapan , A, Nampoothiri, SV, Mini, S. and Raghu, K.G. Antioxidant, antiglycation and inhibitory potential of *Saraca asoca* flower against the enzyme linked to type 2 diabetes and LDL oxidation. European Review for Medical and Pharmacological Science, 2012; 16, 57-65.
14. Ghatak, A., Nair, A., Chaturvedi, P., Samant, S., Soley,K., Kudale, S. and Desia, N. Evaluation of antioxidant activity, total phenolic content, total flavonoids and LC-MS characterization of *Saraca asoca* (Roxb.) De. Wild. International Journal of Advanced Research, 2005; 3(5), 318-327.
15. Seetharam, Y.N, Sujeetha H., Jyotish-waran, G., Barad, A., Sharamabasappa, G. and Parveen, S. Antibacterial activity of *Saraca asoca* bark. India Journal of Pharmaceutical Sciences, 2003; 65, 658-659.
16. Pal, T.K, Bhattacharya, S. and Dey, A. Evaluation of antioxidant activity of flower extract (fresh and dried) of *Saraca indica* grown in west Bengal. International Journal of Current Microbiology and Applied Sciences, 2014; 3,255-259.
17. Pradhan, P., Joseph, L., Gupta, V., Chulet, R., Arya, H., Verma, R. and Bajpai, A. *Saraca asoca* (Ashoka): A Review. Journal of Chemical and Pharmaceutical Research, 2009; 1(1), 62-71.
18. Mishra A, Kumar A, Rajbhar N, Kumar A. Phytochemical and pharmacological importance of *Saraca indica*. International Journal of Pharmaceutical and Chemical Science. 2013; 2(2):1009-1013.
19. V. Maruthappan, K.S. Shree, Antiulcer activity of aqueous suspension of *Saraca indica* flower against gastric ulcers in albino rats, J. Pharm. Res, 2010, Vol 3, pp17-20.
20. S. Singh, TH, Anantha K, S. Kamalraj, Kuriakose GC, Valayil JM and Jayabaskaran C. Phytomedicinal importance of *Saraca asoca* (Ashoka) an exciting past, an emerging present and a promising future, Current Science., 2015, Vol 109 (10), pp1790-1801.
21. Singh V and Kumar R: Study of Phytochemical Analysis and Antioxidant Activity of *Allium sativum* of Bundelkhand Region. Int. J. Life. Sci. Scienti. Res. 2017. 3(6):1451-1458.
22. El-Sokkary GH, Abdel-Rahman GH, Kamel ES. Melatonin protects against lead-induced hepatic and renal toxicity in male rats. Toxicology. 2005 Sep 15; 213(1-2):25-33.
23. Shital Desale, Jagat Yadav, Rupali Patil. Protective Effect of Methanolic Extract of *Saraca indica* Bark on Doxorubicin Induced Hepatotoxicity and Nephrotoxicity in Wistar Rats. Inventi Impact: Ethnopharmacology, 2016(4):118-123, 2016.
24. Singh V and Kumar R: Study of Phytochemical Analysis and Antioxidant Activity of *Allium sativum* of Bundelkhand Region. Int. J. Life. Sci. Scienti. Res. 2017. 3(6):1451-1458.
25. Sharma S, Verma O and Devi L. Kumar R. Antioxidant activity, total phenolic and flavonoid contents of Aloe vera leaves extract. J. Phytol. Res. 2021; 34(1):49-56.

26. Yadav N.K., Sain K.S., Hussain Z., Omer A., Sharma C., Gayen R., Singh P., Arya K.R. and Singh R.K. 2015. *Saraca indica* bark extracts shows in vitro antioxidant, anti-breast cancer activity and does not exhibit toxicological effects. *Oxidative Medicine and Cellular Longevity*. pp. 01-15.
27. Viswanatha Swamy A, Patel UM, Koti BC, Gadad PC, Patel NL, Thippeswamy A. Cardioprotective effect of *Saraca indica* against cyclophosphamide induced cardiotoxicity in rats: A biochemical, electrocardiographic and histopathological study. *Indian J Pharmacol* 2013; 45:44-8.
28. Wang L, Wang Z, Liu J. Protective effect of N-acetylcysteine on experimental chronic lead nephrotoxicity in immature female rats. *Human & experimental toxicology*. 2010 Jul;29(7):581-91
29. Nutan C, Anupama S, Ziyaurrehman AR. Preclinical safety evaluation of aqueous bark extract of *Saraca asoca* Roxb: acute and subacute oral toxicity. *Int J Pharm Res*. 2015; 5:332-7.
30. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with the Folin phenol reagent. *J Biol Chem*. 1951; 193(1):265–75.
31. Reitman S, Frankel S. A colorimetric method for the determination of serum glutamic oxalacetic and glutamic pyruvic transaminases. *Am J Clin Pathol*. 1957; 28(1):56–63.
32. Schmidt M, Eisenburg J. Serum bilirubin determination in newborn infants. A new micromethod for the determination of serum of plasma bilirubin in newborn infants. *Fortschritte der Medizin*. 1975 Oct 1; 93(30):1461-6.
33. Ohkawa H, Ohishi N, Yagi K. Assay for lipid peroxides in animal tissues by thiobarbituric acid reaction. *Anal Biochem*. 1979; 95(2):351–8.
34. Shoumya S, Latha P G, Suja S R, Rajasekharan S, Shyamal S, Shine V J, Anuja G I, Sini S, Vilash V, Shikha P, Krishnakumar N M & Sreejith G. Hepatoprotective Potential of Ethanolic Extract of *Saraca asoca* (Roxb.) de Wilde Stem Bark against Carbon Tetrachloride Induced Hepatotoxicity in Wistar Rats. 2013. *J. Traditional and Folk Practices* Volume 01, No.
35. Dubey CK, Meena AK, Mishra V, Singh P, Bansode FW and Singh RK: Antioxidant and Haematoprotective Activity of the *Saraca indica* Stem Bark. *Int J Pharm Sci Res* 2015; 6(4): 1430-37.
36. Pease DC. Histology techniques for electron microscopy. Academic Press; 1964.
37. Kumar D, Sharma S and Kumar R. Free Radical Scavenging Activity of the Mixture of Different Medicinal Plants of Bundelkhand Region. *World J. Pharm. Res*. 2021; 10(2), 1008-19.
38. Pradhan P, Joseph L, Gupta V, Chulet R, Arya H, Verma R, Bajpai A. *Saraca asoca* (Ashoka): A Review. *Journal of Chemical and Pharmaceutical Research*. 2009; 1(1):62-71.

39. Dkhil MA, Al-Khalifa MS, Al-Quraishy S, Zrieq R, Abdel Moneim AE. *Indigofera oblongifolia* mitigates lead-acetate-induced kidney damage and apoptosis in a rat model. *Drug Des Devel Ther.* 2016; 10:1847–56.
40. Gomes IB, Porto ML, Santos MC, Campagnaro BP, Gava AL, Meyrelles SS, Pereira TM, Vasquez EC. The protective effects of oral low-dose quercetin on diabetic nephropathy in hypercholesterolemic mice. *Frontiers in physiology.* 2015 Sep 2; 6:247.
41. El-Sokkary GH, Kamel ES, Reiter RJ. Prophylactic effect of melatonin in reducing lead-induced neurotoxicity in the rat. *Cellular & molecular biology letters.* 2003 Jan 1; 8(2):461-70.
42. Mukhopadhyay MK, Shaw M, Nath D. Chemopreventive potential of major flavonoid compound of methanolic bark extract of *Saraca asoca* (Roxb.) in benzene-induced toxicity of acute myeloid leukemia mice. *Pharmacognosy Magazine.* 2017 Jul; 13(Suppl 2):S216.
43. Gitto E, Tan DX, Reiter RJ, Karbownik M, Manchester LC, Cuzzocrea S, Fulia F, Barberi I. Individual and synergistic antioxidative actions of melatonin: studies with vitamin E, vitamin C, glutathione and desferrioxamine (desferoxamine) in rat liver homogenates. *Journal of Pharmacy and Pharmacology.* 2001 Oct; 53(10):1393-401.

**Chapter: 15****Phytochemical analysis and evaluation of antioxidant activity in methanolic extracts of *Macrotyloma uniflorum* (Lam)****Ritu Mahajan\*, Muskaan Sharma, Shajaat Hussain and Nisha Kapoor****School of Biotechnology, University of Jammu, Jammu (J&K)****\*E-mail: ritufeb@gmail.com**

**Abstract:** *Macrotyloma uniflorum* locally known as kulth, is a minor legume belonging to Fabaceae family. It is an underutilized crop with high nutritious and ethno-medicinal importance. Seed of *Macrotyloma* are used in the treatment of uterine stones, asthma, bronchitis, piles, diseases related to eyes, and liver. Methanol extracts of seeds of *M. uniflorum* were screened for the presence of phytochemicals. Antioxidant activity was evaluated by free radical scavenging activity and Ferric ion reducing power assay. Phytochemical screening of extracts revealed the presence of phenolics, tannins, saponins, terpenoids and flavonoids. Phenolic content observed was  $34.1 \pm 0.004$  mgGAE/g extract while the flavonoid content was  $81 \pm 0.04$  mgQE/g extract in the methanol extract. All the extracts inhibited DPPH radical in a concentration-dependent manner although methanol extract showed highest inhibition as compared to n-Hexane extract. DPPH assay of methanol seed extracts revealed good antioxidant properties with  $IC_{50}$  values of  $7.80 \pm 0.15$   $\mu$ g/mL while ferric ion reducing antioxidant power was observed to be  $11.2 \pm 0.048$   $\mu$ mol/g dry wt  $\pm$  SD  $Fe^{2+}$  reduced. The antioxidant activity in the seed extract is attributed to the presence of the identified phytochemicals. The reported phytochemical studies and antioxidant potential supports its traditional uses and thus *M. uniflorum* could be used as a natural antioxidant, preservative and medicinal agent in food and pharmaceutical industry.

**Key words:** *Macrotyloma uniflorum*, antioxidants, phytochemicals, flavonoids, phenolics

**Introduction**

Plants being rich source of phytochemicals, provides protection to the human beings against several diseases and oxidative stress (1,2). Horsegram (*Macrotyloma uniflorum* (Lam)) belonging to family Fabaceae, locally called as Kulth is a minor grain legume. It is native to southern Asia and in India the plant grows in northwestern Himalayas, Karnataka, Tamil Nadu

and Andhra Pradesh. The seeds are consumed as sprouts, or as whole meal in India. The plant is a perennial climber that grows at a height of about 55-60 cms. The leaves are trifoliate with petioles up to 7 cm long. The flowers creamish yellowish in colour and the pods are about 8 cm long, containing reddish-brown or black seeds of about 5-6mm in length. Horsegram seeds are deficient in essential amino acids like methionine and tryptophan, but are rich source of iron and molybdenum.

The seeds have medicinal properties against asthma, bronchitis, urinary discharges. Soup of seeds is used in the removal of urinary stones (3). Also the studies were reported for activities against anti-hypercholesterolemic effect, anti-microbial activity, antihelminthic activity, anti-diabetic and anti-oxidant (4,5). The present study highlights presence of various phytochemicals and antioxidant activity in the seeds of horsegram.

## **Material and Methods**

### **Collection of Plant Material and Extract preparation**

Seeds of horsegram were collected from Jammu region of Jammu and Kashmir. The seeds were homogenized into fine powder, and stored in vials. The powdered seeds (40 g) were extracted with methanol (400 mL), followed by continuous shaking. Sequential filtration was carried out thrice for the extracts using Whatman filter paper No.1. The filtrate was collected in sterilized petriplates and airdried to get gummy extract, which was redissolved in 1 mL of DMSO and 9 mL of methanol to get a working solution and stored at 4° C for further experiments.

### **Quantitative Estimation**

Phytochemicals in the *M. uniflorum* seed extracts were quantified to record the concentration of primary and secondary metabolites present in them.

### **Total Carbohydrate Content**

Total carbohydrate content was estimated using 3, 5- Dinitrosalicylic acid) (6). 100µL of extract was taken in test tube and 900µl of distilled water was then added followed by addition of 3mL of DNSA reagent (1g of DNSA, 0.2g of phenol, 0.5g of sodium sulphite and 1g of NaOH was dissolved in 100ml DNSA solution). Tube was incubated at 90°C for 5 minutes and 5ml of distilled water was also added to it. OD was taken at 540nm and dextrose was used as standard.

**Total Protein Content**

Total protein content was estimated using Lowry's method (7). Alkaline copper sulphate solution was prepared by mixing solution A (2% sodium carbonate in 0.1N NaOH) and solution B (0.5% copper sulphate solution in 1% sodium potassium tartarate) in the ratio of 50:1. Folin–Ciocalteu (FC) reagent was diluted with equal volume of water just before use. 5mL of copper sulphate solution was added to the extract and incubated for 10 min at room temperature, followed by addition of 0.5 mL FC reagent. Absorbance was recorded at 660nm. BSA was taken as standard.

**Total Phenolic Content**

Total phenolic content was estimated using Folin-Ciocalteu reagent (FC) (8). To 1 mL of 1N FC reagent 100  $\mu$ L extract was added and the mixture was kept at room temperature for 5 min. Reaction was stopped by adding 1 mL of 20% of sodium carbonate solution. The tubes were further incubated in dark for 2 h and the absorbance was measured at 760 nm. Gallic acid was used as standard.

**Total Flavonoid Content**

Total flavonoid content was estimated using calorimetric method (9). 150  $\mu$ L of 5% sodium nitrite was added to the tubes containing 100  $\mu$ L extract. The tubes were incubated at room temperature for 5 min, followed by addition of 300  $\mu$ L of 16%  $\text{AlCl}_3$  to the tubes and the tubes were allowed to stand at room temperature for 6 min. 1 mL of 1 M NaOH (4%), was added to the mixture along with 550  $\mu$ L of distilled water and absorbance was measured at 510 nm. Rutin was used as the standard.

***In Vitro* Antioxidant Activities****DPPH (2, 2-diphenyl-1-picrylhydrazyl) Assay**

DPPH reagent was prepared by mixing 18 mg of DPPH in 100 mL of methanol. The mixture was incubated at room temperature for 30 min. 4  $\mu$ L of the extract was added to 100  $\mu$ L of DPPH and to it 2 mL of acetate buffer was mixed. The tubes were incubated in the dark for 30 min at room temperature and the absorbance was calculated at 517 nm. Ascorbic acid was taken as positive control, methanol as negative control. BHT (Butylated hydroxytoluene) was used as a reference and the  $\text{IC}_{50}$  value was determined as  $\mu\text{g mL}^{-1}$ .

**FRAP (Ferric Reducing Antioxidant Power) Assay**

Reducing potential of extracts was assessed by FRAP assay. FRAP reagent was prepared by dissolving 300 mmol L<sup>-1</sup> acetate buffer (pH 3.6), 10 mmol L<sup>-1</sup> TPTZ (2,4,6-tri (2-pyridyl)-s-triazine) in 40 mmol L<sup>-1</sup> HCl and 20 mmol L<sup>-1</sup> FeCl<sub>3</sub>. To 3 mL of the FRAP reagent, 100 µL of extract was added and the mixture was incubated at 37°C for 5 min. Absorbance was measured at 593 nm using FeSO<sub>4</sub> as the standard solution. Results are expressed as µmol g<sup>-1</sup> dry weight Fe<sup>2+</sup> reduced.

**Statistical analysis**

All Experiments were conducted in triplicate and results are presented as the mean ± standard Error (SE).

**Results and discussion**

Secondary metabolites present in plant organs have several pharmaceutical properties that have a positive effect on human health (10). Plants rich in phenolics, flavonoids, alkaloid tannins and terpenoids have anti-inflammatory and anti-cancer potential (11).

**Quantitative phytochemical analysis****Total carbohydrate and protein content**

Legumes are rich source of nutrients and phytochemicals which have been known for their contributions to health, food and economy (12). Legume starches contain high content of amylose with less bioavailability and low glycaemic index which is beneficial for health and especially for the prevention of diabetes (13). Carbohydrate content recorded in present study was 27.7 mg/g in the methanol extract while Sudha et al., (14) reported carbohydrate content ranged from 51.9-60.9% and 56.8-66.4% in whole and dehulled horsegram seeds respectively. However, Bravo et al., (15) reported 36±1.17g starch per 100 g dry matter in raw horsegram seeds. Legumes are rich sources of protein, with protein content ranging 16%-43%. (16). The total protein content observed in the methanol extract of seeds of *M. uniflorum* was 10.4 mg/g while Yadav et al. (17) recorded protein and oil content in the seeds of the wild horsegram which was 38.37 ± 1.03% crude protein.

**Total phenolics and flavonoid content**

Phenols and flavonoids are major health promoting substances (10). The total content of phenols observed in the present study was  $34.1 \pm 0.004$  mgGAE/g extract while the flavonoid content was  $81.0 \pm 0.04$  mgQE/g extract in the methanol extract. Misra and Pathan, (18) recorded high polyphenol and tannin content in horse gram as compared to the other legumes like chick pea, mung gram, pigeon pea. They also reported loss of polyphenols in pressure cooked horse gram which was due to the thermal decomposition of these compounds.

### **Antioxidant activity**

The presence of bioactive metabolites in plants helps in avoiding the damage caused by reactive oxygen species (19). The antioxidant activity of horse gram extracts was determined by DPPH and FRAP assay. Ferric reducing potential of the seeds was observed to be  $11.2 \pm 0.048$   $\mu$ mol/g dry wt  $\pm$  SD  $\text{Fe}^{2+}$  reduced while the radical scavenging activity in extracts from horsegram seeds was observed to be with  $\text{IC}_{50}$  values of  $7.80 \pm 0.15$   $\mu$ g/ml. Similarly, Siddhuraju and Manian (20) observed good antioxidant activity in different extracts of horsegram seeds. Interestingly, they reported that 70% acetone extracts of dry-heated samples showed significantly ( $P < 0.05$ ) higher hydroxyl radical-scavenging activity.

### **Conclusion**

The present study reveals the use of horsegram seeds as potential sources of natural antioxidants with significant antioxidant potential. The high antioxidant content in the methanolic extracts is due to the presence of phenolics and flavonoids. So, the seeds can be used as potent source of secondary metabolites in herbal and pharmaceutical industries.

## References

1. Kaur R, Aslam L, Kapoor N, Mahajan R. Phytochemical analysis and antioxidant activity of wild pomegranate collected from Patnitop, Jammu & Kashmir. *Biosci Biotech Res Asia*. 2018, 15: 335-341.
2. Aslam L Kaur R, Kapoor N, Mahajan R. Phytochemical composition and antioxidant activities of leaf extracts of *Viola odorata* from Kishtwar, Jammu and Kashmir. *J Herbs, Spices Med Plants*. 2020, 26: 77-88.
3. Mohanraj R. Phytochemicals in *Macrotyloma uniflorum* – A Review. *Series Bot Environ Sci*. 2021,1: 1-9
4. Sree VK, Soundarya M, Ravikumar M, et al. *In vitro* screening of *Macrotyloma uniflorum* extracts for antioxidant and anthelmintic activities. *J Pharmacogy Phytochem*. 2014, (4): 6-10.
5. Gautam M, Datt N, Chahota RK. Assessment of calcium oxalate crystal inhibition potential, antioxidant activity and amino acid profiling in horse gram (*Macrotyloma uniflorum*): high altitude farmer's varieties. *3 Biotech*. 2020, 10(9): 402.
6. Lindsay H. a colorimetric estimation of reducing sugar in potatoes with 3-5, dinitrosalicylic acid. *Potatoes Res*. 1973, 16(3): 176-179.
7. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with the Folin phenol reagent. *J Biol Chem*. 1991, 193: 265–275.
8. Ainsworth EA, Gillespie KM. Estimation of total phenolic content and other oxidation substrates in plant tissues using Folin-ciocalteu reagent. *Nat. Protoc*. 2007,2: 875–877
9. Khodaie L, Bamdad S, Delazar A, Nazemiyeh H. Antioxidant, total phenol and flavonoid contents of two *Pedicularis* L. Species from eastern Azerbaijan, Iran. *Bioimpacts*. 2012, 2(1): 43-57.
10. Kaur R, Aslam L, Hussain S, Kapoor N, Mahajan R. Flavonoid biosynthetic pathway: Genetics and biochemistry. *Biosci Biotechn Biores Asia*. 2021, 18 (2):271-286.
11. Gahtori R, Tripathi AH, Kumari A et al. Anticancer plant-derivatives: deciphering their oncopreventive and therapeutic potential in molecular terms. *Futur J Pharm Sci*. 2023, 9: 14.

12. Tor A, Garcia-Aloy M, Mattivi F et al. Phytochemicals in legumes: A qualitative reviewed analysis. J Agric Food Chem. 2020, 68(47): 13486-13496.
13. Guillon F, Champ M. Carbohydrate fractions of legumes: Uses in human nutrition and potential for health. The British J Nutr. 2003, Suppl 3(S3): S293-306.
14. Sudha N, Begum JM, Shambulingappa KG, Babu CK. Nutrients and some anti-nutrients in horsegram (*Macrotyloma uniflorum* (Lam.) Verdc). Food and Nutrition Bulletin. 1995, 16(1): 100.
15. Bravo L, Siddhuraju P, Calixto FC. Composition of underexploited Indian pulses: comparison with common legumes. Food Chem. 1999, 64:185-192.
16. Mani-López E, Enrique P, López-Malo A. Legume proteins, peptides, water extracts, and crude protein extracts as antifungals for food applications. Trends Food Sci Tech. 2021, 112: 16-24.
17. Yadav S, Negi K, Mandal S. Protein and oil rich wild horsegram. Genet Res Crop Evol. 2004, 51: 629–633.
18. Mishra H, Pathan S. Polyphenols and tannins in horse gram a lesser known legume from a drought prone area of Maharashtra. SSRG International Journal of Humanities and Social Sci. 2019, 6: 37-39.
19. Dumanović J, Nepovimova E, Natić M, Kuča K, Jaćević V. The significance of reactive oxygen species and antioxidant defense system in plants: A concise overview. Front. Plant Sci. 2021, 11: 552969.
20. Siddhuraju P, Manian S. The antioxidant activity and free radical-scavenging capacity of dietary phenolic extracts from horse gram (*Macrotyloma uniflorum* (Lam.) Verdc.). Food Chem. 2007, 105(3): 950-958

**Chapter: 16****Reusable versus Disposable Surgical Gowns: A Preference Comparison among the Surgical Staff based on Comfort and Protection Performances of the Surgical Gowns****M. Nazeem Banu<sup>1</sup> and Dr. Shabiya Thaseen<sup>2</sup>**<sup>1</sup>Assistant Professor & Ph.D. Scholar - JBAS College for women, Chennai.<sup>2</sup>Associate Professor & Research Supervisor- JBAS College for women, Chennai,  
E-mail: nazeembanu84@gmail.com.

**Abstract:** Surgical gowns act as a barrier to protect both the patient and the surgical staff by preventing the transmission of microorganisms and body fluids. The fabric construction of the surgical gown (woven/nonwoven) affects the comfort when worn for prolonged hours. This study aimed to determine the preference of surgical staff for reusable (woven) and disposable (nonwoven) surgical gowns, and analyse their opinions on the reusable surgical gowns using recycled fabric.

Descriptive research design with a sample size of 35 was used. The study participants were surgical staff with an average age of 42 years. An online survey using Google form was done to collect data. Wilcoxon Ranked Test was used for statistical analysis of the data. Statistically significant differences at  $p < 0.01$  were revealed for parameters such as comfort, increase in body temperature and environmental impact of the surgical gowns. Fluid repellence and movement restriction showed significance of  $p < 0.05$ . No significant difference for moist free and itch free properties.

Reusable gowns scored high on comfort and thermal properties, and its use could be encouraged, even with lower fluid repellence due to large pore size of the fabric, and reduced barrier protection after repeated washing and sterilisation cycles. Disposable gowns were preferred by fewer surgical staff for the superior barrier protection; however it raised environmental concerns due its non-biodegradability.

**Keywords:** Reusable Surgical Gown, Disposable Surgical Gown, Comfort properties, Thermal Properties, Recycled Polyester.

**Introduction**

During patient care, protective clothing/personal protective equipment (PPE) is health care worker's line of defence from the infectious diseases, harmful microorganisms, blood and body fluids. The surgical gowns are the second most used PPE, following gloves (McQuerry et al., 2021). Emerging illnesses like Ebola haemorrhagic fever, hepatitis B and C, SARS and, surge capacity situations like Covid-19 pandemic have underlined the importance of wearing PPE, especially the surgical gowns worn by doctors, nurses and other operation theatre staff in the operating room. (Aslan et al., 2013). These surgical gowns act as a barrier to protect both the patient and the surgical staff by preventing the transmission of microorganisms and body fluids (Atay et al., 2021). The surgical gown should provide absolute barrier protection along with comfort to the wearer for longer hours as lack of comfort in the surgical gown can be disregarded during any minor operation, but not during surgeries of longer duration. The fabric of the gown should have pores to transfer the excess heat produced by the body, thus enabling sufficient evaporation of sweat (Kaplan et al., 2012). Therefore, the surgical gown must have breathability to avoid accumulation of sweat. There are two types of surgical gowns commercial available – Reusable (woven) and Disposable (nonwoven). Re-usable surgical gowns are usually woven type, made of 100% cotton or 100% polyester or polyester/cotton blends or with polyester and viscose rayon blended fibre. Reusable gowns can generally be used for 50 or more washing and sterilisation cycles. Disposable surgical gowns are with materials that provide greater protection against fluid penetration (e.g., plastic films). Nonwoven fabrics are made from various forms of natural fibers (wood pulp, cotton) and synthetic fibers (polyester, polyolefin) that can be adjusted to desired properties through specific fiber types, bonding processes, and fabric finishing (Atay et al., 2021). Although , both reusable and disposable gowns have their pros and cons, but both the types of gowns have an environmental impact when seen from material life cycle perspective; and this influences the decision making process while selecting the surgical gowns. Reusable gowns are biodegradable when cotton or biodegradable polyester fibers such as poly lactic acid (PLA) are the main components, yet these contribute to water and air pollution by generating volatile organic compounds during washing and sterilizing processes. Disposable gowns have greater environmental impact, as these release greater amount of toxic compounds such as dioxins and mercury into the environment and add to the landfills during disposal process (Atay et al., 2021). From an environmental perspective, there is a need to emphasize the use of reusable surgical gowns and investigate the acceptability and sustainability of the surgical

gowns made of recycled fabric. The purpose of this study was to determine the preference of surgical staff for reusable and disposable surgical gowns in terms of comfort and protection; and also analyse their opinions on the reusable surgical gowns using recycled fabric.

## **Methodology**

### **Study design**

Descriptive research design was adopted for this study, conducted over duration of one month.

### **Study sample**

The study had a sample size of 35. The study participants were surgeons and an operation theatre staff of hospitals in Chennai region, with an average age of 42 years (19yrs – 68yrs.). Convenient sampling method was chosen for the selection of the study participants.

### **Data collection**

The survey method using questionnaire was used to know the clothing comfort of reusable and disposable gowns, and the opinion about the recycled fabric surgical gowns. The questionnaire was developed as an online survey form using Google form to collect data. The Google form was used as it allows quick and easy collection, management and optimisation of the data. The forms were shared with the study participants via email. The form's response destination was set to Google Sheets for direct addition of the data received in the form.

### **Data analysis**

Statistical analysis of the data collected in Google spread sheet was done using SPSS software version 20. Due to a small sample size of the study, a non-parametric test was chosen to compare the responses for both reusable and disposable gowns and opinions about the use of recycled fabric reusable surgical gown. Wilcoxon Signed Ranks Test was used to determine the statistically significant differences between the reusable and disposable surgical gowns. A p-value of 0.05, 0.01 or less was considered statistically significant.

### **Ethical considerations**

All study participants were informed about the aims of the survey, and their informed consent was obtained. The survey responses were kept confidential, and the response data was used for specifically stated purpose of this study.

## Results

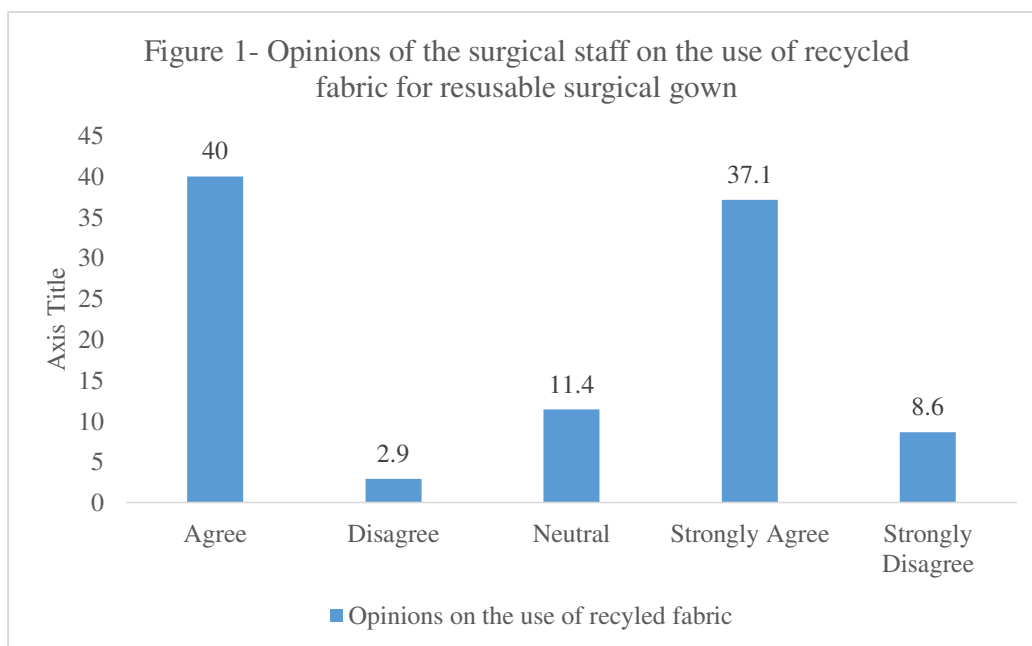
The study had 35 participants with the mean age of  $42.14 \pm 13.36$  yrs (19 yrs – 68 yrs) and work experience ranging from 5 yrs to above 15 yrs; 15 years above ( $n = 11$ ), 5-10yrs ( $n = 15$ ) and 0-5yrs ( $n = 9$ ).

The responses of the survey questions and Wilcoxon ranks test have been collated for comparison in Table 1. The reusable gowns had higher percentage of study participants strongly agreeing for comfort properties (37.1% for moist-free, 40.0% for itch free and 31.4% for freedom of movement). For thermal properties also reusable gowns had higher acceptance, 34.3% strongly agreed that it did not increase the body temperature. The results of fluid repellence comparison between the gowns showed higher preference for disposable gowns, 48.6% strongly agreed that disposable gowns have better in fluid repellence. Statistically significant differences at  $p < 0.01$  were revealed for parameters such as comfort, increase in body temperature and environmental impact of the surgical gowns. The Wilcoxon ranks test showed significance of  $p < 0.05$  for parameters such as fluid repellence and movement restriction. There were no significant differences between gowns for moist free and itch free properties. A strong agreement of 37.1 % (Figure- 1) was revealed by the results of the opinions of the surgical staff on the use of recycled fabric for the reusable surgical gown.

**Table 1: Level of agreement and Wilcoxon Ranks Test statistics of responses of the surgical staff for comparison of different properties of reusable and disposable surgical gowns**

| Level of Agreement | Type of surgical gown | Comfort properties |      |           |      |                     |      | Thermal properties<br>(No increase in body temperature) |      | Fluid repellence |      | Environmental concerns<br>(Adding to landfill) |      |
|--------------------|-----------------------|--------------------|------|-----------|------|---------------------|------|---------------------------------------------------------|------|------------------|------|------------------------------------------------|------|
|                    |                       | Moist free         |      | Itch free |      | Freedom of movement |      | N=35                                                    | %    | N=35             | %    | N=35                                           | %    |
|                    |                       | N=35               | %    | N=35      | %    | N=35                | %    |                                                         |      |                  |      |                                                |      |
| Strongly agree%    | Reusable              | 13                 | 37.1 | 14        | 40   | 2                   | 31.4 | 12                                                      | 34.3 | 6                | 17.1 | 2                                              | 5.7  |
|                    | Disposable            | 6                  | 17.1 | 8         | 22.9 | 8                   | 22.9 | 3                                                       | 8.6  | 17               | 48.6 | 15                                             | 42.9 |
| Agree%             | Reusable              | 10                 | 28.6 | 1         | 2.9  | 13                  | 37.2 | 17                                                      | 48.6 | 8                | 22.9 | 8                                              | 22.9 |

|                    |            |                     |      |                    |      |                    |      |                     |      |                     |      |                     |      |
|--------------------|------------|---------------------|------|--------------------|------|--------------------|------|---------------------|------|---------------------|------|---------------------|------|
|                    | Disposable | 7                   | 20   | 12                 | 34.3 | 11                 | 31.5 | 6                   | 17.1 | 10                  | 28.6 | 12                  | 34.3 |
| Neutral%           | Reusable   | 5                   | 14.3 | 11                 | 31.4 | 6                  | 17.1 | 4                   | 11.4 | 6                   | 17.1 | 5                   | 14.3 |
|                    | Disposable | 13                  | 37.1 | 8                  | 22.9 | 10                 | 28.6 | 13                  | 37.1 | 3                   | 8.6  | 5                   | 14.3 |
| Disagree%          | Reusable   | 2                   | 5.7  | 6                  | 17.1 | 3                  | 8.6  | 1                   | 2.9  | 14                  | 40   | 13                  | 37.1 |
|                    | Disposable | 8                   | 22.9 | 5                  | 14.3 | 4                  | 11.4 | 10                  | 28.6 | 3                   | 8.6  | 3                   | 8.6  |
| Strongly disagree% | Reusable   | 4                   | 11.4 | 3                  | 8.6  | 2                  | 5.7  | 1                   | 2.9  | 1                   | 2.9  | 7                   | 20   |
|                    | Disposable | 1                   | 2.9  | 2                  | 5.7  | 2                  | 5.7  | 3                   | 8.6  | 2                   | 5.7  | 15                  | 0    |
| Test Statistics    | z-value    | -1.679 <sup>c</sup> |      | -.167 <sup>b</sup> |      | -.888 <sup>c</sup> |      | -3.459 <sup>c</sup> |      | -2.324 <sup>b</sup> |      | -3.846 <sup>b</sup> |      |
|                    | p-value    | .093                |      | .868               |      | .375               |      | .001                |      | .020                |      | .000                |      |



**Figure 1: Opinions of the surgical staff on the use of recycled fabric for reusable surgical gown**

## Discussion

The present study evaluated the preference of the commonly used surgical gowns - reusable (woven type) and disposable gowns (nonwoven type) by the surgical staff. Surgical Gowns are the protective apparel designed to ensure the protection of the wearer from the spread of

infection should they come into contact with potentially infectious liquids and solid materials (Karim et al., 2020). A surgical gown must have performance features of microbial protection, thermal comfort (maintenance of body temperature), moist-free, itch-free, freedom of movement, fluid repellence, and resistance to tears and abrasions, and has least environmental impact. The performance features depend on the fabric construction of the surgical gowns. The presence or absence of any of these performance features affects the decision making process in selection of the surgical gown by the surgical staff. Both the types of surgical gowns have their advantages and disadvantages, and lack one or more of the performance features due to its fabric construction. The greater advantages with reusable surgical gowns include less solid waste from limited disposal and more comfort to the wearer, but there is a loss durability and barrier protection after repeated washing (Vinay et al., 2022).

Comfort is a critical feature during surgical operations of longer duration. Air permeability influences the comfort level; the movement of heat and water vapour through a garment are probably the most important factors in clothing comfort (Behera & Arora, 2009). This study evaluated the comfort performance of the reusable and disposable gowns based on the survey responses of the surgeons to the preference and perception of the surgical gowns. Thermal comfort and breathability are related to the ability of the fabric to maintain skin temperature and allow transfer of perspiration generated from the body (Behera & Arora, 2009). The analysis of the data collected for comfort properties (moist-free, itch-free and freedom of movement) and thermal properties showed substantial preference for the reusable gowns over the disposable gowns. A study by Aslan et al. (2013) investigating comfort and microbial protection performances by subjective wear trials, found that thermal comfort performance of the reusable (micro fibre polyester woven) gowns was higher than the disposable (nonwoven) gowns despite their higher permeability and lower resistance values.

Water repellence and water absorbency are critical to surgical gowns, as it prevents a 'fluid bridge' forming that pathogens can cross when the fabric wets out. Few studies have reported that reusable fabrics allowed some liquid penetration and bacterial transmission but disposable fabrics with an impervious layer prevented liquid penetration (Beam, 2011; Rivero, 2015). Disposable nonwoven surgical gowns were highly favoured over reusable gowns by the

participants of this study. The property of lower fluid repellence was considered a barrier in selection of reusable surgical gowns.

Previous research has highlighted the sustainability of reusable gowns noting they are more cost-effective throughout their life cycle in terms of production costs, waste, and carbon footprints, and thus have a better environmental profile (McQuerry et al., 2021). Reprocessing of the surgical gown minimises clinical waste and reduces cost in terms of incineration. A study evaluating the environmental impact of reusable and disposable surgical gowns related to natural resource energy, global warming potential, blue water consumption, and solid waste generation, indicated that using reusable gowns reduced natural resource energy consumption by 64%, greenhouse gas emissions by 66%, blue water consumption by 83%, and solid waste generation by 84% when compared with disposable gowns (Vozzola et al., 2020). The responses of the survey conducted in this study showed that surgeons concur with the environmental concerns as indicated by the other studies. Their responses also reflected that they would prefer a surgical gown which has higher barrier, provides comfort, reusable and had least environmental impact. The survey conducted in this study also highlighted the acceptability and willingness to adopt surgical gown made of recycled fabric.

A limitation of this study was a small sample size. In the future large scale studies can be pursued for comparing comfort, protection and environmental impact of the different types of surgical gowns.

## **Conclusion**

Depending upon the fabric type and characteristic of the surgical gown, wearing it for long hours could cause considerable discomfort and lower work efficiency. The comparison analysis of the reusable and disposable surgical gowns done in this study reflected that reusable gowns are the preference of the surgeons and other surgical staff. Reusable gowns scored high on comfort and thermal properties, and its use could be encouraged, even with lower fluid repellence due to large pore size of the fabric, and reduced barrier protection after repeated washing and sterilisation cycles. Disposable gowns were preferred by few surgical staff for the superior barrier protection; however it raised environmental concerns due its non-biodegradability. With an approach to

minimise the waste and reduce the environmental footprint, the use of reusable gowns made of recycled fabric can be considered as a sustainable and responsible choice.

## References

1. Aslan S, Kaplan S & Cetin C (2013). An Investigation about Comfort and Protection Performances of Disposable and Reusable Surgical Gowns By Objective And Subjective Measurements. *The Journal of the Textile Institute*; 104 (8), pp 870–882.
2. Atay, Y., Pamuk, O., Boyaci, B., Yildiz, E. Z., Göksel, T., Metin, D. Y., Gül, S., Devrim, G., & Topbaş, Ö. (2021). A New Approach to Surgical Gowns. In A. Agrawal, & S. Kosgi (Eds.), *Healthcare Access*. IntechOpen. <https://doi.org/10.5772/intechopen.98563>
3. Beam EL, Gibbs SG, Boulter KC, Beckerdite ME & Smith PW, *Am J Infect Cont*, 39(5) (2011) 415.
4. Behera, B. K., & Arora, H. (2009). Surgical Gown: A Critical Review. *Journal of Industrial Textiles*, 38(3), 205–231. <https://doi.org/10.1177/1528083708091251>
5. Karim, N., Afroj, S., Lloyd, K., Oaten, L. C., Andreeva, D. v., Carr, C., Farmery, A. D., Kim, I.-D., & Novoselov, K. S. (2020). Sustainable Personal Protective Clothing for Healthcare Applications: A Review. *ACS Nano*, 14(10), 12313–12340. <https://doi.org/10.1021/acsnano.0c05537>
6. McQuerry, M., Easter, E., & Cao, A. (2021). Disposable versus reusable medical gowns: A performance comparison. *American journal of infection control*, 49(5), 563–570. <https://doi.org/10.1016/j.ajic.2020.10.013>
7. Rivero PJ, Urrutia A, Goicoechea J & Arregui FJ, *Nanoscale Lett*, 10(1) (2015) 1.
8. Selçuk Aslan, Sibel Kaplan & Cem Çetin (2013) An investigation about comfort and protection performances of disposable and reusable surgical gowns by objective and subjective measurements, *The Journal of The Textile Institute*, 104:8, 870-882, DOI: 10.1080/00405000.2013.764754
9. Vinay Kumar Midha, Shubham Joshi & Arjun Dakuri. 2022. Surgical gown fabrics in infection control and comfort measures at hospitals. *Indian Journal of Fibre & Textile Research Vol. 47, March 2022*, pp. 96-104
10. Vozzola, E., Overcash, M., & Griffing, E. (2020). An Environmental Analysis of Reusable and Disposable Surgical Gowns. *AORN Journal*, 111(3), 315–325. <https://doi.org/10.1002/aorn.12885>

**Chapter: 17****Lived Experiences of Incarceration: A narrative review**

*“A prisoner is required to be treated as a human being entitled to all the basic human rights, human dignity and human sympathy”*

**Kiran Sharma<sup>1\*</sup> and Dr. Pawan Kumar Sharma<sup>2</sup>**

**Department of Nursing, Sharda School of Nursing Science and Research**

**Sharda University, Greater Noida, 201310 UP**

**\*Email- kiran.sharma@sharda.ac.in**

**Keywords:** Lived Experiences, Incarceration, Prisoners, Incarcerated people, emotional experiences, Psychological impact of incarceration.

**Introduction**

Crimes are actions that are against the law, are punishable, and may endanger the safety of the community or cause harm to any of its members. The act of imprisoning someone who has committed a crime keeps them confined to a secure area where everyone must abide by the same severe laws. Crime is a manifestation of thoughts in the mind, just like any other physical action. Retribution is no longer seen as the goal of reform as crime is now primarily seen as a societal issue. The scope of detention as a goal of imprisonment is also quite constrained. The ultimate goal of the prison sentence is thought to be the reformation of the criminal. In addition to the criminal side, the hardships of incarceration cause many prisoners to develop mental problems while they are there. The trial period is really stressful for the person. The under trial's mental condition deteriorates if the trial time is prolonged for months or years, which is fairly usual. The predicament is made worse by the difficult life in prison. The above-mentioned prison conditions have a significant negative impact on the quality of life and subjective wellbeing of the defendant. Criminal behavior may be caused by a negative attitude towards the law, which needs to be changed during reforms. A mismatch between personal objectives and cultural conventions frequently leads to a sense of alienation from mainstream life, which may lead to criminal activity. (Khurana et al; 2000)

Every country has a portion of individuals who act illegally, violating the law and disrespecting other people's rights and needs. Yet, not all persons commit crimes with the same regularity;

most of them are involved only in a one-off illegal event and then once again they become contributing members of society and avoid criminal conduct. On the other side, others find themselves again in illicit activities and finally in prison. Such continuing offenders are characterized as recidivists. Hence, recidivism in its general definition refers to those activities and behaviors, which are being against the law and are enacted by an already convicted criminal (Zara and Farrington 2016). Recidivism has had various definitions over the years. It includes, among other things, re-arrest, re-conviction, and re-incarceration. (Oruta, 2016). Recidivism, in broad terms, refers to an offender's relapse into criminal behaviour after being processed through the criminal justice system once or more. (McKean, 2004).

In Indian society, women are taken into consideration as Goddess, however then additionally from history to the existing society ladies are going through numerous ups and downs in their popularity. The past 30 years have witnessed a remarkable growth in the women crime. In India there are 14,657 (3.9%) female inmates until 2006 and circumstance of women prisoners may be very grim. (Instances of India file)

As consistent with jail information India, there are 419,623 folks in jail in India. Wherein women represent 17,834. In India, an evaluation of prison facts at 5-12 months' periods exhibits a growing fashion within the variety of women prisoners. Three % of all prisoners in 2000, Nine% in 2005, 4.1% in 2010 and four. Three % in 2015 have been women. Lady prison population has improved quicker than the male prison populace on every continent. A majority of female inmates are inside the age group of 30 - 50 years (50. Five %), followed with the aid of 18-30 years (31. Three %). Of the full 1,401 prisons in India, simplest 18 are one of a kind for girls, housing 2,985 female prisoners. Accordingly, a majority of female inmates are housed in ladies' enclosures of preferred prisons. (Country wide Crime Information Bureau, 2015)

Jail is an organization which reflects societal norms. Ladies in jail represent a unique institution in the jail population, first and predominant because of their intercourse and gender inequalities. They represent a small share of prison populace international. They face many troubles some as a result of their lives prior to imprisonment others attributable to their imprisonment itself. Social factors that marginalize their participation in mainstream society and contribute to the growing variety of ladies in jail consist of poverty, lack of social guide, separation or single motherhood

and homelessness. Ladies' paths to incarceration are complicated and frequently rooted in histories of more than one abuses. (Bull world fitness Organ, 2011)

Incarcerated ladies receive minimal reproductive fitness care and what they do acquire is regularly now not provided in accordance with expert ethic popular. They also have restricted get right of entry to statistics and in reality no say over choices even basic ones like which health practitioner they see or whether or not they'll see a physician at all. For folks who need to prevent or end a being pregnant, alternatives are further restricted and abuses are common. Crook justice handbook series (United countries, 2014)

Within the beyond few many years, the jail population has expanded appreciably, growing a number of challenges inclusive of safety, health & hygiene, overcrowding and so forth. As jails had been generally designed to cater to male inmates, special steps want to be taken to make certain adequate situations for ladies as properly. Female inmates are regularly faced with jail infrastructure and administrative systems, which might be in large part oblivious to their gender - precise desires.

Most of the research monitor that diverse socio-financial factors i.e., instructional popularity, paintings status, environmental factors and fashionable of dwelling affect women's common properly-being. Moreover, women have much less access to the use of health care offerings in society. Imprisoned women are characteristically girls of decrease socio-financial historical past, unemployed, married, moms of young youngsters, and survivors of bodily and sexual abuse. Additionally, they generally tend to have a fragmented family records, decrease social integration and balance, substance abuse issues, and more than one physical and mental health troubles. They rarely get hold of adequate fitness care before coming into the jail. As a setting, prisons provide a unique possibility to invest within the health of disadvantaged and marginalized populations and deal with fitness inequalities and social exclusion, thereby attaining sustainable upgrades in well- being for offenders and their families and in turn, helping to reduce costs of re- offending. Sadly, prisons typically ignore these fitness problems, at some stage in imprisonment and after launch, which exacerbate the trouble. In spite of the supply of minimum stage of fitness care, prisons prove to be aid simply because of the hapless and impoverished ladies' population. (Elsevier Public Health Emergency series, 2020)

Imprisonment as a technique of punishment has advanced over the centuries. In India, and maximum of the world nowadays, prisons are regarded as centers for the reform of criminals, in place of only a manner of punishment. 'The environment of prisons has to be surcharged with superb values and the inmates have to be uncovered to a healthy environment with appropriate opportunities to reform themselves'. Very best court has affirmed the simple rights of prisoners – "there will be several elements that lead a prisoner to dedicate a criminal offense however however a prisoner is needed to be treated as a man or women entitled to all of the primary human rights, human dignity and human sympathy." (Ministry of home Affairs,).

It is observing, social shape and society have been equally liable for crime causation. Consistent with him ladies are vulnerable to commit crimes whilst they're did not attain 'culturally defined desires' via 'Institutional method.' Highlighting the stress & theory of criminal activity based on anxiety or pressure of labor. (Merton, 1949)

Ladies's precise needs are ignored in jail, no longer unexpected; women in prison are not pinnacle precedence for people who do have women on their agenda. But, if imprisoned girls are visible as in need of attention, it's miles their maximum basic needs (i.e., reproductive fitness troubles, childbirth or physical harm) which might be considered worth of consciousness and not counselling and/or emotional/intellectual assist or repair which might represent an indulgence. Though it is less difficult to become aware of people with excessive mental illness and medicalized problem, however common mental issues or intellectual misery i.e., tension, depression, panic etc. That need other interventions (e.g., counselling) is an area that has been glossed over because those disorders are not taken into consideration severe sufficient (Shankardass, 2012). Similarly, Anthropological studies have determined that inequalities in almost all recognized societies, past and present, choose guys over girls. Ladies are every now and then equal to guys economically, politically or socially however in no known society do they have got extra manipulate over financial and political assets, workout extra electricity and authority or revel in extra status than men. Many sociologists provide an explanation for this inequality by using noting that girls on my own can supply delivery to and nurse infants, two sports crucial to a society's continuation however usually missing in social popularity. For the reason that a first-rate supply of electricity, wealth and standing is the ability to earn cash or

accumulate different items of price, any problem on ladies's potential to pursue these rewards influences their social function (Chambliss and Eglitis, 2014).

Recidivism is one of the most crucial ideas in the criminal justice system on a global scale, and it is a significant issue that all nations must deal with. (Forkuor 2017; Akporaro 2019). The rate of recidivism has increased globally despite numerous intervention measures, with negative results for individuals as well as for the social and economic life of the community. (Akporaro 2019). Additionally, the impact of recidivism on governments, global corporations, and humanitarian groups has made it a significant social issue. (Simasiku 2018). United States of America (USA) as the country with the worst crime rate in the world (Atieno 2017), in the same way, with more than 76.6% of freed inmates committing new crimes and going back to jail, it has the highest recidivism rate in the entire globe. (Flores 2018). (Tsegaye, 2022)

The use of imprisonment as a form of punishment has evolved over time. Prisons are no longer just seen as a means of punishment, but rather as centers for the reform of criminals in most of the world today, including India. Prison environments must be enhanced with excellent values, and inmates must be exposed to a healthy atmosphere with appropriate opportunity for self-reform. The highest court has upheld the fundamental rights of prisoners, stating that "there are a number of factors that can cause a prisoner to commit a criminal action, but a prisoner needs to be regarded as a man or woman entitled to all fundamental human rights, human dignity, and human sympathy." (Ministry of home Affairs,).

With the exception of self-reported illegal drug usage, socioeconomic standing (often determined by the three factors income or wealth, occupational level, and years of schooling) has a negative correlation with criminality. There is certainly an inverse association between crime and higher parental socioeconomic position. Criminality has a favorable correlation with unstable work and frequent unemployment. (Morgan, 2010).

It is believed that lower socioeconomic position is positively connected with higher levels of stress and, consequently, the negative mental and psychological impacts of stress. These increased stress levels would likely have a positive correlation with the likelihood of committing a crime. (Baum, 1999)

A positive correlation between low income levels, the percentage of the population living in poverty, low education levels, and significant economic disparity in a region with increased crime is suggested by some, albeit inconclusive, research. (Ellis et al; 2009).

### **Research problem**

The present review was aimed to gain a comprehensive understanding of health status and causing factors that leads to crime in incarcerated persons. The narrative review had been examined in eight, eight International and national respectively related studies.

### **Methods**

A narrative review was designed. A systematic electronic search was used to identify relevant studies. The original research papers were only included in study. The electronic databases searched were: PubMed, EBSCO, Research Gate, Scopus and Allied Health Literature (CINHAL). The existing literatures were very systematically opted to recruit into this narrative review.

### **Inclusion Criteria**

1. The paper which is easily accessible online and full text available.
2. Original Research paper related to the topic.
3. The studies which are completed in English language.

### **Exclusion Criteria**

1. The research studies which are not available on journal database.
2. Poor quality journal publications.
3. The research study which is published in without ISSN number journals.
4. The studies which are published in local language.

### **Results and discussion**

#### **International Literature**

The study used Western literature to identify prison victimization risk variables in Taiwan and evaluated how much of it could be applied to an Eastern setting. Four male prisons in Northern, Central, Southern, and Eastern Taiwan were used as the sample, and 1,181 valid surveys were

gathered overall. The principal conclusions of the current Western studies are generally supported by the data. However, none of the statistical models found a significant correlation between crowding and the likelihood of victimization, which could be explained by the fact that American and Taiwanese prisoners in the free community had quite different experiences and living circumstances. The study produced clear policy recommendations that could lessen victimization in jail and foster a culture of improved well-being there. (Kuo et al; 2012).

A random sample of 996 people was used in a research to examine the health state of the New South Wales jail population. According to the study's findings, blood-borne infections, drug usage, alcoholism, and issues with physical and mental health are all very common among convicts. The majority of participants were overweight, and women were more likely to develop heart-related issues such high blood pressure and chest or angina symptoms. Additionally, poor eyesight, asthma, arthritis, and back problems were the most often reported illnesses by older women. Anxiety, depression, and substance abuse were the three most prevalent mental health disorders. Many of the women, however, have never used any type of community health care. For many prisoners, incarceration does give them a chance to deal with their health difficulties in a reasonably. (Indig et al., 2009)

The purpose of the study was to investigate the experiences of male convicts who participated in quantitative and qualitative studies on violence and suicide. Before and after data collection for a cross-sectional study as well as a qualitative interview, participants at four male prisons completed a visual analogue scale of mood. In addition, participants were asked to provide three words to summarize their participation experience. The difference between pre- and post-mood ratings was investigated using paired samples T-test, and content analysis was used to investigate both positive and unfavorable remarks about the participants' experiences. Overall, there was no significant difference in mood following participation in a similar qualitative study (5.1 to 5.0,  $p = 0.793$ ), but there was a significant improvement in mood following participation in a cross-sectional study about suicide and violence (from 4.8 to 5.3,  $p = 0.016$ ). The majority of participants gave good feedback about their experiences, saying that the process had been gratifying, relaxing, engaging, illuminating, and helpful. A lower percentage of individuals described their experiences as stressful, difficult, depressing, strange, and uncomfortable. According to this study, participants generally found the experience to be enjoyable when

investigating difficult subjects with male convicts, such as violence and suicide. These results refute the notion that conducting sensitive subject research with convicts is too risky, and they may help future researchers gauge participant risk. (Hemming et al., 2021)

A study was done to examine how gender and health are related. The results of the study indicated that although there were significant disparities (affected) between men and women, both genders were impacted by the changing patterns of health (i.e., the growth in communicable diseases to non-communicable diseases). Cardiovascular diseases, which women and men experienced differently, account for about half of the rise in non-communicable disease. Women and men bear a disproportionate share of the burden of the rapidly rising tobacco-related diseases that are afflicting the world; women also faced HIV/AIDS and the sharp rise in mental health issues in distinct ways. In order to comprehend the differences and similarities between sex and gender, the relative importance of biological and socially constructed differences, and the ways in which these intersect with other factors affecting men's and women's health, the study examined the influences of sex and gender on both men's and women's health. (Payne, 2006)

It comments on how including people with lived experience in a study looking at cancer care in prison and how doing so enhanced the research process from both an academic and lived experience standpoint. It is based on both written and vocal perspectives from academic and lived experience researchers involved in a study looking at the cancer diagnosis and treatment of inmates. The study included inmate cancer patients, prison medical professionals, oncology specialists, and custodial workers in interviews. Researchers with lived experience were involved in all stages of the study, including helping to conduct and analyses patient interviews. This demonstrates the significance and benefit of involving lived experience researchers in all stages of the study process. It considers how conducting interviews and interpreting data obtained while incarcerated is affected by the lived experience of jail. It considers how researchers' academic backgrounds and real-world experiences interact. It illustrated how difficult jail research is, but how teaming up with academic and lived experience researchers may help researchers better prepare for the field, ask more insightful questions, and establish rapport with participants. These partnerships can be effective ways for academic and lived experience researchers to improve their skills, but they demand time commitment and a willingness to exchange knowledge. In order for academics and researchers with lived experience to work together successfully and

meaningfully, attention must be made to establish fair, open, and equal working relationships. It's crucial for academic and lived experience researchers to strengthen their skills. Relationship development and maintenance require dedication. These interactions can be facilitated and fostered by using a third person as a mediator. It is crucial to put the "do no damage" principle into reality and to have resources available to reduce this, especially with those who have first-hand experience with incarceration. (Visser, 2021)

The qualitative analysis investigates the actual incarceration experiences of older persons. A larger mixed-methods longitudinal study that involved 23 older persons included interviews with them about their experiences in jail and upon release. Results discuss loss experiences, medical neglect, abuse by staff and other convicts, as well as the uncertainty and risk of prison life. Those who had been in prison admitted to feeling tension and anxiety after being released. While participants noted that getting older made it harder to handle prison life, they also talked about the advantages of being a senior. Older convicts may be able to remove themselves from dangerous situations due to maturity. Participants shared their rest and recovery experiences, demonstrating coping strategies and resiliency that may enhance psychosocial outcomes both inside and outside of jail. Informing measures to support this vulnerable community, this descriptive research focuses the voices of elderly prisoners. (Smoyer, 2020)

According to a review of the literature, 93% of prisoners are released back into society. Recidivism—the practice of returning to prison after engaging in criminal activity—needs to be addressed, and the massive return of former criminals to society only serves to emphasize this. The goal of this phenomenological study was to interview former prisoners to learn about their opinions of prison educational programmes and to determine whether or not their education had influenced their decision-making and prevented them from committing crimes. This study's focus is on Texas's high rate of recidivism among male ex-offenders between the ages of 20 and 40. 15 Texas-based male ex-offenders between the ages of 20 and 40 who were released from jail between six months and two years ago made up the study sample. The conceptions of motivation, the legitimacy of the legal system, learning as a component of personal development, and individual interpretation of one's life purpose served as the study's framework. The interview questions were designed to elicit comments from the participants that would demonstrate the degree to which information, personal growth, and social interaction shaped their experiences of

their educational programmes. Their improved awareness of how they interact with the world and the people they come in contact with was influenced by the knowledge they gained from their educational programmes. To the extent that they felt comfortable disclosing details about their experiences, the participants spoke about what they thought was significant. The foundation for identifying emergent themes was a synopsis of the key elements from the interviews. Recidivist study will always be necessary as society struggles with crime and deterrence. Legislation was passed during the study period to address some of the problems that the criminal justice system was experiencing. The need for this study stems from the need to advance our understanding of recidivism. (ELLIS, 2020)

Inmates have high rates of both adult and childhood traumas. Childhood trauma is linked to a higher likelihood of criminal activity in addition to mental illnesses (such as depression and anxiety) and co-morbid conditions including alcohol and drug misuse as well as antisocial behaviours in adulthood. This study assesses rates of trauma in infancy and adulthood and investigates the effects of trauma's age of beginning and type on emotional issues and behaviour in a sample of jailed males (N4,000 Age at time of trauma, race, and the kind of mental health care received while incarcerated were used to build prevalence estimates for various types of trauma. HLM models were employed to investigate the relationships between traumatic experiences in childhood and adulthood and difficulties with depression, anxiety, substance abuse, interpersonal issues, and violence (each model estimated separately and controlling for age, gender, race, time incarcerated, and index offense). Childhood rates of physical, sexual, and emotional trauma varied from 44.7% (physical trauma in childhood) to 4.5 %. These rates were greater than adult rates (sexual trauma in adulthood). Many behavioural issues and clinical symptoms were discovered to be closely related to trauma exposure. Targeted intervention is essential due to the enormous number of males who are incarcerated and the power of these networks. (Wolff, Shi, 2012)

Ethiopia currently faces a serious problem with crime in general and recidivistic behavior in particular. Every crime has social and economic costs for both society and the offender, but recidivism has the greatest negative social and economic effects because it makes society feel unsafe and fearful, leads to continued loss of life and property, and increases the cost of the criminal justice and law enforcement systems. Recidivisms and its causes, though, are little

known in Ethiopia. As a result, the purpose of this study was to investigate the causes of recidivism with a focus on Hawassa Correctional Centre inmates. They used a cross-sectional study design and a mixed research methodology. The quantitative data came from the 80 recidivists who were chosen after thorough sampling. On the other hand, key informant interviews, semi-structured interviews, and case studies were used to collect qualitative data from 70 individuals who had been purposefully chosen. Thematic analysis was used to study the qualitative data while descriptive and inferential statistical methods were used to analyse the quantitative data. The study's findings indicated that recidivism is caused by both institutional and personal factors, including institutional factors such as mistreatment by prison staff, ineffective services, overcrowding, lack of an inmate classification system, inmate subculture, and lack of family support. Personal factors include age, sex, educational background, alcohol and drug use. Socioeconomic factors include peer pressure. The researcher suggests, in light of the findings, that efforts be made to include the problem of recidivism and social reintegration of offenders in current criminal policy, that prison management introduce offender-oriented treatment programmes, and that it collaborate with community organizations, faith-based institutions, and volunteer people and organizations to help recently released prisoners create opportunities for themselves. (Tsegaye, 2022)

### **National Literature**

The amount of socially excluded people is more likely to be present in prisons. Prisons are necessary to separate and isolate some of those who have broken the law, according to the fundamental justification of the community that expresses its wishes through the use of courts. This segregation's idea has existed for as long as society has. This article covers Indian prison management, prison functions, and prison classifications. Prisons have a limited impact on reducing crime, and they can occasionally be quite harmful to the people within. There is dispute over who should be imprisoned and for how long, despite the fact that some people are dangerous and should be removed from society. Learn about the history of prisons, the sentencing practices that contributed to the current prison overcrowding issues, the philosophy that served as the foundation for the development of prisons, as well as the scope and consequences of jail overcrowding. The following section looks at inmate classification, educational opportunities for prisoners, prison businesses, treatment options, and convict

subculture, with particular attention to the past and present experiences of women and minorities. It looked at concerns with jail administration as well as the function and background of correctional personnel. The privatization of incarceration, inmate lawsuits, and jail operations, administration, socialization, and subcultures were all given additional attention. The last chapter focused on the future of prisons and prison concerns, with particular attention paid to the effects of drug laws, overcrowding, race, inmates' rights, prison violence, prison industries, other prison programming, and the role of correctional professionals. According to the analysis, prisons will likely continue to operate substantially as they have since they first began. (Naik, 2019)

A study conducted to analyse the rising prevalence of non-communicable diseases in Indian prisons and calculate the prevalence of depression among them. According to PRISMA standards, a total of 9 papers that examined the prevalence of NCDs in Indian prisons and were published between January 2010 and August 2022 were considered. The channel plot was employed in STATA Version 16 statistical analysis to determine publication bias. 9 papers out of a total of 167 that were related were examined in this research. Depression was detected in 48.78 percent of catches, on average. The review found that self-murder creativity, dental cavities, poor periodontal health, and moderate to severe depression were all much more common in the captures. The study's conclusions helped policymakers design and create practical preventive and remedial programmes for the benefit of prisoners as a whole. (Manna, 2022)

In India, viral hepatitis is still seen as a significant contributor to the burden of disease. It is the most frequent reason for liver cancer and cirrhosis. One of the populations most at risk for hepatitis is prisoners. The purpose of the study was to calculate the combined estimates of the prevalence of hepatitis B and C among Indian convicts. The study chose studies in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. The databases of PubMed, Embase, and Google Scholar were used for the thorough search. This meta-analysis included all cross-sectional studies published up to June 2020 that looked at the prevalence of hepatitis B and C among prisoners in India. The random-effects model was used to conduct the analysis. The I<sup>2</sup> indicator was used to estimate the heterogeneity. Using Stata version 12 after extracting the necessary data, the meta-analysis was carried out (Stata Corp LLC, College Station, Texas). Five studies that satisfied the inclusion criteria were included and evaluated out of a total of 970 papers that were looked up in the databases of

PubMed, Embase, and Google Scholar. Four studies each reported the prevalence of hepatitis B and C. According to the findings, hepatitis B and C were present in convicts at rates of 8% (95% CI: 4-12) and 7% (95% CI: 1-13), respectively. High variability is seen in the studies, and there is no sign of publication bias. Hepatitis B and C prevalence among male inmates was 4.48% (95% CI: 3.64%-5.32%) and 6.35% (95% CI: 5.48%-7.23%), respectively, while it was 1.53% (95% CI: 0.31-2.75) and 2.10% (95% CI: 0.28-3.93) among female inmates. The results of the study indicate a significant prevalence of hepatitis B and C in convicts, which is very alarming. Interventions that are appropriate and efficient are crucial for reducing the spread of hepatitis B and C in prisons. (Ajeet, 2021)

Criminality and drug usage have a complicated relationship. There are significant rates of drug usage among convicts and criminal activity among drug users in public places. Inadequate data are available from South Asian nations, including India. The study's objective was to evaluate the criminal behaviour pattern of the opioid-dependent participants as well as their substance usage throughout the month before, during, and after incarceration. With the aid of a specially created tool to track criminal acts and substance use before, during, and after last incarceration, opioid-dependent subjects (n=101) attending two community drug treatment clinics who have ever come into contact with the law were evaluated using a cross-sectional study design and purposive sampling. 93% of the participants had engaged in unlawful activity at some point in their lives. The most frequent unlawful activity was physical assault, while 23% admitted to selling narcotics and 9% to committing major offences. Around 95% were detained by the police and 92% had been arrested. Approximately 29% of people were detained for drug-related offences such possession or usage, and 3% of injectable drug users were detained for having injection equipment on them. Approximately 85% of those who had been incarcerated at least once had used psychoactive drugs 88% of the time in the month before to their most recent incarceration. The most often used substance on a daily basis (68%) was an opioid, followed by cannabis (34%) and alcohol (22%). Ninety-seven percent of respondents said drugs are available in jails, and 65% said they used drugs when they were imprisoned previously. The most often used drug in prisons was marijuana (35%) followed by painkillers (19%). Seventy-six percent began using drugs immediately after being released from prison and 13% of opioid users overdosed within a year of being released. Cannabis use, injecting drugs, and opiate use before

prison all predicted prison drug use. Opioid addicts frequently run into legal issues, including being imprisoned. Many users become addicted on drugs when they enter prison, which is a significant factor in their continuing drug usage while incarcerated. Treatment for substance misuse is required at all phases of the criminal justice system. (Rao, 2016)

Women's captures in India are tracing gender differences in theories of incarceration. It examines the notions of imprisonment with a focus on female prisoners. The male centric prejudice of criminology is emphasized, and its effects on the cause of women's captures are examined. It aims to identify women's captures in the larger spectrum of social life by connecting vivid social generalities like social justice and social choice with women's captures. The methodology of qualitative investigation was applied. Primarily secondary sources research on prison and captive reforms. (Kamthan, 2018)

Two phases of the exploratory cum descriptive study were carried out: the recitation phase and a baseline examination of the records on file with the state governor's department of captivity. In order to understand the profile of the woman captures and to offer recommendations for their recovery, studies and social, provident, and other aspects are examined. The women who were arrested and the jail staff served as the major sources of information, and secondary sources included interviews, observations, focus groups, and case studies. One-sixth involved lucrative detriment, one-ninth involved moral aberration, and one-seventh were minor malefactors, according to samples of womanish malefactors from Rajasthan, Punjab, and MP. Poor profitability was intended to have more of an impact on a lawbreaker's profile than low cast. 70 female miscreants are used to illustrate how ignorance is almost tied to crime. (Ram, 2018)

The National Institute of Mental Health and Neuroscience, Bangalore, did a study titled Mental Health and Substance Use Issues in Incarcerations: The Bangalore Prison Mental Health Study Original Assignment for National Action. According to the survey, a significant percentage of captured people had physical and mental health issues. A sizable percentage of female patients with schizophrenia were found to have a major psychotic complaint. More than seven out of every hundred captured people admitted to intentionally injuring themselves, and two out of every hundred captured people said they had occasionally attempted self-murder. Around fifteen out of every 100 trial captures who attempted a deliberate tone-detriment after being taken captive expressed a viewpoint about a social personality complaint. In addition, a 1998 joint

study by NIMHANS and the National Commission for Women evaluated internal morbidity in women held in central captivity in Bangalore and simulated severe instances of internal suffering, including dissatisfaction, fussing, bad sleep, and decreased food. The key observation regarding women was that they were noticeably older than men. With one in four being light and nearly an analogous proportion being obese or fat, they had issues with both undernutrition and over nutrition. Important questions are raised concerning the lack of exercise in captivity and the decreased risk of chronic diseases like hypertension and diabetes as a result. (Math et al; 2011)

## **Conclusion**

Following an in-depth document search, Incarceration leads to many physical and mental health problems. Many behavioral issues and clinical symptoms were discovered to be closely related to trauma exposure. Participants shared their rest and recovery experiences, demonstrating coping strategies and resiliency that may enhance psychosocial outcomes both inside and outside of jail. Informing measures to support this vulnerable community, descriptive research focuses the voices of elderly prisoners. The results of the study indicate a significant prevalence of hepatitis B and C and communicable and non-communicable diseases in convicts, which is very alarming.

## **Scope for further work**

The conceptions of motivation, the legitimacy of the legal system, learning as a component of personal development, and individual interpretation of one's life purpose to be served. The efforts be made to include the problem of recidivism and social reintegration of offenders in current criminal policy, that prison management introduce offender-oriented treatment programmes, and that it collaborates with community organizations, faith-based institutions, and volunteer people and organizations to help recently released prisoners create opportunities for them. The study's conclusions helped policymakers design and create practical preventive and remedial programmes for the benefit of prisoners as a whole. The study produced clear policy recommendations that could lessen victimization in jail and foster a culture of improved well-being there. None of the statistical models found a significant correlation between crowding and the likelihood of victimization. A need for researchers to reassess the views of prisoners as a 'sensitive' population, and also to reassess topics such as suicide and violence as 'sensitive' or 'risky'. The involvement of people with lived experience of prison in research is one way to

critically analyse and potentially bring about positive change within this system. The research should be ongoing to mirror the changes occurring in society. The shifts in culture and policy have an impact on the rehabilitation of prisoners and upon their release; they will in turn have an impact on society.

## References

1. Amy, B., Smoyer, Madera, Kim, M., Blankenship, 2019. Older adults' lived experience of incarceration. *Journal of Offender Rehabilitation* 58 (3) 220-239.  
DOI: 10.1080/10509674.2019.1582574
2. Bhadoria, A.S., et.al 2021. Prevalence of Hepatitis B and C Among Prison Inmates in India. 13(11) e19672. doi: 10.7759/cureus.19672. PMID: 34956775; PMCID: PMC8675573.
3. Ellis, P., 2020. A Phenomenological Study of Former Prisoners' Experiences of Prison Education Programs in the United States, Northcentral University.
4. Hemming, L., Pratt, D., Haddock, G., Bhatti, P., Shaw, J., 2021. Male prisoners' experiences of taking part in research about suicide and violence. *Research Involvement and Engagement* 7(1) 65. doi: 10.1186/s40900-021-00303-z. PMID: 34521482; PMCID: PMC8438986.
5. Kuo, Cuvelier, Huang, 2012. Identifying Risk Factors for Victimization Among Male Prisoners in Taiwan. *International Journal of Offender Therapy and Comparative Criminology* 58(2). <https://doi.org/10.1177/0306624X12465272>
6. Rao, R., et.al 2016. Factors Affecting Drug Use During Incarceration of Opioid-Dependent Persons from India. *Journal of substance abuse treatment* 61 13-7. doi: 10.1016/j.jsat.2015.08.009. Epub 2015 Sep 21. PMID: 26470597.
7. Tsegaye , 2022. Factors Contributing to Recidivism. Prison Inmates at Hawassa Correctional Center, Southern Ethiopia, Munich. GRIN Verlag. <https://www.grin.com/document/1188038>
8. Visser, R., Barber, A.E., Wheatcroft, S., Mullen, P., Armes, J., 2021. Collaboration with people with lived experience of prison: reflections on researching cancer care in custodial settings. *Research Involvement and Engagement* 7(1) 48. doi: 10.1186/s40900-021-00284-z. PMID: 34183075; PMCID: PMC8238630.
9. Wolff, N., Shi, J., 2012. Childhood and adult trauma experiences of incarcerated persons and their relationship to adult behavioural health problems and treatment. *International Journal of Environmental Research and Public Health* 9(5) 1908-26. doi: 10.3390/ijerph9051908. Epub 2012 May 18. PMID: 22754481; PMCID: PMC3386595.

**Chapter: 18****Evaluation of effect of grafting materials on implant stability and bone regeneration in patients with transcrestal approach for sinus augmentation at three different time intervals  
- An Experimental study**

<sup>1</sup>Sattyam Wankhade, Dr Yogesh Ingole, Dr Jyoti Wankhade, <sup>1</sup>Archit Kapadia and  
<sup>1</sup>Samiksha Lalsare

<sup>1</sup>Department of Prosthodontics, GDC&H, Nagpur  
E-mail: drsvw6@gmail.com

**Abstract:** Rehabilitation of missing teeth with the use of dental implants has gained popularity in the past few decades. The pneumatisation of maxillary sinus in posterior maxillary area complicates the use of dental implants with an optimum stability. To overcome this, many techniques have been described in literature and transcrestal approach for sinus augmentation is one such technique. To further enhance the healing and improve gain in bone height, many materials and techniques have been developed. This study investigates the effect of Platelet-rich fibrin and allograft on the implant stability and bone regeneration in patients with transcrestal approach for sinus augmentation at three different time intervals.

**Keywords:** Transcrestal sinus augmentation, Indirect sinus lift, Platelet-rich fibrin.

**Introduction:**

The application of dental implants for the prosthetic rehabilitation of missing teeth has provided a multitude of treatment options for patients. Loss of teeth in posterior maxillary area can lead to adverse consequences. Maxillary sinus pneumatisation is one of these that precludes placement of implants due to anatomical constraints. This anatomical situation complicates the achievement of an effective primary stability. Maxillary sinus augmentation has been shown to be a predictable method to increase posterior maxillary bone height, and allow placing dental implants when the residual alveolar ridge is deficient in bone volume.<sup>1</sup>

To tackle with post extraction resorption amounting to deficient bone volume in posterior maxilla, many approaches have been described to augment the residual bone by ensuring sinus membrane elevation up to 5mm without tearing it. Boyne and James first described the sinus lift technique based on a modification of the Caldwell-Luc sinus revision, involving a lateral

approach to the sinus that allows a remarkable bone augmentation upto >10mm even in atrophic ridges.<sup>2</sup>

Tatum Jr in 1986, proposed the use of osteotomes in a definite sequence with a transcrestal approach, to perform a controlled fracture of the floor of the sinus, thus mitigating associated morbidity and post-operative discomfort.<sup>3</sup> Summers, in 1994, modified the technique by using conical osteotomes that provided lateral force compression and thus, increased lateral bone density.<sup>4,5</sup> Cosci and Luccioli in 2000, proposed a single stage crestal approach using a specific drill sequence without fracturing the bone by providing a particular tip-design of the drill.<sup>6</sup> Even after it being a blind approach, the transcrestal technique has reported lesser frequency of sinus membrane perforation compared to the direct sinus approach.

The transcrestal approach using the sinus balloon technique has the advantages of requiring a minimum of 3mm or more of residual bone compared to the osteotome technique which requires a minimum of 6 mm.<sup>7</sup> Muronoi et al. in 2003<sup>8</sup>, and Soltan et al. in 2005<sup>9</sup> described the use of sinus balloon in direct sinus lift, placing it through a window in the lateral sinus wall. Kfir et al. in 2006<sup>10</sup> described the use of sinus balloon technique intranscrestal sinus lift, placing bone grafts and dental implants in the same surgical step. Since elevating the sinus membrane creates a space, various graft materials have been studied over the years to augment this space. The use of autograft has been considered a gold standard for the same but donor site morbidity precludes its use. Hence, allogeneous grafts, xenografts or their combinations have been considered for due application. Owing to its wound-healing and osteogenic properties, Platelet-Rich Fibrin has also been considered either solely or a mixed substitute with bone grafts during sinus lift procedures.<sup>11</sup>

Various materials and techniques have been developed to expedite bone healing process and reduce its healing period. Recent studies have shown that, platelet-rich fibrin (PRF) which is derived autogenously from the own blood of the individuals, increase regeneration and accelerate the wound healing, due to its various growth factors.

This study particularly aims to evaluate the effect of sinus membrane elevation using Platelet-rich Fibrin mixed with allograft using the transcrestal approach with a sinus balloon on the primary stability of implants and also the gain in bone height achieved over a protracted follow-up period including 3 months after prosthetic loading of the implants.

**Material and Methods:****Study design**

This study is a prospective, open label, single arm study that included patients visiting the Department of Prosthodontics at Government Dental College, Nagpur for implant prosthesis with maxillary posterior region. All the patients were explained in detail about the advantages and prerequisites of participating in the study and a verbal as well as written informed consent was obtained from willing patients. Inclusion criteria were patients more than 18 years of age, maxillary posterior edentulous area, good oral hygiene, healed edentulous area for at least 6 months, minimum height of 6mm and width of 5mm, patients providing informed consent. Patients with medically compromised conditions such as diabetes, hyperthyroidism, epilepsy etc: carcinoma, pregnancy, smoking, chronic alcoholism, uncontrolled periodontal disease, poor oral hygiene, parafunctional habits, implants with fenestration and dehiscence, implants failed during study, severe inter-maxillary skeletal discrepancy, sinusitis and infection related to maxillary sinus and patients not willing to undergo surgical procedure were excluded from the study.

**Radiographic Image Acquisition**

Prior to the surgery, general physical and oral examinations were performed. Dental cone beam computed tomography (CBCT) radiographs were taken to determine bone height and width up to the sinus floor. Patients having minimum of 6-8mm of bone height and  $\geq 5$ mm of bone width were included. CBCT was evaluated to rule out any possible maxillary sinus pathology.

**Surgical Procedure**

All surgical procedures were performed by the same operator. The patient received an oral prophylaxis antibiotic (2 g amoxicillin-clavulanate or 600 mg clindamycin in case of penicillin allergy) 1 hour before the surgery. Patients mouth was rinsed with 0.12% chlorhexidine gluconate mouth rinse (for 1 minute after which local anesthesia (2% lidocaine with epinephrine 1:80,000) was administered. A mid-crestal incision was made, and a full-thickness mucoperiosteal flap was raised to expose the underlying bone in maxillary posterior edentulous area. Stage I surgery with indirect sinus lift was performed using OsstemCrestal Approach Sinus KIT (CAS-KIT). Sinus elevation of 3-4 mm was achieved using hydraulic pressure and bone graft material (Xenograft and PRF) was added. The implant of predetermined size based on the

CBCT evaluation was then placed and primary stability was measured using Radio Frequency analysis (Osstell ISQ; Gotegog, Sweden). The flap was sutured with 3-0 nonresorbablemersilk suture. Radiographic evaluation using CBCT was done after sinus elevation.

Patients were recalled after 7 days to examine wound healing and suture removal. After 6 months of postsurgical implant placement, patients were followed up and Stage 2 recovery of implant was performed. Implant Stability values using RFA (radio frequency analysis) and radiographic evaluation (CBCT) of sinus floor was calibrated and prosthetic loading of the implant was instituted. 3 Months after the implants were loaded; patients were followed up to recalibrate Implant Stability values using RFA (radio frequency analysis) and radiographic evaluation (CBCT) of sinus floor.

### Data Analysis:

The continuous parameters were summarized in terms of mean, standard deviation, median and range at each time point. The change in the parameter values across time points were statistically evaluated using repeated measure analysis of variance. The paired comparison of each parameter was done between time points using paired t-test and was corrected for multiple testing using Bonferroni test.

All the analyses were performed using SPSS version 26.0 (IBM Corp, USA) software and statistical significance were tested at 5% level.

### Results

The study included 17 patients (8 men and 9 women) with an average age  $\pm$  SD =  $56.12 \pm 15.89$  years (Table 1). No patients experienced any postsurgical complications. Increased alveolar bone height was radiographically observed in all subjects. New bone continuous with the sinus floor was detected around the apical end of the implant.

**Table 1: Descriptive statistics for demographic parameters**

| Parameter    |                           | Statistics |
|--------------|---------------------------|------------|
| Age in years | <i>Mean</i>               | 56.12      |
|              | <i>Standard Deviation</i> | 15.89      |
|              | <i>Median</i>             | 56.00      |

|             |                |          |
|-------------|----------------|----------|
| Sex [n (%)] | <i>Minimum</i> | 17.00    |
|             | <i>Maximum</i> | 77.00    |
|             | <i>Male</i>    | 8 (47.1) |
|             | <i>Female</i>  | 9 (52.9) |

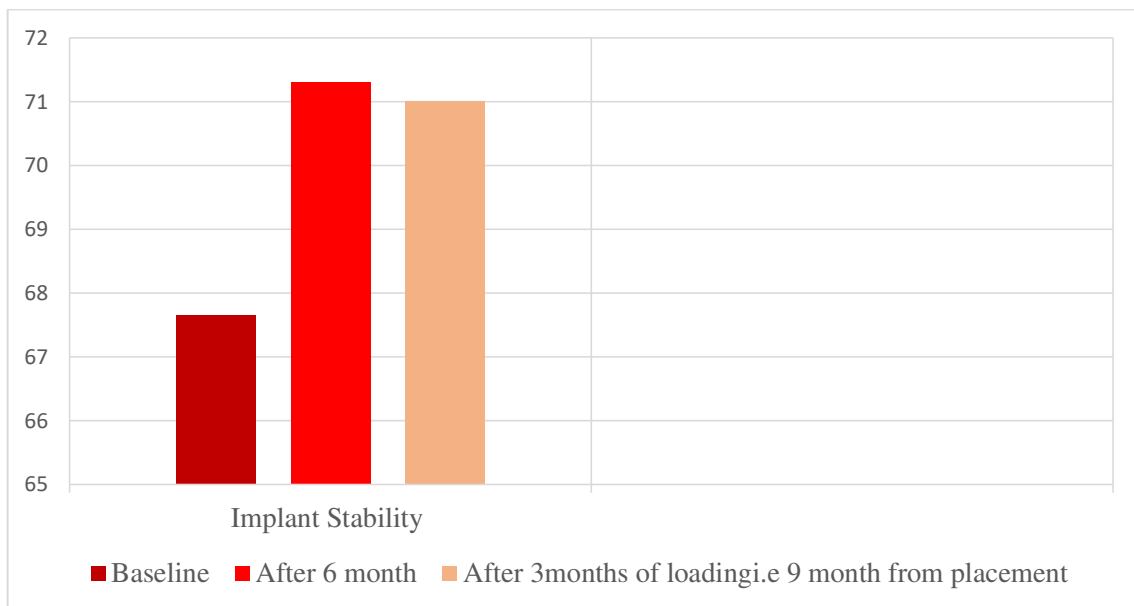
The average implant stability at immediate postop (baseline) RF Analysis was found to be 67.65 (Mean  $\pm$  SD = 67.65  $\pm$  8.31). At 6 months, the average implant stability seen was 71.29 with a standard deviation of  $\pm$  6.9. After 3 months of loading, average implant stability of 71  $\pm$  7.19 was observed. A statistically significant increase (p-value <0.0001) in implant stability from baseline to 6 months was noted, while the change from 6 months to 3 months after loading was non-significant. (Table 2) (Figure 1)

**Table 2: Comparison of implant stability across time**

| Implant stability at      |                           | Statistics | P-value* |
|---------------------------|---------------------------|------------|----------|
| Baseline                  | <i>N</i>                  | 17         | < 0.0001 |
|                           | <i>Mean</i>               | 67.65      |          |
|                           | <i>Standard Deviation</i> | 8.31       |          |
|                           | <i>Minimum</i>            | 52.00      |          |
|                           | <i>Maximum</i>            | 79.00      |          |
| After 6 months            | <i>N</i>                  | 17         |          |
|                           | <i>Mean</i>               | 71.29      |          |
|                           | <i>Standard Deviation</i> | 6.90       |          |
|                           | <i>Minimum</i>            | 58.00      |          |
|                           | <i>Maximum</i>            | 82.00      |          |
| After 3 months of loading | <i>N</i>                  | 17         |          |
|                           | <i>Mean</i>               | 71.00      |          |
|                           | <i>Standard Deviation</i> | 7.19       |          |
|                           | <i>Minimum</i>            | 57.00      |          |
|                           | <i>Maximum</i>            | 81.00      |          |

\*Obtained using repeated measure analysis of variance

Statistically significant increase in implant stability with time. The change from baseline to 6 months was significant, while the change from 6 months to 3 months after loading was non-significant.

**Figure 1: Implant stability across time**

An average sinus elevation of  $3.82 \pm 0.73$  at baseline evaluation,  $2.26 \pm 0.71$  at 6 months, and  $2.15 \pm 0.63$  at 3 months after loading was observed. The decrease in the sinus elevation from baseline to 6 months was statistically significant ( $p$ -value  $< 0.0001$ ), whereas the change from 6 months to 3 months after loading was non-significant. (Table 3) (figure2)

**Table 3: Comparison of sinus elevation across times**

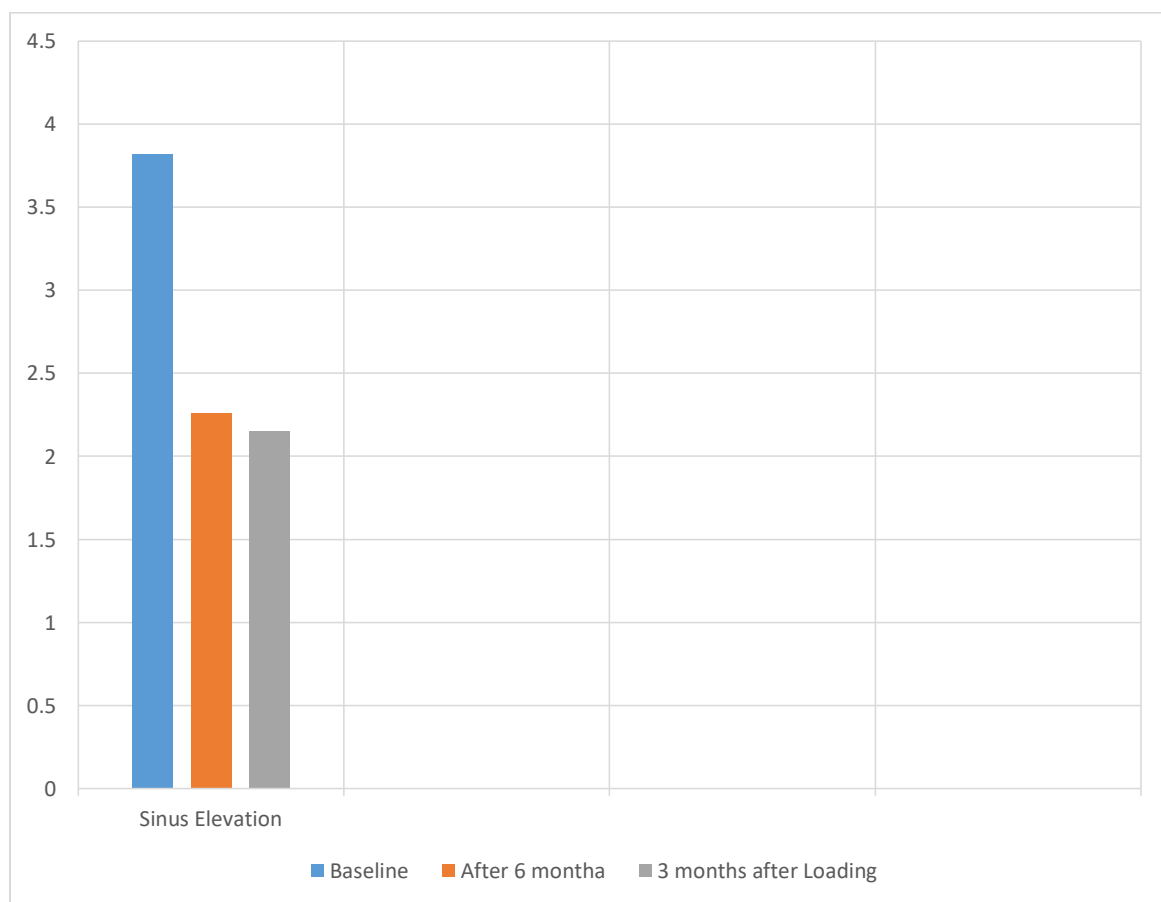
| Sinus elevation at     |                           | Statistics | P-value* |
|------------------------|---------------------------|------------|----------|
| Baseline               | <i>N</i>                  | 17         | < 0.0001 |
|                        | <i>Mean</i>               | 3.82       |          |
|                        | <i>Standard Deviation</i> | 0.73       |          |
|                        | <i>Minimum</i>            | 3.00       |          |
|                        | <i>Maximum</i>            | 5.00       |          |
| After 6 months         | <i>N</i>                  | 17         |          |
|                        | <i>Mean</i>               | 2.26       |          |
|                        | <i>Standard Deviation</i> | 0.71       |          |
|                        | <i>Minimum</i>            | 1.00       |          |
|                        | <i>Maximum</i>            | 3.50       |          |
| 3 months after loading | <i>N</i>                  | 17         |          |
|                        | <i>Mean</i>               | 2.15       |          |
|                        | <i>Standard Deviation</i> | 0.63       |          |

|  |                |      |  |
|--|----------------|------|--|
|  | <i>Minimum</i> | 1.00 |  |
|  | <i>Maximum</i> | 3.50 |  |

\*Obtained using repeated measure analysis of variance

*Statistically significant decrease in the sinus elevation with time. The change from baseline to 6 months was significant, while the change from 6 months to 3 months after loading was non-significant.*

**Figure 2: Comparison of sinus elevation across times**



## Discussion

Different sinus augmentation procedures have shown their effectiveness towards gain in bone height in maxillary posterior regions with pneumatised maxillary sinuses. The present study investigated the effect of Platelet-rich Fibrin mixed with allograft on primary stability of

implants and gain in bone height in patients treated with transcrestal approach for sinus augmentation.

Transcrestal sinus elevation with the use of graft materials has shown to enhance the rate of bone formation. Adding a bone substitute provides an osteoconductive scaffold and maintains the space required to support the Schneiderian membrane and prevents its premature collapse.

This study showed an increase in mean implant stability from 67.65 at baseline to 71.29 at 6 months. The sinus membrane and the surrounding bony walls have an innate osteogenic potential. This is further enhanced by the use of a graft material. The increase in stability could be attributed to the use of Platelet-rich fibrin along with allograft.

Platelet-rich fibrin, as a fibrin biomaterial, carries favourable constituents present in a blood sample such as, a large quantity of platelets and leukocyte cytokines.<sup>12</sup> Concentrated platelets contain many growth factors, including the PDGF, TGF- $\beta$ , IGF, EGF, fibroblast growth factor, and bone morphogenic protein.<sup>13</sup> These growth factors play a central role in hemostasis, angiogenesis, osteoblastic proliferation and differentiation which makes PRF advantageous. Its molecular structure and low thrombin concentration facilitate the migration of endothelial cells and fibroblasts.<sup>14</sup> PRF aids in postoperative protection of the surgical site and seems to accelerate the integration, maturation, and remodelling, and enhances bone graft density. The use of PRF during bone grafting constitutes the following four advantages. First, PRF plays a vital mechanical role in maintaining and serving the grafted materials. Second, the fibrin network at the regenerative site facilitates cellular migration, vascularization, and survival of the graft. Thus, PRF aids in keeping the graft particles together and provides a scaffold for formation of new bone, especially during early bone healing period. Third, the platelet cytokines (PDGF, TGF- $\beta$ , and IGF-1) are gradually released as the fibrin matrix is resorbed, thus continuing the process of healing. Finally, the presence of leukocytes and cytokines in the fibrin network facilitate the self-regulation of inflammatory and infectious phenomena within the grafted material.<sup>15</sup>

The decrease in sinus elevation from a mean of 3.82 at baseline to 2.26 at 6 months can be attributed to graft contraction which is similar to data available in literature.<sup>2</sup>

Long term follow-up will further help to determine the survival rate of sinus augmentation and implant.

**Conclusion:**

Implant placement in the posterior maxilla that are atrophied can be greatly extended by indirect sinus lift procedure through the crestal approach as the procedure is very easy, less invasive, time saving with reliable results. The use of Platelet-rich fibrin mixed with allograft aids in the increase of stability of implants place along with transcrestal sinus elevation.

## References

1. RamírezFernández MP, Mazón P, Gehrke SA, Calvo-Guirado JL, De Aza PN. Comparison of Two Xenograft Materials Used in Sinus Lift Procedures: Material Characterization and In Vivo Behavior. *Materials* (Basel). 2017 Jun 7; 10(6):623. doi: 10.3390/ma10060623.
2. F.Bernardello, D.Righi, E Cosci, P.Bozzoli, M, Soardi Carlo and S. Spinato. Crestal sinus lift with sequential drills and simultaneous implant placement in sites with<5mm of native bone:a multicentre retrospective study, *Implant Dentistry*,vol.20(6); 439-444:2011.
3. Tatum H., Jr. Maxillary and sinus implant reconstructions. *Dental clinics of North America*. 1986; 30(2): 207–229.
4. Summers R. B. A new concept in maxillary implant surgery: the osteotome technique. *Compendium*. 1994; 15:154–156.
5. Summers R. B. The osteotome technique: part 3—less invasive methods of elevating the sinus floor. *Compendium*. 1994; 15(6): 698–700.
6. Cosci F., Luccioli M. A new sinus lifts technique in conjunction with placement of 265 implants: a 6-year retrospective study. *Implant Dentistry*. 2000; 9(4): 363–368. doi: 10.1097/00008505-200009040-00014.
7. Kfir E, Goldstein M, Rafaelov R, Yerushalmi I, Kfir V, Mazor Z. Minimally invasive antral membrane balloon elevation in the presence of antral septa: a report of 26 procedures. *J Oral Implantol*. 2009; 35: 257-67.
8. Muronoi M, Xu H, Shimizu Y, Ooya K. Simplified procedure for augmentation of the sinus floor using a haemostatic nasal balloon. *Br J Oral Maxillofac Surg*. 2003; 41:120-1.
9. Soltan M, Smiler DG. Antral membrane balloon elevation.*J Oral Implantol*. 2005; 31:85-90.
10. Kfir E, Kfir V, Mijiritsky E, Rafaeloff R, Kaluski E. Minimally invasive antral membrane balloon elevation followed by maxillary bone augmentation and implant fixation. *J Oral Implantol*. 2006; 32:26-33.
11. Diss A., Dohan D. M., Mouhyi J., Mahler P. Osteotome sinus floor elevation using Choukroun's platelet-rich fibrin as grafting material: a 1-year prospective pilot study with microthreaded implants. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology*. 2008; **105**(5): 572–579.

12. Toffler M, Toscano N, Holtzclaw D, Corso MD, Dohan DM. Introducing Choukroun's platelet rich fibrin (PRF) to the reconstructive surgery milieu. *J Implant Adv Clin Dent* 2009; 1: 22-31.
13. Dohan DM, Choukroun J, Diss A, Dohan SL, DohanAJ, MouhyiJ, et al. Platelet-rich fibrin (PRF): A second-generation platelet concentrate. Part II: Platelet-related biologic features. *Oral Surg Oral Med Oral Pathol Oral RadiolEndod* 2006; 101: e45-50.
14. Prakash S, Thakur A. Platelet concentrates: Past, present and future. *J Maxillofac Oral Surg* 2011; 10:45-9.
15. Kökdere NN, Baykul T, Findik Y. The use of platelet-rich fibrin (PRF) and PRF-mixed particulated autogenous bone graft in the treatment of bone defects: An experimental and histomorphometrical study. *Dent Res J* 2015; 12: 418-24.

**About The Edited Book:** This Edited book “Recent Research in Medical and Life Sciences” is based on the proceedings of the “International Conference on Advance Interdisciplinary Research (ICAIR-2023) during (April 07 – 09, 2023)”, Organized by DigvijaiNath Post Graduate College, Gorakhpur, U.P & Science-Tech Institute run by ManrajKumar Singh Educational Society, Lucknow, U.P. The aim of this conference was to bring together the young as well as experienced researchers on one platform to discuss the recent findings in the aforesaid areas of Medical and Life Sciences. After peer – reviewing process, relevant research papers were finally included in this book as chapters.

## About The Editors



**Dr. M. Usha Rani** M.B.B.S, M.D (physiology) has 20 yrs of teaching experience. She got different national and international awards in her teaching tenure. She guided 200 pg MD and PhD students. She got her studies published in different national and international journals. She is still working as professor and hod Physiology at Andhra Medical College, Visakhapatnam, Andhra Pradesh. She is acting now as Curriculum head, BOS (board of studies) member, member secretary of the ethics committee in her college



**Dr. Neha Singh**, working as a Senior Scientist, Virology Lab, Department of Microbiology, Pt JNM Medical College, Raipur, Chhattisgarh. She is Ph.D., Postdoc in Microbiology. Her area of interest is Antimicrobial compounds, Drug resistance, Infectious diseases, Molecular virology. She is having around 11 years of research experience. She is active **Member of ISC** (Institutional Scientific Committee) of medical college and running various institutional & ICMR research projects. She has contributed in disaster management of ongoing global pandemic of **COVID-19** since last two years as **operational In-charge** of state virology lab of medical college. She is one of the member of **State Advisory Committee** of establishment of molecular virology labs in Chhattisgarh. She is certified, **Master Trainer** for newly recruited HR for molecular virology labs, from USAID, RISE in association with London School of hygiene and tropical medicine. She is **Principal contributor** for operational manual for BSL-II virology laboratory for state of Chhattisgarh. She is recognized as Editor and Reviewer for various referred and peer reviewed Journals. She has presented various papers in different National and International conferences. She has published various original research & review articles in reputed National & International journals.



**Dr. Rajiv Ratan Singh Yadav** (MD, PDCC) is working as Professor (Junior Grade) in the Department of Emergency Medicine, Dr. Ram Manohar Lohia Institute of Medical Sciences Lucknow. He has 11 years of teaching experience. His field of research is Emergency Medicine. He has completed two research project funded Principal Investigator. He has published 30plus research articles in various National and International Journals. He has guided many thesis of MD students. He is recognized as Editor and Reviewer for various referred and peer reviewed National and International Journals. He is a recognized Research Supervisor and Post Graduate Teacher in Dr. RMLIMS Lucknow. He has many achievements & awards.



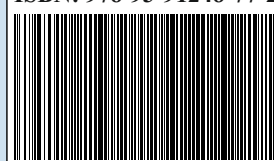
**Dr. Priyanka Singh** is an Associate professor in the Department of Oral Pathology and Microbiology, **King George's Medical University**, Lucknow. Her areas of interest are Academics & research, Histopathology, Exfoliative cytology and Molecular Biology. She participates very actively in conferences, seminars and symposium. She has presented various papers in different National and International conferences. Many publications have been published in National & International journals by her name including Original articles, case reports and reviews. She has filed patents that are in process. She has also written books and book chapters related to her specialty. She is a live member of many associations.



## MKSES PUBLICATIONS LUCKNOW, INDIA

Address: Head office: 1st Floor, Building No-85A,  
(Nanak Arcade Near Shani Mandir, Parag road,  
LDA Colony, Kanpur Road, Lucknow-226012  
Mobile No: +919838298016, +918299547952  
office Land line No: +91 5223587193  
E-mail: [mkespublication@gmail.com](mailto:mkespublication@gmail.com)  
Website : [mksespublications.com](http://mksespublications.com)

ISBN: 978-93-91248-77-2



Available on →



PRICE  
INR (₹): 299/-  
USD (\$): 10/