

# Impacts of Chemical Beauty

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## ABSTRACT

Cosmetics are the group of products, including sun-cream, moisturizers, powders, perfumes, lipsticks, nail polishes, hair colors, shampoo, deodorants, baby products, and others. The use of cosmetic products is increasing day by day throughout the world. Both men and women are using cosmetics for their beautification and attractive looking. Cosmetic products contain a variety of chemical ingredients and some of these can create toxicity. There is a restriction to the use of toxic and non-permitted chemicals in cosmetics but, due to poor surveillance, sometime product contains unauthenticated chemicals. Thus, there is every time chance for the intoxication of cosmetics. The common effects of cosmetic toxicity are skin damage, hypersensitivity reaction and allergic dermatitis, skin rash, skin irritation, the appearance of acne, formation of dry and scaly skin, and carcinoma. The present work has focused on the main toxic chemical substances present in cosmetic products and the possible health complications related to cosmetic use. The side effects of cosmetics are now being an emerging issue of public health. Proper surveillance, authentication of the product and public awareness will be helpful to prevent cosmetic-related health problems.

**Keywords:** Cosmetics, Ingredients, Natural components, Side effects, Toxicity.

*Indian Journal of Physiology and Allied Sciences* (2021);

ISSN: 0367-8350 (Print)

## INTRODUCTION

Cosmetics are the substances used for beautification and to enhance or protect the skin complexion of humans. Cosmetics include skin-care creams, lotions, powders, perfumes, lipsticks, fingernail and toenail polishes, eye and facial makeup, hair colors, hair sprays, and gels, deodorants, baby products, bath oils, bubble baths, bath soaps, and many others (Reed 2007; Bocca *et al.* 2014; Kaličanin and Velimirović 2015; Khan and Alam 2019). Their uses are widespread, especially among women in Western countries as well as Eastern countries. Subsets of cosmetics are called “make-up,” which are primarily colored products, used to enhance the appearance of looking (Lewis 2007).

The majority of cosmetics contain chemical ingredients and many other uncertain components that cause side effects, skin damage, hypersensitivity reaction and may be suspected to be a carcinogen. It is important for people to become conscious of the products that they are using and to understand the potential effects of the ingredients on their bodies. The cosmetic industries are largely unregulated, and it is very difficult to find out safe products. The advertisements of many products mislead the people, and they believe that the product is “natural, safe, and healthy”. However, uses of these products are facing adverse effects due to the presence of chemical ingredients and toxic bases (Nassif, *et al.* 1994; Marrakchi *et al.* 2006; Alani *et al.* 2013; Pereira and Pereira 2018).

The almost universal use of cosmetics in modern times is a fashionable practice. A large variety of cosmetics is available today. Cold cream is an emulsion of various oils and waxes and water; it is employed to cleanse and soften the skin, and to improve skin contact. Face powder and talcum powder (magnesium silicate and zinc oxide) are used to dry the skin and give the skin a satin-like texture (Agner 1991). Lip colors either applied directly as lipstick or brushed on

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**How to cite this article:** Samanta, S. (2021). Impacts of Chemical Beauty. *Indian Journal of Physiology and Allied Sciences*. 73(1), 1-6.

**Conflict of interest:** None

the lips are made of cocoa butter or lanolin. Bath soaps and other bath preparations contain sodium carbonate or borax with perfume. Bath oils are also a popular skin-softening and skin contact performing aid (Loffler and Effendy 1999). The market of body care products and cosmetics has expanded day by day. Different synthetic substances are used in these products. The potential health effects of such chemicals can be sometimes dangerous. The ingredients in cosmetics sometimes can start unintended side effects like skin allergies (allergic dermatitis), skin rash, skin irritation (irritant dermatitis), the appearance of acne, formation of dry and scaly skin, skin patches, exfoliates, carcinogenesis (Marrakchi *et al.* 2006; Alani *et al.* 2013; Ullah *et al.* 2013; Draelos 2014, 2015). Cosmetics have harmful effects, but in recent days, cosmetics are used for artificial beauty. The present review has focused on the chemical composition and the ill effects of cosmetics.

## HISTORY

The first archaeological evidence of cosmetics usage had found in Ancient Egypt around 4000 BC. The ancient Greeks and Romans also used cosmetics. The Romans and Ancient Egyptians were not realizing the dangerous effects of mercury-containing cosmetics and white lead-containing

fragrances (Khan and Alam, 2019). Cosmetics were also used in Persia. An early cosmetologist Abu Al-Qasim Al-Zahrawi (or Abulcasis, 936-1013 AD) was a physician, who wrote the 30-volume medical encyclopedia Al-Tasrif. Chapter 19 of this book was devoted to cosmetics. As the Treatise was translated into Latin, the cosmetic chapter was used in the West. Al-Zahrawi considered that cosmetics are a branch of medicine, which he called "Medicine of Beauty" (Adwiyat al-Zinah). Henna has been used in India since around the 4th or 5th centuries. It is used either as a hair dye or in the art of mehndi. Henna was also used in some North African cultures (Parish and Crissey 1988). The use of eye cosmetics (kajal or kohl) has a long history in Hindu culture (Khan and Alam, 2019). Chinese people began to stain their fingernails with gum Arabic, gelatin, beeswax and egg from around 3000 BC. In Japan, Geishas used lipstick made of crushed safflower petals to paint the eyebrows and edges of the eyes as well as the lips. Queen Elizabeth I of England was one well-known user of white lead for creating a look known as "the Mask of Youth" (Parish and Crissey, 1988).

During the early years of the 20th century, make-up became fashionable in the United States of America and Europe owing to the influence of ballet and theatre stars. But the most influential development started from the movie industry. Embraced dark eyes, red lipstick, red nail polish, and the suntan became a fashion statement for people with white skin (Parish and Crissey, 1988).

In Asia, skin whitening continued to represent the ideal of beauty, as it does to this day. During the 1960s and 1970s, many women in the Western world influenced by feminism decided to go without any cosmetics. The anti-cosmetics movement was an outgrowth of this, feminists. During the period of 1970s, cosmetics were divided into a "natural look" for the day and a more sexualized image for the evening. Deodorant was invented in 1888, by an unknown inventor from Philadelphia under the trademark of "Mumm". Roll-on deodorant was launched in 1952, and aerosol deodorant in 1965.

## COMMON INGREDIENTS OF COSMETICS

Most cosmetics contain a combination of various ingredients such as emulsifier, preservative, thickener, color, fragrance, and pH stabilizers (Salvador and Chisvert 2007; Juhász and Marmur 2014). Many cosmetic products are based on emulsions that are small droplets of oil dispersed in water. Emulsifiers are added to produce small droplets and to prevent the formation of phase separation between oil and water. Emulsifiers work by changing the surface tension between the water and the oil, thus producing a homogeneous product with an even texture. Shampoos and soaps contain surface-active agents that have both lipophilic and hydrophilic parts. The lipophilic part of the product sticks to oil and dirt, while the hydrophilic part allows water to then carry away.

Preservatives are added to cosmetics to prevent the growth of microorganisms. The common preservatives used

in cosmetics are parabens, benzyl alcohol and tetrasodium EDTA (ethylenediamine tetra-acetic acid). Isopropyl alcohol kills bacteria on the skin. This ingredient is present in cleansers, toners and other cosmetic products. Unfortunately, the derivatives of petroleum products create dryness on the skin and may cause miniature cracks in the skin that allow bacteria to enter, potentially causing irritations or pimples. Parabens, a class of common preservatives in deodorants and antiperspirants were found in breast cancer tissue. (Byford *et al.* 2002; Nicolopoulou-Stamati *et al.* 2015; Salvador and Chisvert 2017).

Thickening agents such as polymers are often added to cosmetics to change their consistency. Polymers can be synthetic (e.g., polyethylene glycol) or derived from natural sources (e.g., polysaccharides). Seaweeds are a common source of natural polysaccharides. Carrageenans are extracted from red algae and alginates from brown algae (Salvador and Chisvert, 2017).

Fragrances in lotions, shampoos, and many other cosmetic products are composed of aromatic hydrocarbons. Perfumes containing fragrance can bind with distinct chemicals to produce a distinct smell. A considerable number of these aromas are derived from petroleum products that have toxicity (Bridges 2002).

Mineral oil and petroleum are the basic ingredients in many cosmetic products. Cosmetics such as cleansers and moisturizers contain mineral oil. Mineral oil spreads on the skin's surface can potentially block pores to lose moisture. This may cause the appearance of pimples. Moisturizing lotions are of two types: occlusive moisturizers and humectant moisturizers. Occlusive moisturizers contain isopropyl palmitate, stearyl alcohol or light mineral oil, while humectant moisturizers are the mixture of glycerine or alpha hydroxy acids (fruit acids such as glycolic acid, citric acid, or lactic acid). Occlusive moisturizers prevent the loss of moisture. Humectant moisturizers increase the water-holding capacity of the skin. Lipsticks are made by combining a water-insoluble dye with wax (beeswax) and non-volatile oil (castor oil). Dyes in the lipsticks react with the amino acids of the surface proteins of the skin and turn a deep shade of red color when applied to the lips (Loretz *et al.* 2005).

## TOXIC CHEMICALS IN COSMETIC PRODUCTS

Many cosmetic products contain several chemical additives to increase their performance, effectiveness and viability. These common chemical additives are diazolidinyl, urea, dioxane, formaldehyde and paraformaldehyde, imidazolidinyl urea, heavy metals, methylchloroisothiazolinone-methylisothiazolinone (MCI-MI), methyl dibromo glutaronitrile-phenoxyethanol (MDBGN-PE), parabens, phthalate and others. (Salvador and Chisvert 2007; Juhász and Marmur 2014; Iwegbue *et al.* 2016; Pereira and Pereira 2018).

*1,4-dioxane*: This carcinogen is found in many cosmetics as a by-product of other chemical combinations. The ethoxylated surfactants (foaming agents or emulsifiers) often produce 1,4-

dioxane during the manufacturing process. This chemical is considered toxic if it is absorbed through the skin or ingested (Marrakchi and Maibach 2006; Juhász and Marmur, 2014).

*Isopropyl Alcohol:* This drying agent is a common ingredient in many cosmetic products. It is derived from petroleum products. When used directly on the skin, it shades off the outermost protective layer, exposing the surface of the skin to bacteria and fungus. It may promote the appearance of brown spots or premature aging (Salvador and Chisvert, 2017).

*Anionic Surfactants:* Surfactants are used in about 90% of foaming agents, personal care products. Common anionic surfactants include sodium lauryl sulfate (SLS), sodium laureth sulfate (SLES), ammonium lauryl sulfate (ALS), ammonium laureth sulfate (ALES), sodium methyl cocoyl taurate, sodium lauroyl sarcosinate, sodium cocoyl sarcosinate, potassium coco hydrolyzed collagen, TEA (triethanolamine) lauryl/laureth sulfate, lauryl or cocoyl sarcosine, and disodium oleamide/laureth sulfosuccinate. All these ingredients are toxic to the skin. SLES and ALES combined with other ingredients to form nitrosating agents that have a carcinogenic effect on the body. SLS and ALS are the stimulants of immunological reactions, cause eye irritations, skin rashes, allergic reactions, and hair loss. Triethanolamine (TEA) causes allergic reactions such as dryness of hair and skin and could be toxic when absorbed through the skin (Salvador and Chisvert 2017).

*Cationic Surfactants:* These surfactants are commonly used in hair conditioning products as they have anti-static properties. However, they are irritating to hair follicles and toxic. Long-term use can cause hair loss. Common cationic surfactants include stearylalkonium chloride, benzalkonium chloride, cetrimonium chloride, cetalkonium chloride, and lauryl dimonium hydrolyzed collagen (Salvador and Chisvert 2017).

*DEA (diethanolamine), MEA (monoethanolamine), and TEA (triethanolamine):* These chemicals are often used in personal care cleansers to adjust the pH of the formula. They can cause allergic reactions, eye irritation, dryness, and toxicity if used over a long duration. They also have carcinogenic properties (Salvador and Chisvert, 2017).

*Diazolidinyl Urea and DMDM Hydantoin:* These chemicals contain formaldehyde, a toxic carcinogen. It can cause dermatitis, burning, irritation of the mucous membranes, inflammation, and watering of the eyes (Pfuhrer and Wolf, 2002).

*Ethoxylated Surfactants:* Polyethylene glycol, polyoxyethylene oxynol are commonly used in cosmetics as foaming agents, emulsifiers, and humectants. These chemicals form 1,4-dioxane (a known carcinogen) as a byproduct during the manufacturing process. Propylene glycol (petrochemical byproduct) can cause allergic and toxic reactions (Salvador and Chisvert 2017).

*Polyvinylpyrrolidone (PVP)/Polyvinyl Alcohol (PVA)-Copolymer:* Petroleum-derived chemical used in hairsprays and other hair

products. They act as lung irritants.

*Color Pigments:* These synthetic color pigments are made from coal tar. They contain heavy metals (Pb, Cd, Hg) that produce toxic byproducts on the skin. These chemicals have carcinogenic effects (Bocca *et al.* 2014; Iwegbue *et al.* 2016).

*Formaldehyde:* This is another cancer-causing agent that is commonly found in commercial make-up products. It can cause allergic reactions, headaches, and chronic fatigue (Agner *et al.* 1999; Lv C *et al.* 2015).

*Imidazolidinyl Urea (Trade name Germall) and Diazolidinyl Urea:* These chemical releases formaldehyde as toxic agents (Draeos 2014; Doi *et al.* 2012). They are common preservatives that can cause contact dermatitis.

*Mineral Oil (Liquid Paraffin):* Mineral oil can also be found in paraffin wax, paraffin oil and petrolatum products. Mineral oil is a byproduct of petroleum products that coat the skin like plastic. It disrupts the skin's natural functions, promotes allergic response, and can cause premature aging. Mineral oil or jelly can also produce photosensitivity (sun damage) and prevent the body's moisturizing mechanism (Salvador and Chisvert, 2017).

*Paraben (methyl, ethyl, propyl, and butyl):* These chemicals are often used in cosmetic formulation to inhibit microbial contamination and extend the shelf life of the products. They are cause allergic reactions and skin rashes (Mowad 2000; Bledzka *et al.* 2014; Juliano and Magrini 2017).

*Silicon-derived emollients:* Common silicon-derived emollients are dimethicone, dimethicone copolyol, and cyclomethicone. Like other emollients, these products coat the skin like plastic wrap and disrupt the skin's normal functions, resulting in skin eruption and acne.

*Stearalkonium chloride:* Originally developed as a fabric softener. This chemical is often found in hair conditioners and creams. They are toxic chemicals that cause allergic reactions on contact.

*Synthetic Colors:* Many are used in hair dyes and may show carcinogenic effects.

## SIDE EFFECTS AND RISKS OF COSMETIC USE

Our skin covers the body and acts as a physical barrier. Cosmetics come into direct contact with skin. Researchers had found that the skin can absorb up to 60% of the chemicals of cosmetic products that come into direct contact. Several studies had been employed to evaluate the potential health effects of the ingredients (Wolf *et al.* 2001; Zhang *et al.* 2012; Park and Zippin 2014; Yim *et al.* 2014; Kaličanin and Velimirović 2015). The use of cosmetics is also a risk factor for pregnant women as the chemicals absorb through the skin and reach the bloodstream. Finally, the toxic components can affect the developing fetus. Paraben-like substances are harmful to the reproductive system of the growing male child. Many ingredients of cosmetics exhibit long-term effects and may act as carcinogens (Smith and Alexander 2005).



Shampoo containing alkyl-phenol and ethoxylates that reduce sperm count. Glycolic and lactic acids in anti-wrinkle products and exfoliators increase the light sensitivity of the skin and the development of cancer. Benzaldehyde is commonly found in perfume, cologne, hairspray, deodorants, moisturizers, shaving cream, shampoo, and bath soap. It has systemic effects like irritation to the mouth, throat, eyes, skin, lungs, causing nausea and gastrointestinal pain (Loretz *et al.* 2006). Benzyl acetate is present in perfume, shampoo, soap, hairspray, after-shave, and deodorants. It is the irritating agent of the eyes and respiratory passages. It can be absorbed through the skin causing systemic effects as well as cancer. Benzyl alcohol is the component of many cosmetics including nail enamel remover. It causes irritation to the upper respiratory tract and can cause headache, nausea, vomiting, dizziness, drop in blood pressure, and depression. Butyl alcohol or butyl products sometimes used in cosmetics. It is a strong irritant and shows toxic effects (Hatti 2007). Butylated hydroxytoluene is found in lipsticks, baby oil, eyeliners, and soaps. It is known to cause cancer in animals and is suspected of causing birth defects as well as carcinoma (Silva 2004). Hair sprays contain butylenes, which are toxic to the central nervous system and kidneys.

Camphor is found in perfume, shaving cream, nail enamel polish, nail color, and stickup fresheners. Camphor readily absorbs through body tissues. It is an irritant and causes eye, nose and throat irritation. It also acts as a CNS stimulant and can cause dizziness, confusion, nausea, twitching muscles, convulsions (Loretz *et al.* 2006). Try to avoid the inhalation of vapors of camphor containing perfume and other cosmetic products. Carbomer 934, 940, 941, 960, 961 are used in many cosmetics and toothpaste as a thickener and fragrance. It can cause eye irritation. Cetyl alcohol is a wax, derived from the head of the sperm whale. Can easily become rancid and causes skin irritation, contact eczema. (Song 2005; Nardelli *et al.* 2011). Collagen is derived from cattle hide or bird's feet. These molecules are too large to penetrate our skin pores. Once again, this just coats the skin giving it an appearance of softness, but, drying out the skin by inhibiting the body's natural moisturizing process (Gateva 2006; Handa 2006).

Diethanolamine is found in the bubble bath, body washes, shampoos, soaps, and facial cleansers. DEA is a hormone-disrupting chemical known to form cancer-producing nitrates and nitrosamine. Repeated skin applications of DEA-based soaps resulted in a major increase in the incidence of liver cancer and kidney cancer. Formaldehyde vapor inhalation or touch from the cosmetic products reacts quickly with body tissues. It affects sites of direct contacts, such as the lungs, eyes, and skin. The most common effects are irritation of the eyes, nose, throat, skin, damage to the cornea, skin dryness, flaking, cracking, and dermatitis allergic skin reaction (Turkoglu *et al.* 1999; Brocardo 2007). It also acts as a human carcinogen. Fake tans also change color on contact with skin. The active ingredient in most fake tans is dihydroxyacetone, a colorless compound that darkens when it reacts with the amino acids in the top layer of the skin. The color change is

permanent, but because skin cells are constantly being shed the tan is usually gone after about a week.

## ALTERNATIVES OF CHEMICAL COSMETICS

The skin dries out when too much water evaporates from its surface. This increases as we make worse washing with hot water and soap that removes the layer of natural oil on the surface of the skin. The urea-containing cream when applied to the skin, penetrates the stratum corneum, where it readily absorbs and retains water. This increases the capacity of the skin to hold moisture and the skin becomes rehydrated. Normally, urea is the natural constituent of the skin surface. The moisturizing cream containing urea and some special ingredients like Shea butter or Jojoba oil also provides a layer of oil on the surface of the skin, which helps to prevent water evaporation from the skin surface. Both actions soothe and soften the skin and reduce the scaling and itching of dry skin conditions such as eczema and ichthyosis. Manufacturers are now producing a wider range of organic body care products, but the popularity of natural cosmetics comes at a price. To satisfy such a huge demand for natural products many manufacturers offer regular cosmetics under the mark of natural or organic cosmetics. To fight against unfair manufacturers, many countries have introduced special organic standards. This drive restricts the use of synthetic chemicals in body care products and cosmetics (Vigan and Castelain, 2014). The number of natural products is increasing almost every day because all the manufacturers perform numerous studies in the sector of organic products. Thus, these promising approaches will reduce the number of synthetic products soon that will mitigate undesirable side effects of cosmetics.

## CONCLUDING REMARKS

Cosmetics are now associated with our daily life and is being a part of our culture. Most cosmetics contain several chemical ingredients that may cause harmful effects on the body, particularly on the skin. Moreover, very little is known about the long-term effects of cosmetics. In the cosmetic sector, there is no specific agency to assess the safety index of cosmetic products, no marketing authorization with specific requirements, no evaluation of the risk-benefit ratio, and no guarantee of the composition. The constancy of the product may change from one batch to another. So, manufacturers should concern about the ingredients and the effects of the cosmetics. The composition of the product must be labeled on the pack that indicates what ingredients have been contained in the product. In the context of public health "cosmetovigilance" should be started to monitor the health impacts and safety factors of cosmetics in the commercial sectors. Restriction list of cosmetic ingredients should be maintained by the manufacturers and surveillance from the health agencies is also necessary. Manufacturers can increase the strength of Research and Development to improve the quality of the product by using non-toxic natural ingredients.

Finally, it can say that chemical constituents can be replaced with the much safer natural analogs that may reduce the toxicity of cosmetics.

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# Quiz as an Academic Tool for Teaching Learning Physiology in Indian Medical Students: A Cross-sectional Study

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## ABSTRACT

**Background:** In a changing world, education has become a priority. It has become a need of the hour to explore more innovative teaching methods effectively. Active teaching in small group discussions and interactive activities like quiz have been explored to ensure healthy and competitive learning. Not many studies have been done in India and thus, we undertook to assess the effectiveness of quiz as an academic tool.

**Methods:** 96 First-year medical undergraduates participated in quizzes on various topics of Physiology that were organized every 3 to 4 weeks. At the end of the year, they were asked to give their feedback anonymously in a Likert scale that was duly analyzed. **Results:** 49% of students strongly liked the quiz, 40% liked it, and only 1% did not like it. The majority of the students liked various contents and organization of the quiz. Most of the students liked the quiz procedure, e.g., pattern of team formation, weightage of topics, frequency, duration, pattern of scoring, time for answering questions, contents, rounds, difficulty level, and usefulness in the study.

**Conclusion:** Activities like quizzes are beneficial to the students and must be encouraged as a part of the curriculum.

**Keywords:** First year medical students, Physiology curriculum, Quiz.

*Indian Journal of Physiology and Allied Sciences* (2021);

ISSN: 0367-8350 (Print)

## INTRODUCTION

As times are changing, the need to reinvent and renew the education system to maximize its effectiveness is increasingly felt. The medical curriculum is no exception to it! The success of education lies in imparting knowledge and the application of that knowledge in day-to-day life. Thus, the way of teaching has changed considerably over the years: from didactic lectures in large groups using blackboard teaching, overhead projectors and power-point presentations to small group teaching in the form of group discussions, demonstrations, tutorials and seminars (Sprujit *et al.*, 2013). Poor results in traditional methods for promoting students' creativity have become the stimulus to finding out newer modalities of teaching (Ruben, 1999).

Conventional didactic lectures tend to be very monotonous and make students more oriented towards passing exams by memorizing isolated facts without understanding (Mehta *et al.*, 2016). It has been found that small group interaction enables the student to practice communication and interpersonal skills, which are useful in their professional life later (Gleeson *et al.*, 2007; Marangos, 2000). Also, the concept of passive teaching is increasingly becoming redundant. The active participation of the students is considered valuable for the learning process. In the active learning, the teacher/ professor plays the role of a guide to the students and students are involved in the knowledge construction process instead of sharing a narrator-receptor relationship (Yeo, 2005). Various teaching styles have been experimented upon to involve students more and refine their critical thinking and attitude (Steinert, 1996). It has also become imperative to invoke keen interest and enthusiasm in students in passing the knowledge. Thus, the usual protocol of lectures that are fixed for one hour and the need for

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**How to cite this article:** Agrawal, M., Singh, J., Patel, D., Goel, A., Kathrotia, R., Patil, P.M. (2021). Quiz as an Academic Tool for Teaching Learning Physiology in Indian Medical Students: A Cross-sectional Study. *Indian Journal of Physiology and Allied Sciences*. 73(1), 7-9.

**Conflict of interest:** None

**Submitted:** 09/07/2021 **Accepted:** 24/09/2021 **Published:** 25/12/2021

recreational breaks is being deliberated upon (Mohit *et al.*, 2016). Moreover, holistic learning in the form of vertical and horizontal integrated teaching with the help of innovative technologies, e.g., audio visual aids, patient simulations (Khoa *et al.*, 2017), clay modeling (Akle *et al.*, 2018), etc. explored like never before. However, the impact and implementation of these methods are yet to be analyzed and discussed.

As teaching is meant to benefit the students, students' perspective must also be considered by the regulatory bodies to form undergraduate training guidelines (Mohit *et al.*, 2016). Very few studies have been done in India in this regard. Hence, this study was undertaken to assess the effectiveness of quiz as an academic tool. A quiz was chosen to involve students actively through team participation, develop their



interest in Physiology, and improve their existing knowledge on the subject.

## METHODS

### i) Subjects

96 First year medical undergraduates (MBBS students, batch 2016-17) participated in the quiz. The quiz was organized in the lecture theatre of institute.

### ii) Instruments

The quiz covered many systems and had questions that tested concepts, applied aspects, recent advances, Nobel Prizes etc. The following rounds were conducted:

- General physiology round
- Systemic and applied physiology round
- Visual round
- Rapid fire round

Later on, an anonymous feedback was taken from the students under the following headings:

- Pattern of team formation
- Weightage of topics
- Frequency of quizzes
- Duration of each quiz
- Pattern of scoring
- Time for answering questions
- Contents of the quiz
- Different rounds of the quiz
- Difficulty level
- Usefulness in study

### iii) Methodology

96 students belonging to various parts of the country voluntarily enrolled for the quiz and were divided into three major groups. Three students from each group were selected in a randomized manner using the lottery system to represent their group for each system. The range of topics consisted of many systems and had questions that tested concepts, applied aspects, latest advances, Nobel Prizes etc. The quiz had four rounds: the general physiology round, the systemic and applied physiology round, the visual round and the rapid-fire round. Such quizzes were conducted once every 3-4 weeks for spacing and reinforcement and were of 100 marks each. The winning teams were awarded suitable prizes as an incentive. The duration of each quiz lasted for around an hour and the pattern of scoring consisted of no negative marking. Students were given approximately 1 minute time to answer each question. The difficulty level was moderate-hard and the questions were framed from standard textbooks of Physiology. The incorrectly answered questions were passed on to the audience, and scores were given to correct answers in the audience as an incentive to facilitate cooperative and competitive learning. Teams entering Final rounds were decided based on their total scores (score of team during the participation in respective quiz round and scores attained as audience during quiz of other teams). At the end of the

year, they were given a feedback form that had to be filled out anonymously. It had a Likert scale (strongly disagree to agree strongly) that was further analyzed.

### Statistical Analysis

The data was compiled and analyzed in Microsoft Excel 2016 and is expressed as percentages/number.

## RESULTS

### i) Feedback on overall usefulness of the quiz in studies

Inference: 49% students strongly liked the quiz, 40% liked it and only 1% of the students did not like it.

### ii) Feedback on structure (contents and organization) of the quiz.

Inference: Majority of the students liked various contents and organization of the quiz.

### iii) Feedback on overall procedure of the quiz

Inference: Most of the students liked the procedure of the quiz.

## DISCUSSION

More and more creative approaches are being used to improve medical education like quizzing in the current context. Our study found that the maximum number of participants liked/strongly liked the inclusion of quiz as an academic tool and found it useful in studies. Furthermore, most of the students liked the content, procedure, and manner of the quiz.

Most previous studies have supported the idea of small group teaching and active learning. In a study done by Mohit M in 2016, 57.14% of students were of the opinion that didactic lectures should be supplemented with small group discussions. Also, 46.81% of students felt that the optimum duration of a lecture should be between 30 to 45 minutes. Other aspects like proper breaks between lectures, the respite in the form of a small quiz/ relevant videos, easy-to-understand enjoyable lectures, and interaction were also relevant. Marden NY in 2013 found that the majority of the students perceived online quizzes as a valuable learning tool. Also, performance in quizzes was significantly linked to end-of-course examination scores. It was also realized as an identification tool for students who need assistance, as those who could not perform well in quizzes also were more likely to fail the examination. Of the four quiz models, the quiz model that allowed multiple unsupervised and untimed attempts were associated with a significant increase in mean examination performance, suggesting higher effectiveness if the stakes are low.

Mehta B and Bhandari B, 2016 explored another approach of quizzing that involved teams asking questions to each other. Student feedback revealed that they were satisfied, motivated, and confident of applying these learning and communication skills in future clinical practice. They also



supported this activity being implemented as a regular curriculum feature. It led to an increase in student perceptions of their knowledge on the topic and improved their communication, analytical skills and learning. Abdul Rahim Ali Bakhsh *et al.* in 2014 found that approximately 53.5% of the participants were multi-modal learners. However, two-thirds of the participants preferred studying alone, citing that they could maintain focus and operate at a preferred pace when they studied alone.

Factors that accounted for nonparticipation in quizzes were identified in yet another study and were inadequate feedback, curriculum organization and student mistrust, time constraints and fear of judgment (Abney *et al.*, 2017). Also, Brown GA *et al.* in 2015 found that an online review quiz taken the day before an in-class test increases performance on some in-class tests but does not consistently enhance performance on comprehensive examinations, suggesting a short-term impact and need for reinforcement. The spacing effect can overcome this, which refers to repeated exposure to medical knowledge over a given period. Reinforcement and consolidation of retention improve a learner's performance. This model is successful with medical students, pediatric residents and surgical trainees (Kerfoot *et al.*, 2009; Kerfoot *et al.*, 2012; Gyorki *et al.*, 2013; Mathes *et al.*, 2014).

Ensuring self-study on the part of learner is a challenging task. It is a time-consuming approach (Somannavar *et al.*, 2011) and Quiz-based reinforcement systems show promise in fostering active engagement, collaboration, healthy competition and real-time formative feedback, although further research on their effectiveness is required (Shaikh *et al.*, 2017).

The limitations of this study were our inability to objectively assess the level of questions and improvement in students' concepts after that. Also, only the teams that were chosen for the quiz were assessed for a particular organ system although the questions that were incorrect/passed were open to score for the audience later on. Future directions would be to follow up with the study population and analyze the improvement in their academic scores and incorporate other modalities of teaching in the curriculum.

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# The Influence of Different Phases of Menstrual Cycle on Autonomic Reactivity to a Cognitive and Emotional Stressor- A Cross Sectional Study

Suri Ridhi, Nirmala S. Anand\*

## ABSTRACT

To study the impact of different phases of menstrual cycle on certain select parameters affecting autonomic reactivity and cognitive and emotional status.

**Materials & Methods:** 62 eumenorrheic females aged 18–20 years were recruited after obtaining ethical clearance. Cognitive and emotional stressors in the form of PASAT and emotional stroop test and were conducted on 10<sup>th</sup> (follicular) and 20<sup>th</sup> (luteal) day of menstrual cycle after phase determination using basal body temperature and prism calendar. Hr, sbp and dbp were measured at baseline and following stressors.

**Statistical Analysis:** was done using SPSS version 20. Students paired t test was used to compare the results between the two phases. P < 0.05 was considered as statistically significant.

**Results:** Baseline: hr, sbp and dbp were more in the luteal phase as compared to the follicular phase.

*PASAT:* hr recovery was (3 minutes and 30 seconds) follicular and (4 minutes and 10 seconds) luteal phase, sbp recovery was (2 minutes and 20 seconds) follicular and (2 minutes and 50 seconds) luteal phase, dbp recovery was (1-minute and 40 seconds) follicular and (2 minutes and 10 seconds) luteal phase.

*Emotional Stroop Test:* positive word latency (1256.437 ms) follicular and (1034.54 ms) luteal phase. Negative word latency (1145.786 ms) follicular and (1335.304 ms) luteal phase.

**Conclusion:** the luteal phase was characterized with greater sns reactivity and hence cognitive and emotional stressors gathered more sympathetic activity and finally a definite interaction was sought between the gonadal hormones, ans and higher cognitive centres of a female.

**Keywords:** Blood pressure, Cognition, Emotional stroop.

*Indian Journal of Physiology and Allied Sciences* (2021);

ISSN: 0367-8350 (Print)

## INTRODUCTION

Every female has a unique kaleidoscope of changing sex hormonal profile which fluctuates in accordance with the phases of menstrual cycle. The menstrual cycle is defined as a natural repetitive phenomenon occurring in the female throughout the reproductive years of her life. The steroid hormones, mainly estrogen and progesterone and the rhythmic fluctuation in their secretion correspond to the physiological psychological and emotional responses in the female.<sup>1</sup> Ovarian steroids do not follow a linear trend and interact with the hypothalamo-hypophyseal axis as well as all the organ systems. The first half of the cycle, namely the follicular phase is constituted by an increase in the estrogen levels whereas the latter half of the cycle or the luteal phase experiences a peak in progesterone levels.<sup>2,3</sup> The hormonal alterations occurring during the different phases of menstrual cycle not only have a function in reproduction but have a profound interaction with the ans.<sup>4,5</sup> Experimental animal studies have shown that endogenous estrogen functions by increasing the vagal response and decreasing the sympathetic activity<sup>6</sup> whereas on the other hand progesterone functions in an opposite manner thereby increasing the sympathetic response.<sup>7</sup> These hormonal alterations are associated with significant neurohumoral changes which regulate the

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**How to cite this article:** Ridhi, S., & Anand, N.S. (2021). The Influence of Different Phases of Menstrual Cycle on Autonomic Reactivity to a Cognitive and Emotional Stressor- A Cross Sectional Study. *Indian Journal of Physiology and Allied Sciences*. 73(1), 10-15.

**Conflict of interest:** None

**Submitted:** 24/06/2021 **Accepted:** 29/09/2021 **Published:** 25/12/2021

working of the cardiovascular system therefore changing the blood pressure, heart rate and rhythm.<sup>8,9</sup>

Stress is one of the major causes for increasing the mortality rate among females.<sup>10</sup> The nature of the cycle, in addition to being associated with future reproductive outcomes like fertility and timing of menopause, are also related to many other health-related outcomes.<sup>11</sup> Stress involves the activation of the sympathetic system, releasing catecholamines, namely adrenaline and noradrenaline into the bloodstream giving rise to cardiovascular changes in the form of raised blood pressure and heart rate. We have seen a rising trend of ischemic heart disease in post-menopausal

women which give strong evidence to the nature of the cycle to the cardiovascular system.<sup>12</sup>

Our brain processes new information, creates new memories and helps in recalling necessary information. We therefore have short term and long-term memory. Short term memory, also known as working memory is the kind of memory we receive, use quickly and discard. It stays active for a brief period of time.

Studies linking menstrual cycle phases to cognition suggest that the early follicular phase is associated with cognitive abilities such as spatial abilities and the luteal phase of the cycle associated with cognitive abilities like verbal fluency and verbal memory.<sup>13</sup>

The paced auditory serial addition test (PASAT) test involves a visual stimulus used to measure and assess this working memory and attention capacity<sup>14</sup> and how the hormones in our menstrual cycle interfere with this working memory and affect it.

The luteal phase, is usually one wherein the female experiences varying degrees of pre menstrual syndrome (pms)<sup>15</sup> and factors such as stress, age, body mass index and marital status contribute to this syndrome and its problems.<sup>16</sup> These emotionally disturbing symptoms occurring during the luteal phase have the potential to affect the normal working life of a female.<sup>17</sup> It is important to record the nature, timing, and severity of menstrual cycle-related symptomatology, and a prism (prospective record of the impact and severity of menstrual symptoms) calendar is used for the same. We will use this tool to assess the psychosomatic status of females during the month and how they fluctuate with the hormonal status.<sup>18</sup>

During this cycle, different emotions are experienced by a female. These are known to fluctuate with the changing hormonal status. An emotional stroop test will be used by us to grade the type of emotions and how these varied emotions can affect the degree of cognition within them.<sup>17</sup> there have not been many studies which have correlated this emotion affecting cognition phenomena with a females menstrual cycle.

We used PASAT and emotional stroop as cognitive and emotional stressors respectively to study the interactions of these different phases of menstrual cycle on executive and emotional and psychosomatic functioning.<sup>18</sup>

It is imperative to study these cardiovascular, cognitive, and emotional changes occurring within the female and correlate these with cyclical changes. These responses to cognitive and emotional stressors show the need for an everyday alteration and importance of the homeostatic mechanism in a female. Therefore, we put forward a hypothesis that the variation in cardiovascular, executive as well as emotional functioning occurring throughout the menstrual cycle may be due to the fluctuating gonadal hormones.

## MATERIALS AND METHODS

### Source of Data

75 non-obese females within the age of 17–19 years of MBBS phase 1 of Jawaharlal Nehru Medical College and Hospital,

Belgaum were enrolled for data collection according to a predetermined inclusion-exclusion criteria after which 13 students were excluded and all the tests were performed on these 62 subjects.

### Inclusion Criteria

- Females with history of at least 2 regular menstrual cycles (26–32 days)
- Age group 17–19 years

### Exclusion Criteria

- Females with history of irregular menstrual cycle for at least previous two cycles
- History of regular cigarette smoking, oc pill and alcohol consumption
- Students who practice regular exercise regime (3 times/week)
- History of cardiac, respiratory, and hormonal disorders

### Procedure

62 students were selected and briefed about the nature of the study and written, voluntary, informed consent was obtained from them. Prior ethical clearance letter no. Mdc/dome/84 was taken from the institute and all the procedures were conducted according to Declaration of Helsinki. All the participants reported to the research lab at the same time (8:30 am) to avoid bias due to circadian rhythms.

A prism (prospective record of the impact and severity of menstrual symptoms) calendar had to be filled for at least 2 consecutive cycles (complete cycles to be filled).

A prism calendar covers physical and emotional changes in the cycle under the following headings:

- Weight change
- Symptoms
- Lifestyle impact
- Life events
- Medications

And thus provides an overall state of physical and mental well-being of a female and helps identify psychosomatic symptoms and mood changes occurring throughout the cycle.

The subjects were examined on two separate occasions (based on basal body temperature)

1. Once during the follicular phase (10<sup>th</sup> day; with day 1 as the first day of bleeding)
2. Once during the luteal phase (20<sup>th</sup> day from the first day of bleeding)

Prior instructions were given to subjects to avoid coffee, nicotine, alcohol 24 hours prior to, heavy food 2 hours before the test. Drugs affecting cardiac autonomic functions like anti- cholinergic, sympathetic, and parasympathetic drugs were contraindicated 2 days before the test.

These tests conducted were non-invasive.

- Tests performed:
- The patient was introduced to 4 testing procedures:
- Baseline blood pressure and hr
- PASAT practice.

- PASAT 2.4, 2.0, 1.6, 1.2
- Emotional stroop test

A baseline rest of 20 minutes in supine position was given to all the participants so that all parameters are within the baseline.

### Baseline Blood Pressure

The blood pressure was recorded for each subject in a sitting posture using the omron m6 semi-automated sphygmomanometer model 11 em- 403c, Tokyo, Japan. The arm was initially relaxed and supported at the level of the heart.

The mean blood pressure is taken for 3 consecutive readings.

### Paced Auditory Serial Addition Test (PASAT)

PASAT, also known as paced auditory serial addition test, is used to assess the role of immediate memory and attention capacity where the stimuli is of a visual nature.<sup>14</sup>

PASAT involved presentation of a series of single digit numbers wherein the two most recently seen digits need to be added. For example, if the digits '2', '4' and '5' were presented, the participant would respond with the correct sums, which are '6' and then '9'. The speed of processing information was altered, and a similar sequence of digits were shown at different rates. 2.4 s, 2.0 s, 1.6 s, 1.2 s were used as rates of presentation of digits. A practice trial was used prior to beginning the first trial. The score reported was usually in the form of number of correct responses.

In our experiment, PASAT was used as a cognitive stressor. PASAT test contained 2 phases, namely PASAT practice and PASAT 2.4.

Following the measurement of baseline blood pressure, the subjects were introduced to the standard computer administered PASAT practice session.

Once the practice session was over, the subjects performed the PASAT trials and simultaneously, their blood pressure and hr was recorded.

It has been observed that when the PASAT test is administered on a subject, the subject is under a sympathetic nervous system stimulation, which normally raises the blood pressure and heart rate.

The PASAT has demonstrated high split-half reliability and evidence for convergent and divergent validity with good sensitivity for deficits in the areas of auditory information processing speed and flexibility.<sup>19</sup> It is a reliable test that is legitimate, highly sensitive and can be administered to assess immediate memory.

### Emotional Stroop Test

This test is based on the principle of how emotional disturbances within a person can affect their cognitive thinking and modulate their capacity and capability to take decisions under these stressful conditions.<sup>20</sup>

Words in different color were presented on the screen and the subject was required to name the color in which the word was presented accurately and quickly.

The words are from 4 categories:

category 1: aggressive words like 'death', 'bomb', 'ghost'

category 2: neutral words like 'box', 'chair', 'door'

category 3: positive words like 'warm', 'calm', 'cheerful'

category 4: color words like 'cyan', 'bronze', 'orange'

It was usually observed that the participants take a longer time (increased latency) to identify the

Color of negative words as compared to the neutral and positive words. Studies have shown that

Subjects show a slower response to identify the color of a word if it is associated to their emotional state.<sup>21</sup>

The emotional stroop test has been used as an experimental measure to assess the bias in attention with emotion laden information.

Results of some studies that have used emotional stroop have indicated that retest reliabilities for reaction times derived across interval were very high.<sup>22</sup>

This test was employed during the follicular and the luteal phase, and the latency to negative words is compared with positive words and again compared within the 2 phases of the cycle.

The results will reflect how the emotional status of a female is mainly due to the hormonal imbalance throughout the cycle.

## RESULTS

### A. Demographic Information

The 30 healthy females were included for the above study and the demographic data was plotted. Mean age group was 20 years (s.d. = 0.66), average weight was 54.7 kg (s.d.= 5.55), average height was considered to be 1.60 metres (s.d.= 0.04). Table 1 shows the demographic statistics of the study.

### B. Physiological Recording

Autonomic function tests for the testing of sympathetic activity were recorded and compared in follicular and luteal phase. The difference in the blood pressures was recorded. Table 2 shows the difference in the baseline blood pressure in the follicular and the luteal phase of the subjects. Figure 1 shows how the variables of heart rate, systolic and diastolic blood pressure increase in the luteal phase suggestive of increase in the sympathetic activity in the phase.

**Table 1:** Average demographic characters of participants

Age (yrs)	20.3 ± 0.66 (16-21)		
Weight (kg)	54.7 ± 5.55 (44-67)		
Height (m)	1.60 ± 0.04 (1.55-1.65)		
Body mass index (kg/m <sup>2</sup> )	21.4 ± 3.46 (20.44-36.38)		

**Table 2:** Baseline heart rate and blood pressure of participants

Variables	Follicular	Luteal	P value
Hr (rest)	80.5 ± 7.6	88 ± 5.44	0.03*
Sbp (rest)	110.9 ± 5.45	122.8 ± 5.3	0.05*
Dbp (rest)	71.3 ± 2.2	74.5 ± 8.1	0.03*



**C. PASAT Test**

Table 3 shows the time taken for the variables of heart rate, and blood pressure to come back to normal when a cognitive test is administered on the subjects.

It is observed that the mean blood pressure and the variation of the blood pressure with the administration of the PASAT test (cognitive stressor), was statistically significantly higher ( $p > 0.005$ ) in the luteal phase as compared to the follicular phase (Figure 2).

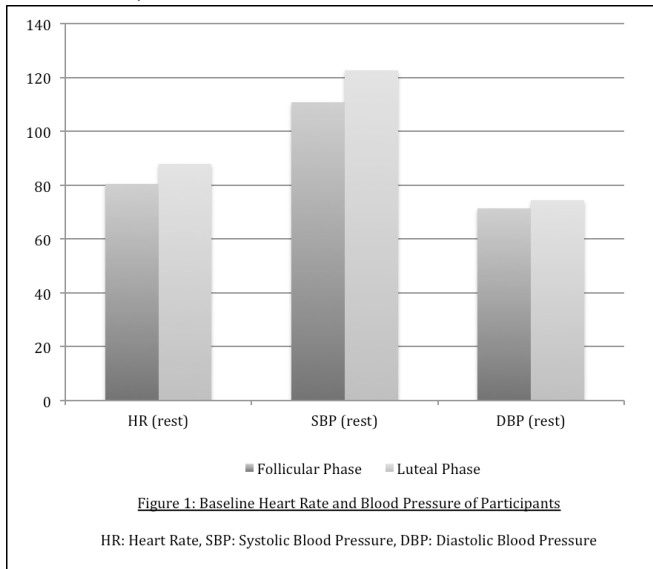
**D. Emotional Stroop Task**

Table 4 shows the latency (in milliseconds) for the identification of positive and negative words in the follicular and luteal phase respectively.

It is observed that there is increased latency of positive words in the follicular phase, where as in the luteal phase, increased latency is observed to negative words (Figure 3).

**DISCUSSION**

The current study was conducted with an intention to assess autonomic reactivity and cognitive and emotional status across different phases of menstrual cycle. The results show an increased sympathetic reactivity in the form of raised hr() bpm , sbp() mmhg and dbp () mmhg during luteal phase of menstrual cycle.



**Figure 1:** Baseline Heart Rate and Blood Pressure of Participants

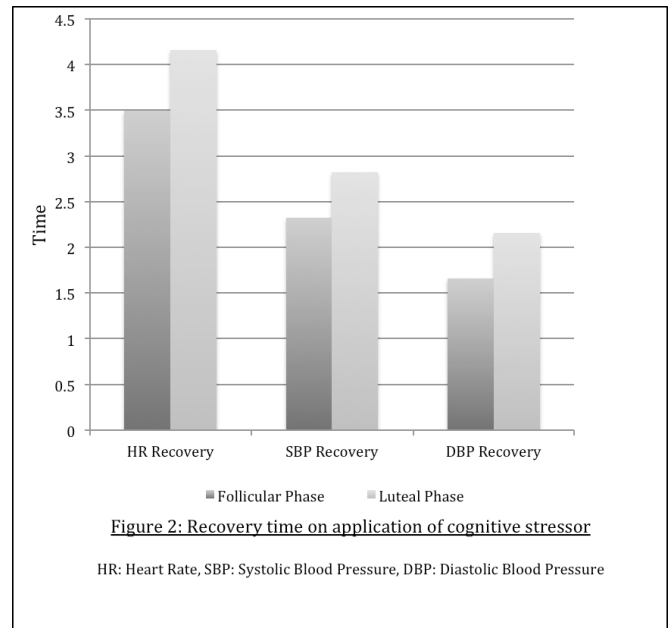
**Table 3:** Recovery time on application of cognitive stressor

Variables	Follicular phase	Luteal phase	P value
Hr recovery	3 mins 30 secs	4 mins 10 secs	0.01*
Sbp recovery	2 mins 20 secs	2 mins 50 secs	0.02*
Dbp recovery	1 min 40 secs	2 mins 10 secs	0.05*

**Table 4:** Response after application of emotional stroop task

Variables	Follicular phase	Luteal phase
Positive word latency	1256.437 ms	1034.54 ms
Negative word latency	1145.786 ms	1335.304 ms

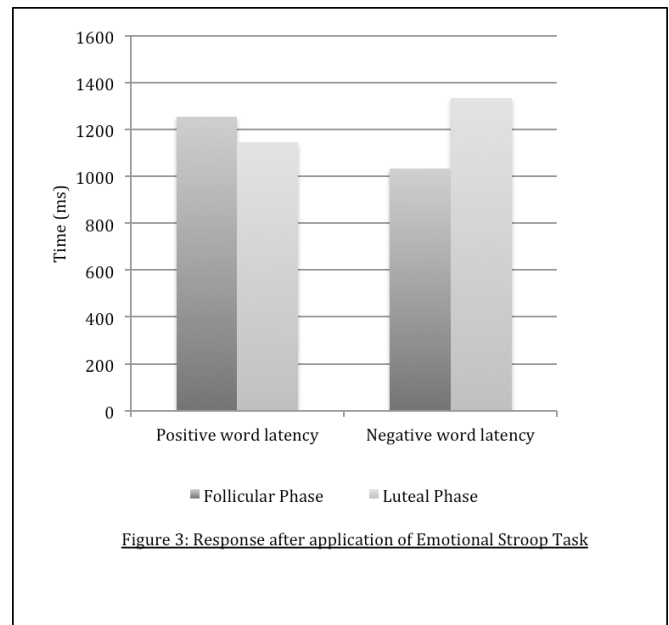
Cardiovascular system functions in an oscillatory manner to adjust with the variations in the external and internal environment throughout the day, also the blood pressure which shows diurnal variation. Variation in bp during the 2 phases of the cycle can also be accredited to the effect of ovarian hormones on cardiovascular function. There is significant vagal activity in the follicular phase as compared to a high rate of sympathetic response in the luteal phase. (4)the increased vagal activity at ovulation has shown to be influenced by the presence of estrogen while the greater sympathetic activity during the 2<sup>nd</sup> phase of the cycle has been contributed to the increased endogenous progesterone levels<sup>23</sup> estrogens exert their actions through two receptor



**Figure 2:** Recovery time on application of cognitive stressor

HR: Heart Rate, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure

**Figure 2:** Recovery time on application of cognitive stressor



**Figure 3:** Response after application of Emotional Stroop Task

**Figure 3:** Response after application of Emotional Stroop Task

subtypes (era and erβ).<sup>24</sup> It was seen that sex hormones can influence the level of substances such as endothelin (et), most commonly et 1 and therefore cause its fluctuation.<sup>25</sup> Progesterone is known to counter this action.<sup>26</sup> A study has demonstrated an increase in nitrate/ nitrite levels in the follicle developing phases<sup>27</sup> estrogen regulates the production of these mediators by many mechanisms; it increases the responsiveness of endothelium dependent, bradykinin mediated vasoconstriction. It increases the levels of no synthase and thereby mediates vasodilation. Progesterone plays the opposite role.<sup>28</sup> As progesterone levels increase during luteal phase, they cause decrease in nitric oxide mediated vasodilation and therefore a predominance of sympathetic vasoconstrictor activity and a greater rise in the blood pressure and heart rate by acting directly on the sa node and increasing the automaticity.<sup>29</sup>

Measurement of urinary catecholamine during the ovulatory cycles of females have revealed a relative increase in the levels of norepinephrine in the 2<sup>nd</sup> half of the menstrual cycle (30) there has also been observed an increase in the incidence of hypertension and a greater heart rate variability in females who indulge in the administration of progesterone containing oral contraceptives as a documentary proof.<sup>31</sup> The vagal preponderance during the follicular phase has been demonstrated using hrv in young menstruating females.<sup>6</sup> heart rate and blood pressure have shown an increase due to the withdrawal of parasympathetic influence of estrogen due to antagonism by progesterone.<sup>32</sup>

With regards to a cognitive stressor in the form of PASAT it was observed that our participants showed an increase in the sympathetic response to stressor reactivity during their luteal phase as compared to the follicular phase. Hr recovery was (3 minutes and 30 seconds) follicular phase and (4 minutes and 10 seconds) luteal phase, sbp recovery was (2 minutes and 20 seconds) follicular phase and (2 minutes and 50 seconds) luteal phase, dbp recovery was (1-minute and 40 seconds) follicular phase and (2 minutes and 10 seconds) luteal phase this can be attributed to the predominance of progesterone in the luteal phase.<sup>19</sup> These changes can be concluded with a finding that cognitive stressors induce a greater sympathetic response in the luteal phase of the cycle which means that females perceive the second half of the cycle as being mentally and physically tasking.

To link the cycle phase to emotional responses we employed the emotional stroop test in our participants and we observed an reduced latency to negative words during the second half of menstrual cycle whereas reduced latency to positive words was seen during the follicular phase.

With the above said results we derived a conclusion that the luteal phase of a female is a 'negative emotional' driven phase. There have been many studies to show that a female shows a slower response to identify the color of a word which depicts her current emotional state of being<sup>21</sup> and our study came to the same conclusions. Positive word latency was (1256.437 ms) follicular phase and (1034.54 ms) luteal phase.

Negative word latency was (1145.786 ms) follicular phase and (1335.304 ms) in luteal phase.

Our findings indicate a higher sympathetic activity to cognitive and emotional stressors in the luteal phase due to increased progesterone levels as compared to follicular phase. Hence gender-based cyclical training & moderation is advocated for optimum results.

## CONCLUSION

Hormones throughout the menstrual cycle follow a rhythmic trend and have an unpredictable effect on the cardiovascular system. Luteal phase is predominated due to the hormone progesterone, which causes a higher sympathetic activity when cognitive and emotional stressors are applied, whereas the follicular phase which is dominated by estrogen does not lead to this relative increase in sympathetic activity.

## IMPLICATIONS

Modulation of these receptors by therapeutic agents is currently being considered for prevention and treatment of a wide variety of pathological conditions.<sup>24</sup>

Using these findings, modifications can be made in ones lifestyle and work understanding their cognitive capacities during different times of the month.

## ACKNOWLEDGEMENT

We extend our gratitude towards the participants of our study as well as our statistician abhay ghag for lending value to our study.

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# Osteoporosis: A Silent Life-threatening Disease

Krishna Roy\*

## ABSTRACT

Osteoporosis is a pervasive multi-factorial chronic disorder characterized by low bone mineral density and increased risk for bone fragility, with a claim for long-term management procedure. Osteoporosis as a disease is a major threat due to our changed lifestyle and aging demographic. It may be viewed as a heterogeneous condition due to various genetic, nutritional, mechanical, endocrine and other lifestyle factors. Although post-menopausal women are the most vulnerable victims, aged men population cannot escape themselves from this disease, as can be diagnosed by Bone Mineral Density (BMD) test. This review work will give insight into how the disease can be controlled by lifestyle changes and usage of some selected pharmaceuticals and nutritional supplements. Hence, assessing the prevalence and awareness of the risk factors associated with the disease may provide the basis of management and future health plans to combat it.

**Keywords:** BMD, Osteoporosis, Post-menopausal women, Risk factors.

*Indian Journal of Physiology and Allied Sciences* (2021);

ISSN: 0367-8350 (Print)

## INTRODUCTION

Osteoporosis, demands the second most important position in the global health care arena (2). In 2013, it was found 50 million people in India are either osteoporotic (T-score lower than -2.5) or have low bone mass (T-score between -1.0 and -2.5) (43). Interestingly, studies indicate that osteoporosis and osteopenia or low bone mass may occur at a relatively younger age in Indian population.<sup>44,45</sup> It is characterized by low bone mass with altered micro-architecture of the bone that leads to increased risk of fragility of bones.<sup>4,10</sup> Conventionally, osteoporosis has been classified into primary and secondary type. Primary osteoporosis refers to osteoporotic conditions which are not related to other chronic illnesses and is usually associated with aging and decreased gonadal function, such as decreased level of oestrogen. In contrast, secondary osteoporosis is the type of osteoporosis caused by other health problems. Disuse is one of the many reasons inducing bone loss and resulting in secondary osteoporosis.<sup>12,24</sup> The disuse osteoporosis refers to decrement of bone mass under certain conditions such as decreased mechanical loading, including decreased ground force reaction, muscular contraction. It is also found in microgravity-related bone loss in astronauts after space flights. Disuse osteoporosis is found regionally, mostly in the areas with tremendous decrease in weight bearing like lower limbs. In daily life, bones of lower limbs are subjected to mechanical stimulations provided by static gravity-related weight-bearing, ground reaction forces, and dynamic loading generated by muscle contractions during locomotion. Physical exercise is also essential for increasing or maintaining bone mass and strength.<sup>25</sup> In post-menopausal women, Milliken et al. (26.) have investigated the effect of one-year supervised weight training exercise on their bone mineral density (BMD) level. The study result showed higher BMDs of trochanter and femoral neck in women with weight training exercise than in those lacking exercise. Similarly, Chan et al.<sup>27</sup> have studied the effect of Tai-Chi exercise

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**How to cite this article:** Roy, K. (2021). Osteoporosis: A Silent Life-threatening Disease. *Indian Journal of Physiology and Allied Sciences*. 73(1), 16-21.

**Conflict of interest:** None

**Submitted:** 12/07/2021 **Accepted:** 14/09/2021 **Published:** 25/12/2021

on the bone quality in post-menopausal women. In fact, there are many effective treatments available for control of primary osteoporosis, but effective treatments for disuse osteoporosis is still to be discovered. This is because of the fact that the aetiology, patho-physiology, and resultant pathology of disuse osteoporosis differ from those of primary osteoporosis.<sup>(32)</sup>

Osteoporosis as a disease in general is a major threat due to our changed lifestyle and aging demographic.<sup>(11)</sup> An analogy may be drawn with respect to asymptomatic condition of hypertension, and dyslipidaemia which culminates in stroke or myocardial infarction. Osteoporosis may similarly predispose to multiple fractures in the bones of the body (10). Although the disease prevails in the post-menopausal women population due to their decreased bone mineral density (BMD) resulting from deficiency of female sex hormone, it has found to touch the male population also (2). Thus osteoporosis has always been mislabelled as a women's disease by the public, but it really affects men, too. Usually, young patients if afflicted by the disease, remain undiagnosed until a fracture brings the patient to a doctor. As a major public health problem, it is often associated with the incidence of bone fractures which lead to morbidity specially among older population, culminating in mortality also. It is true for the entire population of the world also. The disease is also associated with a huge financial burden even in the developed countries (10). Indeed it is a multi-factorial disease,



easily affected by a number of risk factors that influence Bone Mineral density or BMD. (6, 10). Unfortunately this important health hazard though known for a long time, has received a low level of attention in primary health care program in most of the under -developed countries, where specifically most of the women though vulnerable to this disease are almost unaware of the graveness of the disease (1). Naturally, they are also quite in the dark about the remedial measures to be adopted as a part of their lifestyle. The present article aims at reviewing the basic information of the disease, current prevalence and awareness of osteoporosis not only among the women population, but also in the male community in the perspectives for this particular health hazard.

## **AETIOLOGY OF THE DISEASE**

Osteoporosis may be considered as a heterogeneous condition which may express at any age of life and is attributed to various factors, such as advancing age, physical disability, genetic, endocrine, nutritional, metabolic, mechanical factors as well as deficiency of Immune system of the body (4, 10). These may again be categorized as non- modifiable and modifiable factors. Non- modifiable factors include genetic pattern, age, sex, physical structure and modifiable factors are usually body weight, lifestyle factors specially sedentary lifestyle or exposure to microgravity etc. (32).

### **Genetic Factors**

Gene for vitamin D receptor is believed to be a determinant factor for bone mass and difference in VDR gene polymorphism in different races may be responsible for difference in bone mass (7,9 ). This has been significantly shown in Indian women (8). Moreover, oestrogen receptor  $\alpha$  (ER  $\alpha$ ) gene polymorphism may also be associated with BMD in Indian women (8). Other gene, i.e. collagen type I $\alpha$ 1 gene and Insulin like growth factor I (IGFI) gene, ( specially in men have proved their role in earlier studies( 2, 15).

### **Nutritional Factors**

Bone health depends much on Calcium and Vitamin D status in the body and thus deficiency of these two factors seems to be the major contributing factors for osteoporosis. Apart from body weight, age and menopausal state, Calcium intake is found to be an important determinant of BMD (10,44). Similarly, low level of serum Vitamin D is associated with low BMD. status (17)

### **Hormonal and Metabolic Factors**

Medical conditions like hypogonadism, thyrotoxicosis, Adrenal cortical disorder like Cushing Syndrome, Chronic Inflammatory conditions, Anorexia nervosa, Renal disease, Chronic liver disorder, malabsorption syndrome, may lead to osteoporosis. (21,32)

### **Level of Peak Bone Mass Achieved at Puberty**

This is usually achieved by proper nutrition and physical exercise (4).

## **Medications**

Use of drugs in the group of Glucocorticoids, Antilipidemics etc may lead to osteoporosis (9). It may be called as secondary osteoporosis.

## **Osteoporosis due to Disuse of body components**

It is in general bone loss or a reduction of bone mass in relation to bone volume, while the ratio of bone mineral to collagen remains unchanged. The loss of trabecular bone is more rapid and dramatic, while the cortical loss continues for a longer period (28). However, during long term bed rest, paralysis, bones of lower limbs are subjected to three categories of mechanical loadings during daily life, namely, static gravity-related weight bearing, ground reaction forces, and dynamic loading generated by muscle contractions during locomotion. Different health problems are associated with absence or decrease in one or more of these mechanical stimulations and may result in bone loss differently in anatomical location, quantity, velocity, and through different mechanisms. (31) Several studies on effects of microgravity on skeleton, i.e reduced weight bearing and ground reactions focused on the impacts on skeletons of astronauts after spaceflights. Collet et al. (29) analyzed the BMD and biochemical parameters of 2 astronauts who stayed one and six months, respectively, in space. However, the impacts of microgravity on human skeletons are highly varied, but in case of astronauts it is to be noted that muscle contractions are not limited or restricted.

## **EPIDEMIOLOGY**

There is no doubt that Human population of all races and ethnicity is susceptible to osteoporosis. Worldwide, life time risk for osteoporotic fractures in women is 30-50% and 15-30% in men (12.) Based on 2001 census, it was postulated that by 2015, Indian aged population (age above 50 years) would become 230 million from 130 million when 20% of women and 10-15% of men population would be osteoporotic (10). The National Health and Nutrition Examination Survey (NHANES) III data had shown that prevalence of osteoporosis is highest in older White women, followed by Mexican American women and finally by Black women as based on BMD. estimation of femur (8). In current Indian context, it appears from the situation analysis of the elderly in India, most common disability among the aged population is the locomotor disability which may arise due to osteoporosis (5,45). In USA, Osteoporotic fractures are extremely common, with an estimated figure of 1.5 million people suffering from fragility fractures each year.(13) A similar burden of disease was also observed in the UK, with epidemiological studies hypothesizing that one in two women and one in five men aged over 50 years will suffer an osteoporotic fracture in their lifetime.(47). In India, low calcium intake, extensive Vitamin D deficiency, early menopause, increasing longevity, and genetic predisposition, give rise to high prevalence of osteoporosis in women (33).

## **PATHOGENESIS OF OSTEOPOROSIS**

Our Bone continually undergoes modelling (during growth) or remodelling (during adult life), and this is brought about by the co-ordinated action of two types of cells, osteoblasts and osteoclasts. Osteoblasts form new bone, whereas osteoclasts are responsible for bone resorption. Both types of cell exert their actions being under hormonal regulation. Osteoporosis, is a condition when bone resorption exceeds bone formation leading to a reduction in bone mass, which again predisposes to fracture. The most important cause of osteoporosis is oestrogen deficiency, resulting in increased bone turnover in which resorption exceeds formation. Corticosteroids can also induce osteoporosis in which trabecular bone is particularly affected. This mainly results from suppression of osteoblastic activity. (46) Pathogenesis of Osteoporosis, unlike other chronic diseases is rather complex. Its prevalence is associated with genetic and other risk factors. An individual's peak bone mass attains a maximum value after sufficient deposition of bone mineral and skeletal growth. The process slows down after adulthood. After that, bone resorption process begins to exceed bone formation. As cancellous bone is metabolically more active than cortical bone, during accelerated bone loss, cancellous bones become three-fold more osteoporotic and the result is evident in the important cancellous bone like vertebrae.<sup>19</sup> Regulation of bone turnover is influenced by hormones, physical activity, nutrition, age and genetic factors.

Osteoporosis is conventionally classified into two main groups, considering the factors which affect bone metabolism: Primary osteoporosis and Secondary osteoporosis.

*Primary osteoporosis* is again sub-divided into two groups:

- *Involution or Type I Osteoporosis:* It is also known as post-menopausal osteoporosis, mainly caused by the deficiency of female sex hormone oestrogen. Oestrogen mainly affects the trabecular bone. As a result, women are more susceptible to osteoporosis than men, and it is evident by a men/women ratio of 4/5.7.<sup>30</sup>
- *Involution or Type II Osteoporosis:* Also known as senile osteoporosis, and it is related to loss of bone mass during the aging of cortical and trabecular bones.<sup>41,42</sup>

*Secondary osteoporosis:* is mediated by many factors:

- Different diseases such as Vitamin D deficiency, Vitamin A excess, Thyroid hormone in excess.<sup>21</sup>
- Different medications, especially those used for the treatment of acidity (Aluminum in antacids), anxiety reliever drugs, sedative drugs (Barbiturates,) Anticoagulants (heparin), anticonvulsants, cancer, chemotherapeutic drugs, depomedroxyprogesterone (premenopausal contraception), glucocorticoids ( $\geq 5$  mg/day prednisone or equivalent for  $\geq 3$  months), GnRH (gonadotropin-releasing hormone) agonists, Lithium Cyclosporine A, Tacrolimus, Methotrexate, Parental nutrition, Proton pump inhibitors Selective serotonin reuptake inhibitors, Tamoxifen® (premenopausal use) Thiazolidinediones,

- Lifestyle changes such as, high salt intake, alcohol abuse, low calcium intake, physical immobilization, low physical activity can cause secondary osteoporosis.<sup>40,47</sup>

## **DIAGNOSIS**

Osteoporosis is a silent disease since it does not show any symptom until a fracture occurs. Hence, the bones become so weak that sudden strain, bump or fall causes vertebrae to collapse or cause a hip fracture. If vertebrae collapse, it initially exhibits back pain, followed by loss of height, spinal deformities such as kyphosis or stooped posture, Major signs of osteoporosis are sloping shoulders, the curve in the back, loss of height, back pain, hunched posture, protruding abdomen etc.<sup>22</sup> Osteoporosis affects all bones of the body. However, breakage is common in the hip, wrist and spine.<sup>23</sup> The gold standard for diagnosing osteoporosis is by measuring BMD using DEXA (Dual Energy X ray Absorptiometry) at different indicative sites such as lumbar spine, femoral neck and total hip. Using the guidelines of WHO, osteoporosis is believed to be present if t-score of BMD is at least more than 2.5 SD below the peak bone mass of reference standard for young white women (2,18). The most important question here arises regarding the appropriateness of Western standard in the case of Indian population, since B.M.D. at all the sites seems to be 5–15% lower than the Caucasians.<sup>3</sup> A few years ago, the International Society for Clinical Densitometry (ISCD) recommended using ethnic- or race-adjusted Z-scores: Z-scores of -2.0 or lower are defined as "low bone mineral density for chronological age" or "below the expected range for age" and those above -2.0 are defined as "within the expected range for age".<sup>33</sup> The bone mineral density can be easily measured, the degree of the bone tissue deterioration cannot be measured in clinical settings, except the biochemical markers of bone tissue.<sup>34</sup> Bone remodeling (or turnover) occurs throughout our life to repair small or minimum fatigue damage and microfractures in the bone and maintain mineral homeostasis. Biochemical markers of bone remodeling include some resorption markers, namely serum C-terminal telopeptide type-I collagen (s-CTX) and urinary N-telopeptide (NTX), and formation markers, such as serum procollagen type-I N-terminal propeptide (s-PINP) may provide information on fracture risk independent of BMD and predict the rapidity of bone loss in untreated patients. Following studies are also necessary to rule out secondary osteoporosis:<sup>40</sup> Complete blood count (CBC), Serum creatinine, calcium, phosphorus, and magnesium, Alanine aminotransferase (ALT), aspartat aminotransferase (AST), and alkaline phosphatase (AP) Thyroid-stimulating hormone (TSH) and free T4, Vitamin D (V-D) (25 (OH) D, Parathyroid hormone (PTH), Total testosterone and gonadotropin in younger men.

## **Remedial Measures for Prevention and Treatment of Osteoporosis**

Osteoporosis is a preventable and treatable disease, but because of a lack of warning signals, people are not aware

or nor being diagnosed in time to receive effective therapy during the early phase of this disease.<sup>36,37</sup> So universal recommendations for all patients are:

- An adequate intake of calcium and Vitamin-D, through natural/artificial sources<sup>16</sup>
- Life-long regular weight-bearing and muscle-strengthening exercises.<sup>12,20</sup>
- Treatment of risk factors for falling<sup>36</sup>
- Cessation of tobacco use and excess alcohol intake

On top of that, it is to be remembered that low serum calcium levels promote bone resorption, and calcium requirements increase among older persons; thus, the older population is particularly susceptible to calcium deficiency. Moreover, all calcium preparations are absorbed adequately if taken along with food, particularly in the absence of gastric acid secretion. For optimal absorption, the amount of calcium should not exceed 500–600 mg per dose. A few foods are rich in oxalate, and they prevent the absorption of calcium by binding with it. On the contrary excess intake over and above 1200–1500 mg/day may increase the risk of developing kidney stones, cardiovascular diseases, and strokes. Calcium absorption is assisted by Vitamin D. Chief dietary sources of V-D include V-D-fortified milk, juices and cereals, saltwater fish, and liver. Supplementation with V D2 (ergocalciferol) or V-D3 (cholecalciferol) may be used. Many older patients are at a high risk for V-D deficiency,<sup>9</sup> which include the following: patients with malabsorption issues (e.g., celiac disease) or other intestinal diseases (e.g., inflammatory bowel disease, gastric bypass surgery); gastric acidity; some anticonvulsive drugs; or glucocorticoids, which decrease calcium absorption; housebound and chronically ill patients; persons with limited sun exposure; individuals with very dark skin; and obese individuals. Therefore, Serum 25 (OH) D levels should be measured in patients at the risk of V-D deficiency. V-D supplements should be recommended in amounts sufficient to bring the serum 25 (OH) D level to approximately 30 ng/mL (75 nmol/L).

### Treatment with Pharmacological Agents

Pharmacological interventions are often required especially for persons with a high risk of osteoporotic fractures. The main objectives of this therapy in osteoporotic patients are to improve their quality of life. It is mediated by preventing fractures by improving bone strength and reducing the risk of falling and injury. Most of the current therapies in the prevention of osteoporosis and fractures are designed to arrest bone resorption and increase bone mass and these are known as antiresorptive agents. Some important agents in this group are: oestrogen; Bisphosphonates (BPs) such as alendronate, risedronate, ibandronate, and zoledronic acid; other drugs are Selective Estrogen Receptor Modulators (SERM)-such as Raloxifene; another one is Human Monoclonal Antibody against receptor activator of NF- $\kappa$ B ligand (RANKL): Denosumab; and Strontium Ranelate (SR). Of all these drugs Bisphosphonates are the most widely used drugs for

treating osteoporosis. Bisphosphonates are a group of drugs that work by slowing bone loss. They reduce the risk of hip and spine fractures. Bone renewal is a slow process, but an increase in bone density can be measured over five years of treatment in many people. Alendronate is used to prevent and treat post-menopausal, glucocorticoid-induced, and male osteoporosis cases. Zoledronic acid is used to prevent and treat post-menopausal osteoporosis and osteoporosis in men and glucocorticoid-induced osteoporosis. Ibandronate is another BP used for the prevention and treatment of post-menopausal osteoporosis, which has proven efficacy in reducing the risk of spinal fractures of post-menopausal women who have osteoporosis, but it is not proven in reduction of non-vertebral or hip fractures except for higher-risk subgroup. Ibandronate has been studied in trials of up to 3 years and its efficacy and safety beyond 3 years is unknown.<sup>43,47</sup>

Biphosphonates are the main drug of choice for the usual case of reducing the risk of mild to moderate fractures in vertebrae or non-vertebral regions, while for severe osteoporosis use of teriparatide is the answer.<sup>38,39,47</sup> Teriparatide (recombinant human PTH 1–34) with all its adverse effects has been selected as a drug of choice specially for post-menopausal women with a high risk of fracture, and those who have failed or are intolerant to previous osteoporosis therapies. It is also used to increase bone mass in men with idiopathic or hypogonadal osteoporosis. Denosumab (human monoclonal antibody against RANKL) as a new drug is considered as a drug of choice for the treatment of post-menopausal women at a high risk of fracture and also for patients having a history of osteoporotic fractures, or patients who have failed or are intolerant to other available osteoporosis therapies. Pharmaceutical vitamin D (D3) or its precursor alfacalcidol are approved drugs for treatment of osteoporosis but not for prevention for which Cholecalciferol is more effective.<sup>38</sup> Researchers in this field opine that the lifestyle of an individual is to be modified. We must create general public awareness in this regard. This awareness program must convey a few important points to the susceptible persons, such as a brief idea about B.M.D., importance of regular exercise, consumption of Calcium and Vitamin D rich foods, building up of strong bones at childhood, frequent exposure to Sun light, and special awareness programs are also to be made for post-menopausal women. Apart from these, avoidance of high salt diet, coffee, and alcohol consumption and cigarette smoking, indulgence in regular physical (weight-bearing and muscle-strengthening) exercise, and a balanced diet with adequate calcium and Vitamin intake.<sup>35</sup> Another cheap but useful therapy recommended is daily skin exposure to sunshine for at least 15 minutes.<sup>37</sup> It is also important to motivate our children to drink milk and to enjoy playing under the sun. People with sleep- apnoea are victims of osteoporosis, since oxygen depletion can weaken bones.<sup>36</sup>



## CONCLUSION

Osteoporosis is a common household name. We are also aware of its grave consequences. In fact, osteoporosis causes many people to suffer from a fracture. Every year, we consider 20<sup>th</sup> October as world osteoporosis day. The severity of the disease increases with the increase in the aging population throughout the world. Understanding the reasons behind the multi-factorial nature of bone health, preventive care towards control and mitigation of the problems underlying the disease must be given due importance and this can only be achieved with the adoption of a changed lifestyle, dietary habit, appropriate low-cost medicines and genuine, constructive awareness about this debilitating disease.

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# Environmental Source of Iodine and Hardness in Drinking Water in the Etiology of Endemic Goitre in Selected Areas of Howrah and Purba Medinipur District, West Bengal state of India

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## ABSTRACT

Endemic goitre has been reported from the southern part of the West Bengal. To study the etiological factors for the persistence of endemic goitre, bioavailability of iodine and hardness of water used for drinking in the region were evaluated because these common environmental factors are inversely and directly related with goitre prevalence in several geographical regions. An induction of the iodine content of the soil can be given by the local drinking water concentration. Water hardness is defined by the high concentrations of calcium and magnesium present. In the present study 5 CD Blocks and 8 CD Blocks attached to the river Ganga are selected from Howrah and coastal areas of Purba Medinipur district respectively. From each CD Block at least 8 drinking water samples were collected and analyzed for iodine and calcium and magnesium content. Iodine content in drinking water samples was found in the range from 7.5 to 95.4 µg/L and hardness of drinking water was found to range from 210.3 to 625.7 ppm. Presence of magnesium was found higher than the calcium salts in most of the samples. These findings suggest that all most all the studied region is environmentally iodine sufficient but water is relatively hard and thus possibility of hardness of water for the persistence of endemic goitre may not be ruled out.

**Keywords:** Drinking Water, Endemic Goitre, Micronutrient, Thyroid hormones.

*Indian Journal of Physiology and Allied Sciences* (2021);

ISSN: 0367-8350 (Print)

## INTRODUCTION

Iodine is an important micronutrient for human development because it is a constituent of the thyroid hormones, thyroxine (T4) and triiodo-thyronine (T3). These hormones are involved in many different ways in human metabolism and are essential for normal growth, mental and physical development. Iodine is found in water, soil and plants. Mostly iodine is present in seawater. It also occurs in the deeper layers of the soil and is found in oil wells and natural gas effluents. Water from such deep wells can provide a major source of iodine. An indication of the iodine content of the soil can be given by the local drinking water concentration (Zeltser *et al.*, 1992). Water hardness is defined by the concentrations of calcium and magnesium present (hard water having high concentrations). Since calcium and magnesium are suspected additional goitre inducing factors, this may help to explain why goitre has been observed in some areas without notable iodine deficiency in local waters, rocks and soils. In such areas, iodine deficiency may also be induced by fixation of iodine by calcium in the soils, yielding low concentrations in groundwaters and decreased efficiency of uptake by plants (Fuge & Long, 1989).

In the post-salt iodization phase, endemic goitre has been reported from many areas in India (Chandra & Roy 2001, 2002; Chandra *et al.*, 2006a) including West Bengal (Chandra *et al.*, 2003, 2004a, 2005, 2006b, 2008). Iodine nutritional status of school children in a rural area of Howrah district in the Gangetic West Bengal showed that in spite of adequate iodine intake as evidenced by urinary iodine level, the total

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**How to cite this article:** Debnath, A., Tripathy, S., & Chandra, A.K. (2021). Environmental Source of Iodine and Hardness in Drinking Water in the Etiology of Endemic Goitre in Selected Areas of Howrah and Purba Medinipur District, West Bengal state of India. *Indian Journal of Physiology and Allied Sciences*. 73(1), 22-24.

**Conflict of interest:** None

**Submitted:** 07/06/2021 **Accepted:** 21/09/2021 **Published:** 25/12/2021

goitre prevalence was 37.6% (Chandra *et al.* 2004). In an epidemiological study, conducted in some selected areas of Howrah district showed that 38% student suffering in goitre though there is no iodine deficiency as evidenced by urinary iodine level (Chandra *et al.*, 2008). Slott (1931) suggested that goitre in India is directly related to the high calcium content in drinking water (Slott, 1931). High mineral content particularly of magnesium and calcium salts have been implicated as goitrogenic factors in several goitre endemic Areas (Koutras 1980, Langer 1960, Das *et al.* 2004, Chandra *et al.*, 2007).

For the purpose of the present study five CD Blocks attached to the river Ganga and eight CD Blocks from the coastal areas of Purba Medinipur district were selected to

evaluate the environmental source of iodine or iodine content and hardness of water that is used by the people for drinking in this region.

## METHODS AND MATERIALS

Howrah is one of the most thickly populated districts in Gangetic West Bengal. It has a population of 18,80,530 (2001 Census report) living under 14 Community Development Blocks (C D Blocks). Most of its population lives in completely rural areas where as some other lives in industrial but rural areas. People are engaged in either agricultural activities or working in factories. Purba Medinipur is another district having population of 31,50,357 (2001 Census report) living under 23 C D Blocks. The people of this districts are engaged in agricultural activities, working in factories and fisheries. Their diets are mainly non-vegetarian and consist of cereals (rice), pulses, fish and vegetables of Brassica family with others.

From the selected area of each block at least eight drinking water samples (Chandra *et al.*, 2004) of about 100 mL were collected at random from the available sources i.e., tube wells and kept in wide mouth screw capped plastic bottle for the determination of iodine and calcium and magnesium content/hardness. The collected water samples were brought to the laboratory and kept at 4°C until analysis. On the day of analysis, the samples were brought at room temperature, all the collected samples from the same area were mixed thoroughly and the iodine content of the samples was measured by its catalytic action on the reduction of ceric ion ( $Ce^{+4}$ ) to cerous ion ( $Ce^{+3}$ ) following the method of Karmarkar *et al.*, 1986. The hardness of water/the presence of calcium and magnesium salt in drinking water samples of the same samples used for iodine estimation was measured following EDTA method (Rand *et al.*, 1975).

## RESULTS AND DISCUSSION

A total of 104 drinking water samples were analyzed for iodine content. Iodine content of water was highest in Ramnagar-I (95.4  $\mu\text{g/L}$ ) of Purba Medinipur district and lowest in Khejuri-II (7.6  $\mu\text{g/L}$ ) in the same district (Table 1).

The daily dietary intake of iodine varies widely from region to region depending on the iodine content of soil, water and dietary habit. Iodine is consumed through foodstuffs and water in both inorganic and organically bound forms. Iodate ions are converted into iodide ( $I^-$ ) in the stomach. The rapidity of absorption of organically bound iodine and the form in which it is absorbed are uncertain, but eventually it is made available as inorganic iodide. Iodide per second (NaI) is rapidly (within 30 minutes) and efficiently absorbed from gastrointestinal tract and distributed in extra cellular fluid (ECF). Two main processes are removing the most iodide of the ECF constantly; excretion by the kidney and trapping by the thyroid gland. The thyroid cell trapping mechanism that is the iodine pump, gives the gland and ability to concentrate iodide (Wolff, 1983).

Zeltser *et al.*, 1992 have categorized the iodine deficient zone as the severe deficient zone having iodine less than 4  $\mu\text{g/L}$  of water, moderate iodine deficient zone with iodine level 4 to 10  $\mu\text{g/L}$  of water and relative iodine deficient zone having iodine level below 20  $\mu\text{g/L}$  of water (Zeltser *et al.*, 1992). According to this criterion the overall result showed that the region is environmentally iodine sufficient though Khejuri-II (7.6  $\mu\text{g/L}$ ) had under moderate iodine deficient zone and Contai-I (14.5  $\mu\text{g/L}$ ) and Contai-II (18.0  $\mu\text{g/L}$ ) had relative iodine deficient zone (Table 1). The people use the drinking water from shallow tube well of 150–200 feet deep. In spite of environmental iodine sufficiency, the people of the region is affected by endemic goitre (Chandra *et al.*, 2004, 2008). This observation led us to search for other common

**Table 1:** Bioavailability of iodine and hardness in drinking water in selected areas of Purba Medinipur and Howrah districts.

Serial No	Study areas (C.D. Blocks)	Iodine ( $\mu\text{g/l}$ )	Hardness of water (ppm)		
			Calcium	Magnesium	Total
	Dist. Purba Medinipur				
1	Sutahata	60	21.4	248.5	269.9
2	Haldia	65	50.6	260.4	311.0
3	Nandigram-I	40.5	47.7	300.6	348.3
4	Khejuri-II	7.6	30.5	195.5	226.0
5	Contai-I	14.5	45.1	290	335.1
6	Contai-II	18.0	46.2	315.5	361.7
7	Ramnagar-I	95.4	48.5	190.2	238.7
8	Ramnagar-II	77.8	70.8	139.5	210.3
	Dist. Howrah				
9	Panchla	40.3	95.2	530.5	625.7
10	Ulberia-I	85.6	31	248.2	279.2
11	Ulberia-II	55.2	65.5	368	434.3
12	Shyampur-I	51.4	66.2	170	236.2
13	Jagatballavpur	53.2	73.5	159.8	233.3

environmental factors found in water. Magnesium and Calcium salt present in drinking water have been suspected as goitrogenic factor in certain iodine sufficient goitrogenic areas of South America (Koutras, 1980; Langer, 1960).

Total hardness of drinking water collected from different areas was determined and found in the range from 210.3 ppm to 625.7 ppm. Presence of magnesium salt was higher than calcium salts in all the samples. The hardness of water found highest in Panchla block (625.7 ppm). The calcium hardness values were found in the range 21.4 ppm to 95.2 ppm and magnesium hardness values in the range 139.5 ppm to 530.5 ppm (Table 1).

In the studied areas according to the specification of Indian Standard Drinking Water, calcium level was found within permissible limit that is 200 ppm but the presence of magnesium salt was more in almost all the areas (13 areas of 13 CD Blocks) than the permissible limit that is (Indian Standard Drinking Water -Specification 1993). Day and Propwell-Jacson (1972) reported that magnesium level was more closely correlated with goitre prevalence than calcium levels (Day TK & Propwell-Jacson, 1972). Therefore, the presence of magnesium salt in drinking water as observed in this study may pose a serious threat of thyroid disorders in the studied region. Das *et al.*, (2004) reported that increased hardness of drinking water (Ca<sup>2+</sup>, Mg<sup>2+</sup>) and significant environmental iodine deficiency are important factors in the etiology of endemic goitre in many regions of Nigeria (Das *et al.*, 2004). But exact mechanism by which calcium and magnesium cause goitre is not known. Presence of excess calcium in colloid of the thyroid follicle causes compactness of thyroglobulin molecules (containing T3 and T4) in follicular cells and their subsequent release in circulation (Rousset AB & Dunn JT, 2004). This may be possible reason for the development of hypothyroidism/goitre in such situation.

The overall results of this study suggest that the persistence of endemic goitre in the studied region is not for environmental iodine deficiency except some specific regions of Purba Medinipur district. However, the water is hard for the presence of excess magnesium salt. Thus, possibility of the hardness of water in the persistence of endemic goitre may not be ruled out.

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