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UpDAYtes

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Editor-in-Chief: Prof. (Dr.) Satinath Mukhopadhyay

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Content:

From the Desk of the Editor-in-Chief:

Dear ALL,

GREETINGS from **UpDAYtes** Team!

Being an International Multidisciplinary Research & Innovation Journal, this is a platform dedicated to the pursuit of knowledge across disciplines. **UpDAYtes** is committed to encourage scholarly dialogue that transcends traditional academic boundaries. As a monolingual journal, we encourage the publication of original papers for fostering inclusive and diverse academic participation. Our mission is to create a vibrant space for interdisciplinary research that reflects the complexity of the contemporary world. The journal aims to publish:

- ·Quality research that advances understanding of the complex biological, environmental, behavioral, and social determinants of metabolic health including obesity and Diabetes.
- ·The journal adopts a multidisciplinary approach, integrating perspectives from nutrition science, metabolism, physiology, public health, behavioral sciences, clinical medicine, genetics, and policy research to address the growing global challenges related to metabolic disorders and nutrition-related diseases.

We welcome original articles, systematic reviews, meta-analyses, brief communications, and policy perspectives from various disciplines of science, humanities, student innovation, and management studies that explore the interplay between diet, metabolism, and health outcomes across the lifespan and those may range from molecular and cellular mechanisms to population-level interventions and health policies.

All submissions have undergone a rigorous peer-review process, including the conventional checking to ensure the highest standards of academic integrity and quality. We are deeply grateful to our authors, reviewers, and readers for their continued support in building **UpDAYtes** as a trusted and evolving platform for intellectual exchange.

We wish you a happy reading to explore this issue and invite you to engage with the research, and be part of this growing academic community.

With warm regards,

Editor-in-Chief
Prof. (Dr.) Satinath Mukhopadhyay
MD, DM (Endocrinology), FRCP (London), FAMS (India)
Ex Professor & Head of Endocrinology & Metabolism
Institute of Post Graduate Medical Education and Research

Changing Health Behaviours after COVID-19: A Study on Household Use of Medicinal Plants and Herbs

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ABSTRACT: Background:The COVID-19 pandemic significantly impacted global health practices, leading to a shift toward home-based remedies. This survey examines post-COVID household practices related to the selection, preparation, and utilization of herbal remedies, with a focus on commonly adopted species.

Purpose: The study aims to explore the use of different medicinal plants and herbs in the post-pandemic era at the household level, identifying which plants are used, their potential health benefits, frequency of use, and the satisfaction levels of users.

Methods: A total of 59 participants from different regions of West Bengal were included in the study. Data were collected digitally through a structured Google Form questionnaire. Statistical analysis was performed using R software. The study calculated the relative frequencies of different plants and established associations among selected parameters.

Results: This survey provides an initial overview of the use of home remedies for the treatment and prevention of health issues in the post-pandemic period. Among the 15 plants reported, Tulsi was the most frequently used, with a frequency of 26. It was observed that even participants without a history of COVID-19 used it at least once a week. Overall, the results revealed that people remain aware of and continue to value the potential therapeutic benefits of various medicinal plants and herbs.

Conclusion: The potential use of medicinal plants for symptom alleviation is widely acknowledged; however, further research is necessary to provide stronger evidence regarding their effectiveness.

INTRODUCTION:

Since ancient times, humans have maintained a dynamic and interdependent relationship with nature, particularly with plants, which have served as sources of food, shelter, and medicine. Across civilizations, people have relied on natural resources to treat various ailments. During the COVID-19 pandemic, the use of traditional herbal remedies as household treatments gained renewed significance (Mousavi et al., 2021). Ethnobotanical research plays a vital role in identifying and developing modern pharmaceuticals from natural medicinal plants (Idolo et al., 2010; Njoroge et al., 2004).

In India alone, nearly 7,500 plant species have been documented for their medicinal applications in indigenous healthcare systems and contemporary medicine (Arti et al., 2014; Gowthami et al., 2021). In the post-pandemic era, a growing number of scientific investigations have examined the efficacy and safety of herbal preparations, leading to more standardized products and greater consumer confidence. Furthermore, several medicinal plants and bioactive compounds previously recognized for their therapeutic potential against SARS-CoV-1 have also demonstrated possible efficacy against SARS-CoV-2 (Siddiqui et al., 2020; Nugraha et al., 2020).

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Keywords: Home remedies, medicinal plants, herbs, post-COVID era

COVID-19, or Coronavirus Disease 2019, is a highly transmissible respiratory infection caused by the novel SARS-CoV-2 virus. First reported in Wuhan, China, in late 2019, it quickly escalated into a global pandemic, officially declared by the World Health Organization in March 2020. The virus primarily spreads through respiratory droplets expelled during coughing, sneezing, or speaking (Gangal et al., 2020). Clinically, it presents with symptoms ranging from mild to severe, including fever, dry cough, fatigue, dyspnea, headache, and loss of smell.

Lockdowns and restricted access to conventional healthcare made people more reliant on home remedies using medicinal plants. These included teas, decoctions, steam inhalations, and oil infusions prepared from herbs such as mint, holy basil (Tulsi), neem, turmeric, ginger, and thyme. Various studies have reported that home-based remedies prepared from medicinal plants and herbs received widespread acceptance due to the belief that they cause fewer side effects compared to synthetic medicines.

Several commonly used culinary ingredients in Indian households possess significant phytochemical benefits. For example, Allium sativum (garlic) exhibits inhibitory activity against SARS-CoV-2 replication, making it a promising agent against COVID-19 (Mirzaie et al., 2020). Alhazmi et al. (2021) reported that garlic contains bioactive compounds such as organosulfides, saponins, and polysaccharides. Its immunomodulatory activity is primarily attributed to polysaccharides, which regulate immune homeostasis, maintain immune response, and influence Pcytokine gene expression and proliferation. According to Khubber et al. (2020), other bioactive compounds in garlic form hydrogen bonds with the serine-type protease present in SARS-CoV-2, potentially inhibiting viral activity and acting as a preventive measure against the COVID-19 pandemic. Ginger (Zingiber officinale) is also known to strengthen the body's defence mechanisms due to its antioxidant properties. The compound 6-shogaol, found in ginger, plays a beneficial role in relieving respiratory distress (Logeswari et al., 2020). Curcuma longa (turmeric), a widely used spice and medicinal herb, gained immense importance during the COVID-19 pandemic for its health-promoting properties, attributed to its anti-inflammatory, antioxidant, and immunomodulatory effects. The bioactive compound curcumin (diferuloylmethane) constitutes the major curcuminoid (77%), followed by curcumin II (17%) and curcumin III (3%) (Thomas, 2021).

The ethanolic extract of the aerial parts of holy basil (Ocimum sanctum) contains flavonoids and polyphenolic acids, especially luteolin-7-O-glucuronide and chlorogenic acid, which may covalently bind to the active residue Cys145 of the main protease of SARS-CoV-2 and inhibit the viral enzyme irreversibly, as revealed by in silico screening (Mohapatra et al., 2020). Being a strong antioxidant, it lowers the risk of severe diseases and enhances nutrient bioavailability.

Due to its high alkaloid content, the chloroform extract of Piper nigrum (black pepper) exhibits strong antiviral activity. Its bioactive compounds, piperadine and piperanine, are reported to be effective against COVID-19 (Sinha et

al., 2021). Similarly, Adhatodavasica (Basak), a key traditional medicinal plant, contains phytochemicals with significant therapeutic potential (Singha et al., 2021). Another common herb, Hygrophila auriculata (Kulekhara), traditionally used in treating various diseases, has been reported to contain chebulagic acid and vasicinone—two compounds known for their anti-SARS-CoV-2 activity (Bhattacharya et al., 2021). Several studies have also reported that rosemary extracts and their key compounds—rosmarinic, carnosic, and caffeic acids—exhibit strong anti-inflammatory, antioxidant, antifungal, and insecticidal properties (Shiravi et al., 2021).

Therefore, the present study focuses on the current scenario regarding the consumption patterns of different traditional medicinal plants and herbs in selected Indian households, and aims to illustrate their associated health benefits.

Aim and Objectives:

The main aim of this work is to explore the pattern of consumption of various medicinal plants and herbs in Indian household specially in the post pandemic period.

- To analyse the consumption patterns of different medicinal plants and herbs.
- To assess the satisfaction level of people regarding the use of medicinal plants and herbs.
- To determine the effectiveness of these plants and herbs in alleviating various daily-life symptoms.
- To analyse the current scenario of medicinal plant and herb consumption patterns in the post-COVID-19 period.

Methodology-

1. Study design and sampling technique-

This study follows a descriptive, exploratory, and survey-based design. The survey was conducted in digital mode. Considering the purpose of the study and the nature of the target audience, the purposive sampling method was applied. Data were collected over a one-month period, from 1st April 2025 to 30th April 2025. A structured questionnaire in Google Form was designed and pre-checked by the supervisor and experts to avoid any uncertainty. The Google Form was then shared with participants via email and other social media platforms. Questionnaire was prepared in English and consist of both qualitative and quantitative question stimuli. The questionnaire was structured around three main sections:

(A) General background – age, gender, occupation, education, and family size;

(B) Medical history– COVID-19 diagnosis, occurrence, chronic conditions, and treatment mode;

(C) Consumption habits – plant parts used, frequency, timing, observed changes, symptom relief, satisfaction, side effects, and recommendations.

2.Sample size and sample selection-

A total of 59 adult participants, both male and female, from various regions of West Bengal took part in this survey. The inclusion criteria included participants with the ability to use digital platforms, responsive to the question stimuli and answer their own, and a habit of using household medicinal plants and herbs in the post-COVID era. The exclusion criteria included participants do not use any digital platforms, no relevant practices, unable to understand the

question stimuli.

3. Outcome measures:

A thorough analysis of the collected data was conducted. The data were compiled in an Excel sheet and analysed using frequencies and percentages. Statistical analysis was performed in R software, employing the Chi-square test to assess significant associations, and ANOVA and independent t-tests to compare means and measure significant differences between parameters at a 95% confidence level ($p \leq 0.05$). The results were presented through various bar graphs and charts.

Result:

Sl no.	Local name	English name	Botanical name	Family	Habit	Parts used	Common applications
1	Rosun	Garlic	*Allium sativum*	Alliaceae	Herb	Bulb	Culinary use, antiviral
2	Aada	Ginger	*Zingiber officinale Rosc.*	Zingiberaceae	Herb	Rhizome	Improve digestive health, treat many
3	Holud	Turmeric	*Curcumina longa*	Zingiberaceae	Herb	Rhizome	The rhizome pest is applied to treat the skin diseases
4	Neem	Margosa tree	*Azadirachta indica*	Meliaceae	Tree	Root, bark, flower	The leaf juice is used in diabetes and joint pain
5	Tulsi	Holy basil	*Ocimum sanctum*	Lamiaceae	Herb	Leaves	Curative properties used in cold, cough,
6	Daruchini	Cinnamon	*Cinnamomum zeylanicum*	Lauraceae	Tree	Bark	Culinary use,
7	Golmorich	Black pepper	*Piper nigrum*	Piperaceae	Climber Fruit		Used in common cold and cough
8	Basak	Vasaka	*Adhatoda vasica*	Acanthaceae	Herb Leaves		The leaf juice is used as an expectorant to
9	Pudina	Peppermint	*Mentha piperita*	Lamiaceae	Herb Leaves		The leaf extract used to treat motion sickness
10	Kalmegh	Kalmegh	*Andrographis paniculata*	Acanthaceae	Herb Leaves		The leaf is used for skin diseases and diabetes
11	Amloki	Indian gooseberry	*Emblica officinalis*	Euphorbiaceae	Tree Fruit		Aids in gastrointestinal problem,
12	Chamomile	Chamomile	*Matricariachamilla*	Asteraceae	Herb Flower		As chamomile tea, skin care, medicinal effects
13	Gul mehendi	Rosemary	*Rosmarinus officinalis*	Lamiaceae	Shrub Leaves		Culinary condiment
14	Kulekhara	Swampweed	*Hygrophila auriculata*	Acanthaceae	Herb Leaves		It is used in treatment of anaemia and

Table-1: The major medicinal plants and herbs used by household found in the study

Changing Health Behaviours after COVID-19: A Study on Household Use of Medicinal Plants and Herbs

A. Medicinal Plants Recorded

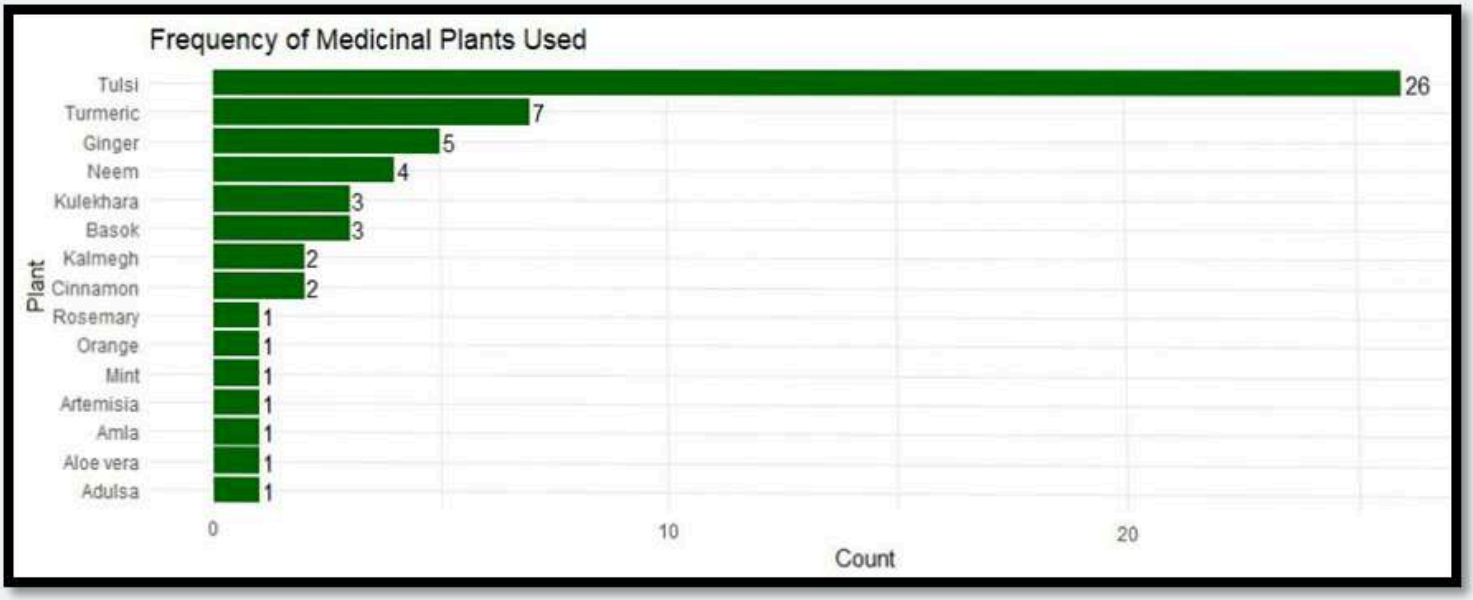

Fig-1: Frequency of medicinal plants and herbs used among the respondents

Medicinal plants	Count(n)
Tulsi	26
Turmeric	7
Ginger	5
Neem	4
Basak	3
Kulekhara	3
Cinnamon	2
Kalmegh	2
Adulsa	1
Aloe Vera	1
Amla	1
Mint	1
Orange	1
Artemisia	1
Rosemary	1

Table-2: Frequency of medicinal plants and herbs used

It's has been observed from the fig 1 and table 2 that Tulsi has the highest frequency among all the medicinal plants and herbs used followed by Turmeric, Ginger, Neem, Basak and so on.

B. Frequency of use of medicinal plants

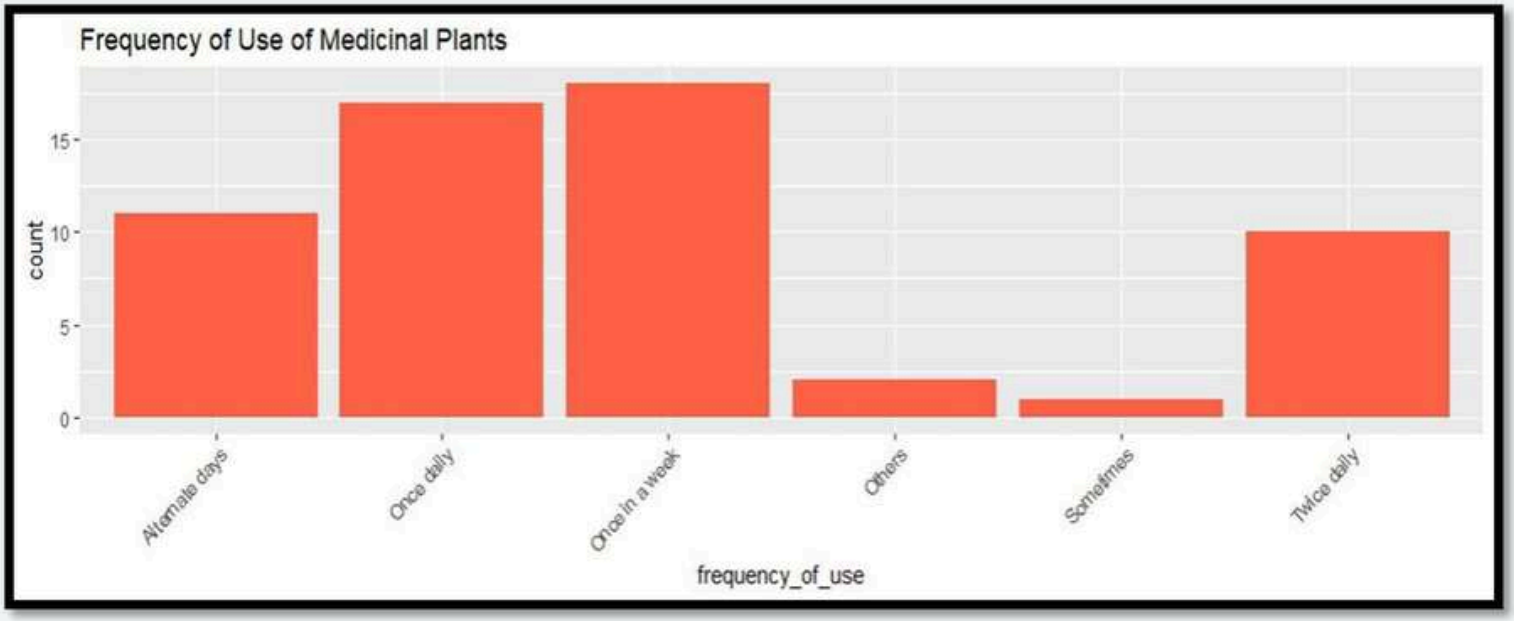

Fig-2: Frequency of use of medicinal plants

From the above figure it can be clearly said that the number of consumptions of the medicinal plants and herbs is maximum in once in a week.More than 15 participants responded that they used the plants atleast once in a week.

C. COVID history and types of medicinal plants used

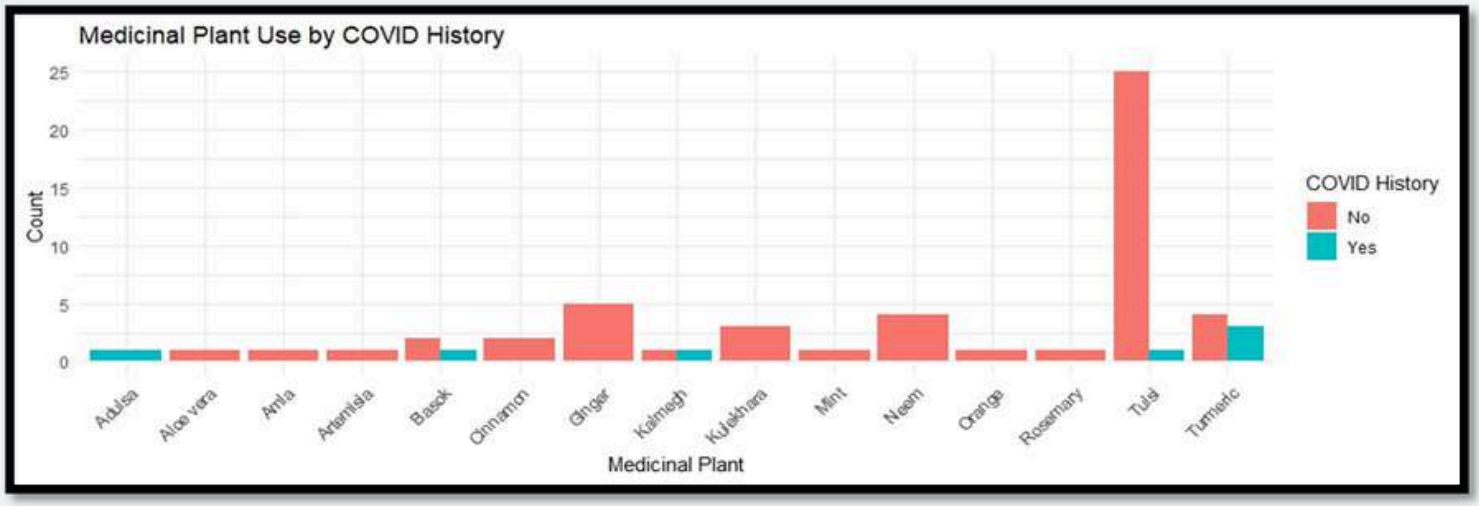

Fig-3: Medicinal plants used by COVID history

The bar chart displays the counts of people using different medicinal plants, grouped by whether they have a history of COVID-19 (Yes or No). However, the p-value of approximately 0.074 indicates a marginal or suggestive association, implying that COVID history might influence the choice of medicinal plants, but more data or further research is needed to confirm this relationship confidently.

D. Medicinal plants used and Satisfaction score

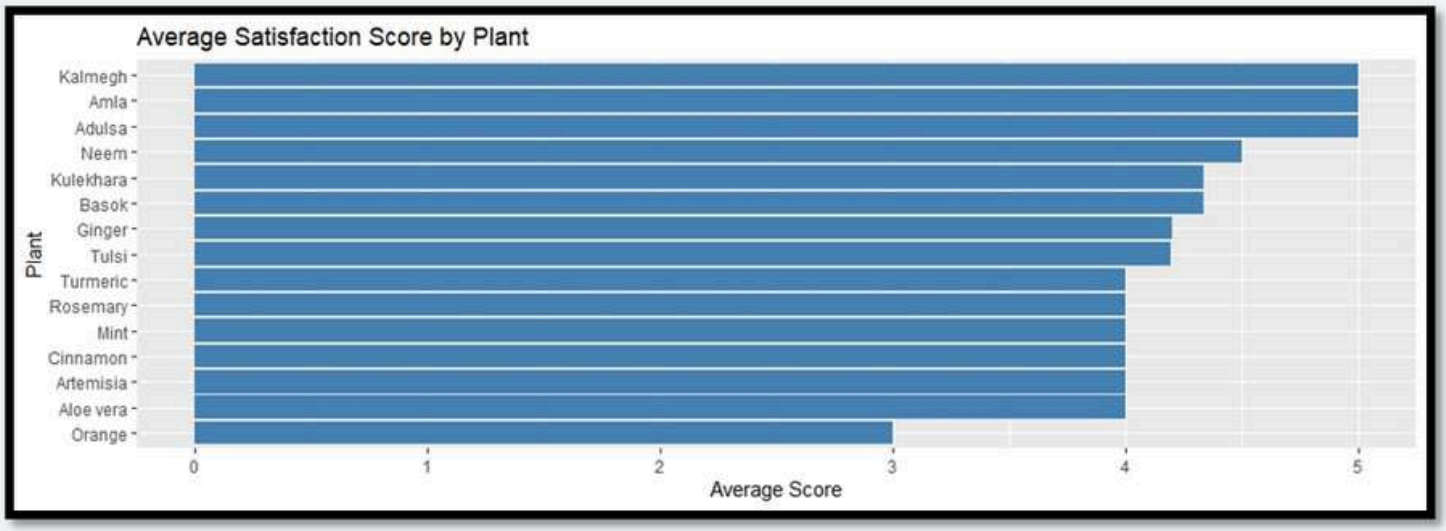

Fig-4: Average satisfaction score by medicinal plants

The visual representation by the above bar graph shows that nearly all the plants have significant impact on symptoms relief, except Artemisia. Although, Ginger, Tulsi and Turmeric have lower proportion as compared to others plants used by the respondents.

E. Satisfaction score and health issues

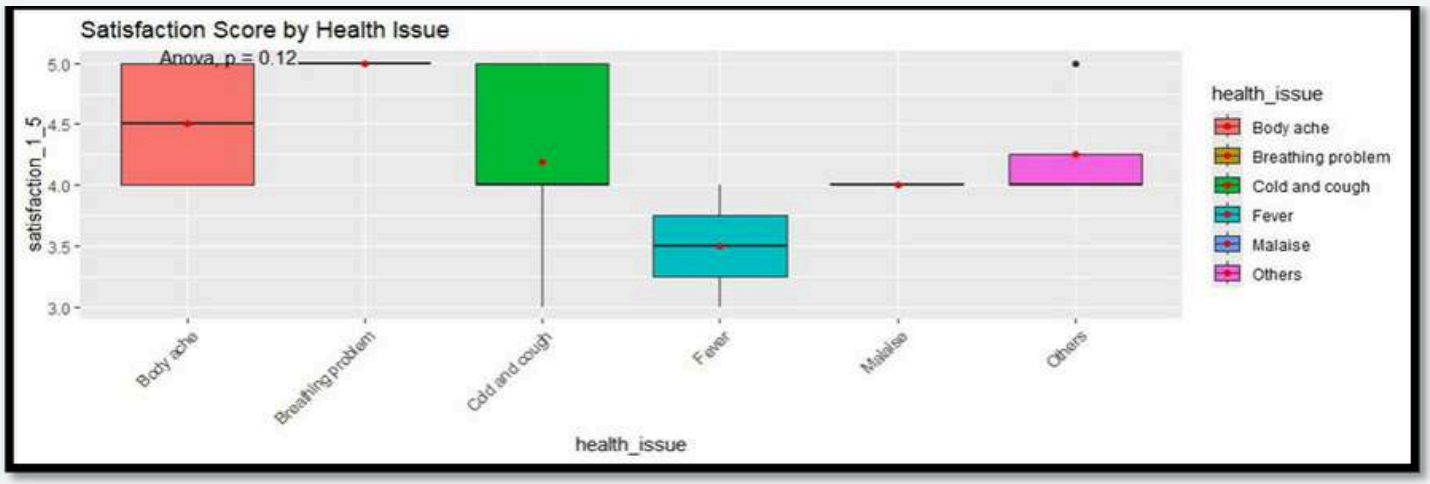

Fig-5: Satisfaction score by health issues

The one-way ANOVA examining the effect of different health issues on satisfaction reveals that the relationship is not statistically significant, with an F-value of 1.851 and a p-value of 0.119. and there is some variation in satisfaction scores across the six health issue categories. Since the p-value is 0.119 ~ 0.12 we fail to reject the null hypothesis at 5% significance error, but can say with 89% confidence indicating that satisfaction levels differ significant weekly across health issue categories.

F. Symptoms relief and plants used

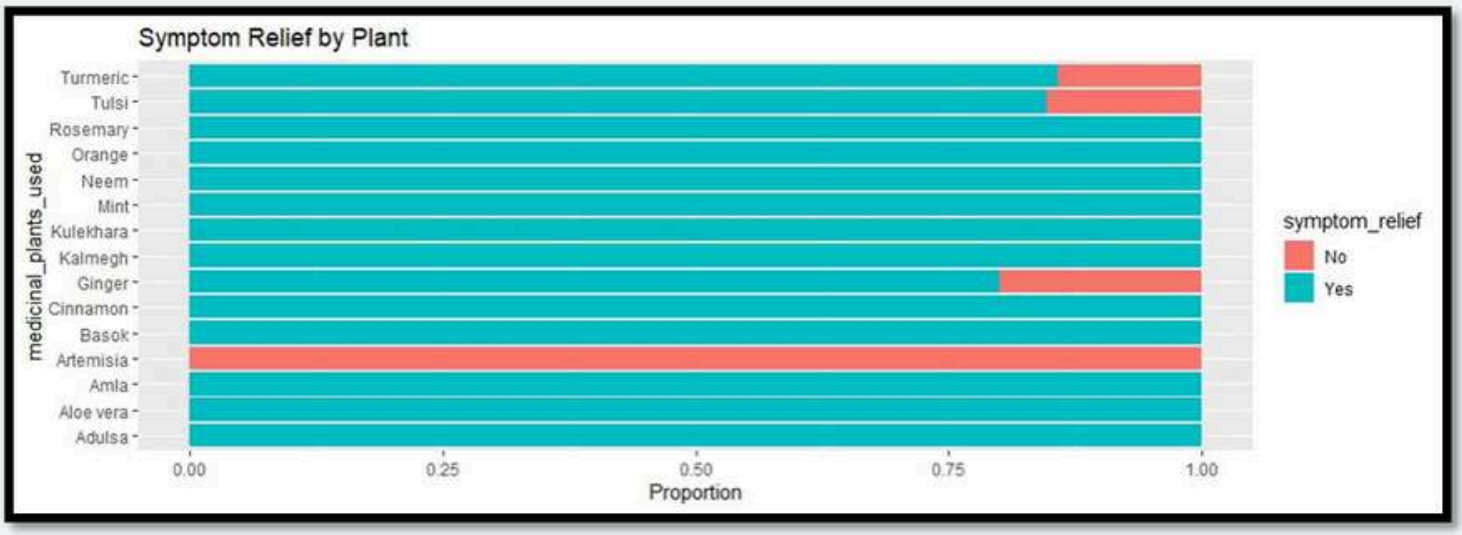

Fig-6: Symptoms relief by plants

Medicinal plants	Satisfaction
Adulsa	5
Aloe Vera	4
Amla	5
Artemisia	4
Basak	4.33
Cinnamon	4
Ginger	4.2
Kalmegh	5
Kulekhara	4.33
Mint	4
Neem	4.5
Orange	3
Rosemary	4
Tulsi	4.19
Turmeric	4

Table-3: Medicinal plats used and satisfaction score

From the above results, it is quite visible that Kalmegh, Adulsa, Amla has highest satisfaction score which is 5 followed by Neem, Kulekhara, Basak and so on. In addition, all the plants which are responded by the participants have more than 3 satisfaction score after use.

G. Frequency of use and Gender

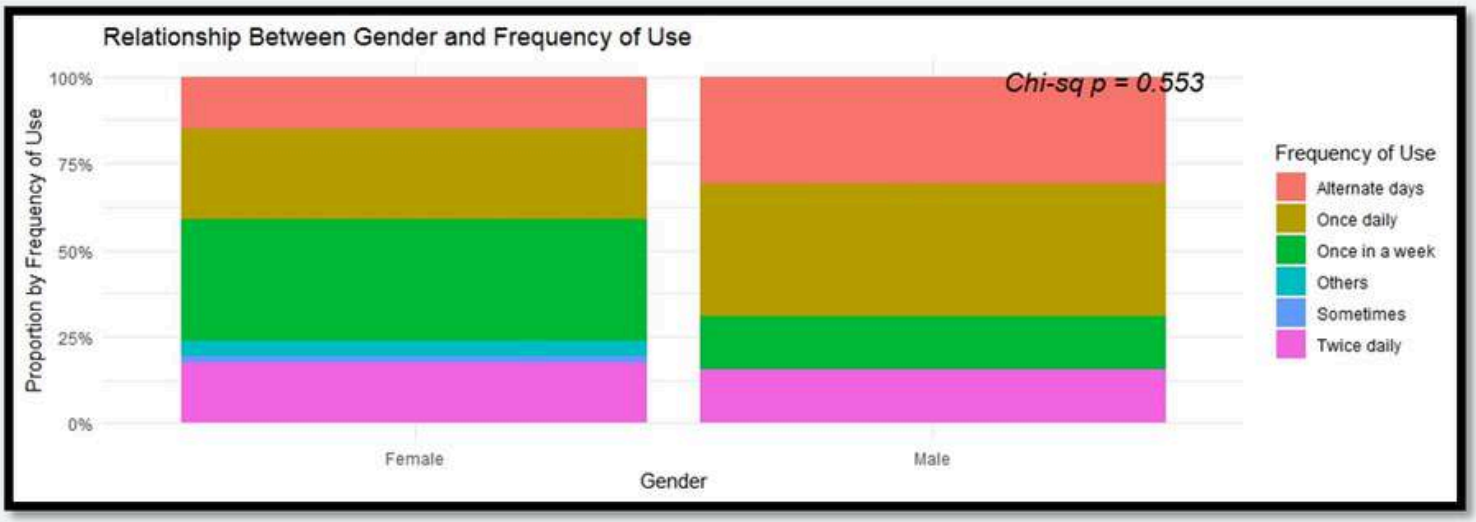

Fig-7: Frequency of use according to Gender

The bar chart and Chi-square test results show that there is no statistically significant relationship between gender and frequency of use. The graph displays the proportional distribution of different usage frequencies (e.g., once daily, twice daily, alternate days) for males and females. Visually, the frequency patterns appear relatively similar between genders, with no clear dominance of any particular frequency among either group. This observation is supported by the Pearson's Chi-squared test, which yields a Chi-square statistic of 3.9755 with 5 degrees of freedom and a p-value of 0.5529. Since the p-value is well above the 0.05 threshold, we fail to reject the null hypothesis, indicating that gender does not significantly influence how frequently the product is used.

H. Symptoms Relief and Form of Use

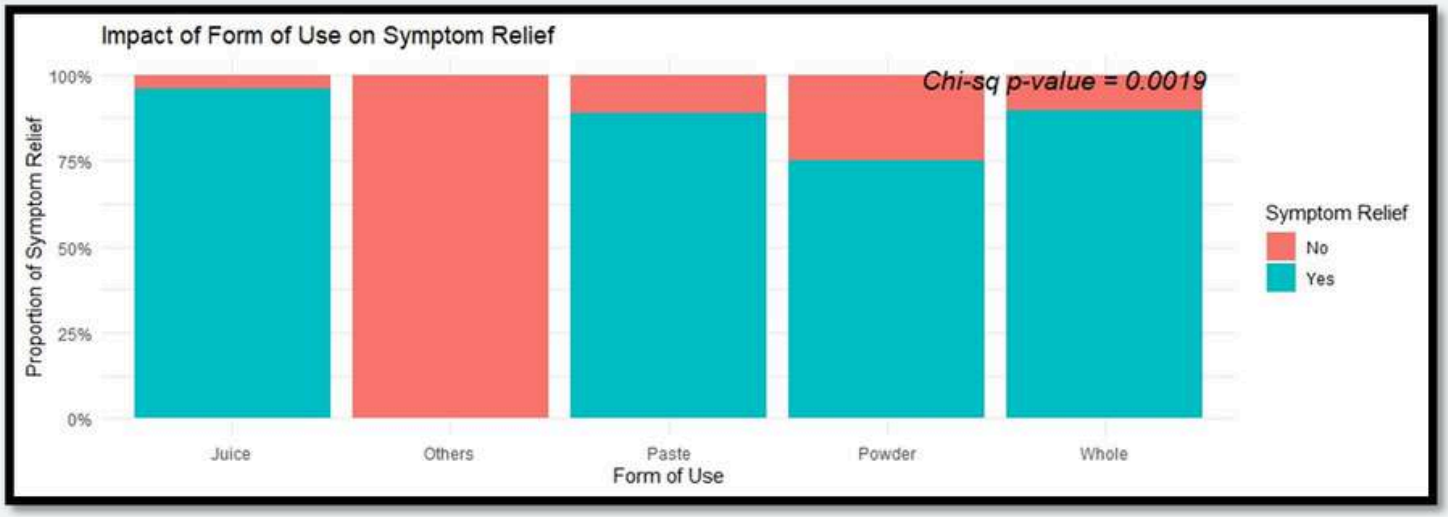

Fig-8: Impact of Form of Use on Symptom Relief

The above proportion of Symptoms Relief Vs Form of use bar graph determines that the maximum yes value in under the Juice category. It prominently indicates that participants who consumed the medicinal plants and herbs in the form of juice get most benefits in terms of Symptom relief.

I. Satisfaction Score and Gender

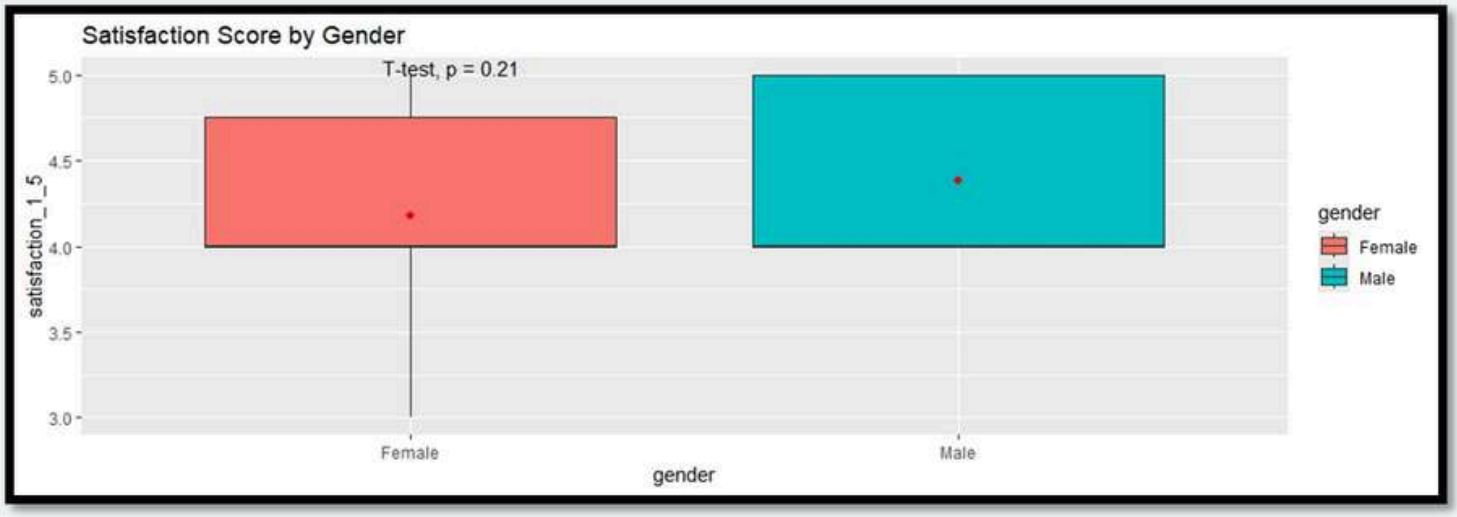

Fig-9: Satisfaction Score by Gender

The above box-plot graph shows that the Male participants have comparatively more mean satisfaction score than females. The Welch Two-Sample t-test comparing satisfaction scores between males and females shows no statistically significant difference, with a t-value of -1.2875, degrees of freedom of 21.393, and a p-value of 0.2117.

J. Medicinal Plants used and Education level

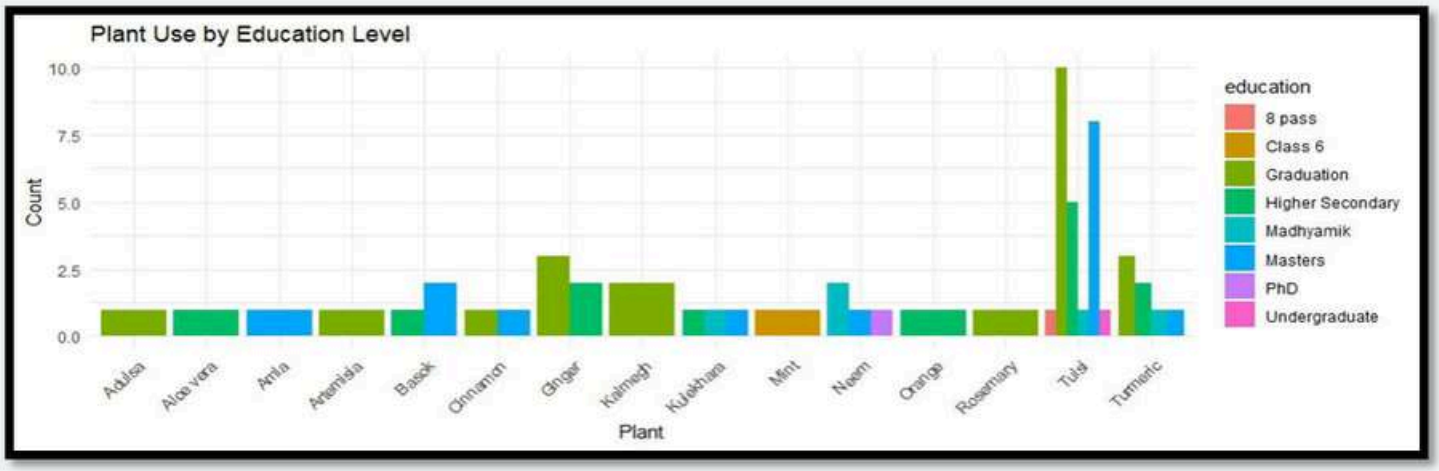

Fig-10: Plants used by Education Level

The Plant used by Education level bar diagram signifies that most participants fall under the graduation level category and they used maximally Tulsi as medicinal plants in post COVID era.

Discussion:

The present study documented the uses of commonly available medicinal plants and herbs in the different regions of West Bengal, India. A total of 15 plant species belonging to different families were reported in this survey and each of the plants have individual potent health benefits which are reported in several studies. It also gives insights on an initial overview on the use of home remedies for treatment and prevention of health issues in post-pandemic period. It has the added benefits in terms of supporting patients to take an active role in their health.

Home remedies are practiced in Indian household over generations resulting in their easy acceptance. The World Health Organization (WHO) considers the Natural and Traditional Medicine, which includes treatment with medicinal plants, as the most natural, safe, effective, and affordable medicine. Home-based treatment is commonly reported response to a wide range of ailments, although very few studies have addressed this health seeking behaviour specially about the practices among Indian households after COVID-19.Turmeric, Ginger and Holy Basil were present in almost all of the home remedies used by the respondents in this study. In the context of respiratory conditions, Zingiber officinale is indicated for common cold and cough. Protective benefits of holy basil and black pepper in COVID-19 have also been elucidated. Use of herbs e.g. Turmeric, Kalmegh, Basak, Neemis considered to act as herbal medicines or supplements, especially are known to possess antioxidant, anti-inflammatory, antiviral properties.

It has also been found by reviewing several journals that the binding of active ingredients presents in different plants used in Kadha preparation with viral proteins and target proteins for prevention and treatment of the COVID-19. Ministry of Ayurveda, Yoga, and Homeopathy (AYUSH), Government of India advocates drinking herbal tea or decoction (kadha) made from Basil, Cinnamon, Black pepper, Dry Ginger and Raisin with natural sugar and fresh lemon juice (optional). Consumption of “Golden Milk” which is turmeric powder in hot milk once or twice a day for boosting immunity and help fight against COVID illness.

A total of 16 species of medicinal plants from different families were documented as being perceived. Among them, the most common families were Lamiaceae, Acanthaceae, Zingiberaceae, Alliaceae, Meliaceae, Lauraceae, Piperaceae, Euphorbiaceae, Asteraceae etc. Out of these most participants use Tulsi which has a highest frequency of 26 followed by Turmeric, Ginger and Neem and so on. Most of the species reported in this study are locally available, home garden species, and used for daily food at home.

From the analysis, it can also conclude that participants who were reporting, use the medicinal plant atleast once in a week. It shows the consistent pattern of consumption. Most plants are used more by those without a COVID history, but some like Turmeric and Adulsa show similar or slightly higher use among those with COVID history. The satisfaction score which are studied against the health issues indicated that people get maximum relief from breathing problem by using the plants .

which was one of the complications of COVID-19. The leaves are the most used parts of the plants and people were mostly consuming it in the form of juice

The mean satisfaction score for males was slightly higher (4.38) than for females (4.17), but the 95% confidence interval for the difference in means (-0.55 to 0.13) includes zero, indicating that the observed difference is not meaningful. Therefore, we conclude that gender does not have a significant effect on satisfaction levels. It has also been reported by the survey that apparently females are consumed these medicinal plants less as compared to males which determines that females often prepare it for the males and other family members but they do not consume it so much

Both males and females report higher satisfaction when symptom relief is experienced, indicating a positive relationship between symptom relief and satisfaction across genders. However, males consistently report higher satisfaction levels than females, both when symptom relief is absent and when it is present. The people with Graduation-level of education were using more plant species compared to people with secondary-level and primary-level education.

The strength of the study is the focus on traditional locally available and acceptable strategies for prevention and possibly treatment of ailments. However, we do realize that the sample size is small and would recommend larger,multicentric studies on the subject to identify the variation in practices and their benefits.

Conclusion:

After the experience of the COVID-19 pandemic, the use of herbal remedies has become increasingly popular in households. Two major factors influencing this trend are the long-standing tradition of Ayurvedic practices and the widespread use of various spices and herbs in Indian cuisine. On the other hand, the survey highlighted that women are often less motivated to take care of their own health, even though they are the ones who prepare these remedies for other family members. This reflects another side of society, where lack of knowledge, awareness, and motivation regarding personal health still persists.

Despite these challenges, the findings emphasize the need for more research to scientifically validate the effectiveness of home remedies derived from medicinal plants and herbs, which are valuable components of our ecosystem due to their sustainability, affordability, and rich phytochemical properties. Therefore, this descriptive survey study provides valuable insights for future research on the household use of medicinal plants and herbs.

Future scopes of the study:

The future prospects for survey-based research on medicinal plants and herbs are vast and encouraging, owing to the worldwide movement toward natural remedies, traditional healing practices, and integrative healthcare approaches. Some are as follows-

- Conduct more meta-analyses focusing on the efficacy, dosage, safety, and therapeutic outcomes of medicinal plants.
- Using larger sample sizes in surveys can enhance the efficiency of research and strengthen the reliability of the evidence.

Acknowledgement:

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Dietary Trends Among University Students: A Comparative Study of Traditional and Modern Eating Habits

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ABSTRACT: This study investigates the comparative dietary patterns, preferences, and nutritional adequacy between traditional and modern eating habits among university students in Hazaribagh, Jharkhand. A cross-sectional survey was conducted among 100 students using structured questionnaires to assess socio-demographic profiles, dietary intake, anthropometric parameters, and health outcomes. The findings revealed that 71% of students preferred traditional diets, characterized by whole grains, seasonal vegetables, and minimal processing, while 29% followed modern dietary trends involving packaged snacks, fast foods, and sugary beverages. Although most respondents maintained a normal BMI (71%), energy and micronutrient deficiencies were observed, particularly among female participants. Statistical analysis using ANOVA showed no significant gender differences in nutrient intake, but overall consumption of energy and iron was below the recommended levels. The study concludes that while traditional diets offer better nutritional balance and cultural value, increasing dependence on modern convenience foods poses emerging health challenges. The findings underscore the importance of nutritional education to promote balanced diets integrating the strengths of both traditional and modern food systems.

INTRODUCTION:

Historically, traditional diets, characterized by a diet abundant in regional and minimally processed foods, have maintained optimal well-being and cultural perpetuity. Westerners of the world today enjoy modern foods that are more convenient and tasty, as well as having consumption patterns influenced by globalisation, industrialisation and food production that tend to be high in refined carbohydrates, trans fatty meals or foods high in sodium. Moving from traditional to contemporary dining habits represents major change, in terms of nutrient provision and diet, especially among youth and university students. University students gain independence and are exposed to different food environments, experimenting with new kinds of food and meal routines. The result is that mainstream meals are being replaced by fast food, soft drinks and canned snacks. This phenomenon, referred to as 'nutrition transition', has been linked to rising levels of obesity, metabolic impairment, and non-communicable diseases (Popkin et al., 2012). Recognition of these changing dietary patterns is necessary to detect health risks and to design prevention programs to change young adults' dietary behaviour.

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Keywords: Traditional diet, Modern diet, University students, Nutrition transition, Dietary habits, BMI, Nutritional assessment

Materials and Methods:

A cross-sectional descriptive study was undertaken among 100 university students aged 19–32 years in Vinoba Bhave University, Hazaribagh. Participants were selected using random sampling. Data collection was conducted through a pretested structured

questionnaire formed into five sections: general information, anthropometric measurements, dietary survey, clinical assessment, and specific questions pertaining to food habits. Anthropometric measures consisted of height, weight, and body mass index (BMI) as per the WHO guidelines. The 24-hour dietary recall procedure was employed to measure daily food intake, while nutrient density calculations were computed using the Indian Food Composition Tables (Gopalan, 2017). Nutrient intakes were compared with ICMR Recommended Dietary Allowances (2020). Minor health problems were diagnosed at the clinical examination, while preference and perceptions on traditional and modern diets were measured through questionnaires. A mean, standard deviation and analysis of variance (ANOVA) were found statistically significant in this study group differences were statistically analysed.

Results:

The demographic analysis revealed that 70% were female and 30% were male, and most of them were between 23-25 years of age. Most (74%) lived in nuclear families and 68% followed non-vegetarian diets. The mean family monthly income was ₹33,000, a measure of middle-income status. Anthropometric results showed that 71% of respondents were normal BMI, 18% underweight, and 10% overweight whereas obesity was comparatively infrequent. Analytical nutritional analysis revealed insufficient caloric intake for both males (1735 kcal/day) and females (1555 kcal/day) compared to their RDAs (2710 and 2130 kcal, respectively). Protein ingestion and fat intake were modestly higher than recommended levels, whereas iron and energy intake were below RDA, especially for female students. ANOVA showed no statistically significant difference in values of male and female intake ($p > 0.05$) of nutrients. While 95% of the participants consumed traditional foods—whole grain, lentils, seasonal vegetables and others—daily consumption of modern foods—packaged snacks and fast foods—was 24%. According to health checks, lethargy (30%) and dehydration (26%) were the most frequent complaints with obesity (9%) and back pain (5%) being reported less often.

Discussion:

The results also indicate that traditional diets still predominate among the students in universities, indicating the perceived cultural and nutritional superiority. But a slow embrace of contemporary fare suggests a continuous diet shift among young people. The low amount of energy intake by participants, although sufficient for protein and fats consumption, indicates underreporting and missing meals due to academic commitments. A related pattern has been found by Tok Chen Yun et al. (2018) and Prabhakaran (2003) who reported that students often skip breakfast and often take processed snacks. The interest in taste and convenience—61% of respondents have opted for modern foods for their flavor—connects with trends in dietary modernisation globally (Al-Otaibi et al., 2017). In contrast, traditional foods were commonly cited as cultural and health motivations. Their diets featured whole grains and seasonal produce, consistent with the findings of

Agrahar and Pal (2005) which highlighted the nutritional value of conventional foods. While the gender differences in nutrient intakes were not statistically significant, lower physical energy consumption and mild iron deficiency was noticed in females, consistent with observations made by WHO (2019) regarding nutrition vulnerability for young adult females. The widespread use of packaged snacks and sugary drinks by students, which are associated with obesity and lifestyle diseases (Hosseini et al., 2021), raises concerns. In the current study's discussion, though, we highlight on the contrary that traditional diet promotes balanced nutrition, but as the food behaviour has been modernised so has the threat of nutrient imbalances in a balanced diet and risk of chronic diseases. This calls for educational and awareness about institutional nutrition programs which promote convenience integrated with nutrition adequacy.

Conclusion:

Traditional diets continue to be better nutritional and more culturally valuable based on the findings, whereas modern diets, although easier to use, may be nutritionally insufficient. Energy and iron deficiencies are an issue, especially in women. Modern dietary practices led by taste, affordability, and accessibility are slowly affecting student health and lifestyle. Nutrition counseling programs focused on eating in moderation that combine traditional knowledge about food with modern lifestyle techniques will help students and university students maintain lifelong health. These strategies are essential for managing health risks and enabling durable eating patterns of the youth population.

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Bridging Health Inequalities Through Public Spending: Pathways to Achieving SDG-3 in India

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ABSTRACT: Persistent inequities in health outcomes and access to care remain a major challenge in India, driven by socioeconomic disparities, geographic divides and gender inequalities. High out-of-pocket expenditure (OOPE) continues to push millions into poverty annually, reflecting inadequate public investment and weak financial protection mechanisms. Strengthening public investment in health care is therefore critical for achieving equity in health status and advancing progress towards Sustainable Development Goal 3 (SDG-3). Enhanced allocation of resources towards infrastructure, human resources, essential supplies and training can improve the accessibility and affordability of quality services, reducing the dependence on private health care. Such investments will not only mitigate catastrophic health spending but also build resilience against future health crises, as highlighted by the COVID-19 pandemic. Equity-focused reformsguided by robust monitoring, evidence-based policymaking and accountabilityare essential to ensure universal health coverage (UHC). A quantum leap in public health spending, with a focus on primary care and risk protection, can bridge systemic gaps, empower vulnerable populations and accelerate India's pathway to SDG-3 by promoting health equity, reducing preventable mortality and ensuring well-being for all.

INTRODUCTION:

India's journey towards achieving Sustainable Development Goal 3 (SDG-3)ensuring healthy lives and promoting well-being for all at all agesis fraught with the persistent challenge of profound health inequalities. Despite significant economic growth, the nation continues to grapple with stark disparities in health outcomes and access to care, driven by socioeconomic status, geography, gender, and caste (Gupta & Ranjan, 2022). The COVID-19 pandemic served as a stark reminder of these deep-seated inequities, exposing the vulnerabilities of a health system characterized by low public investment and high reliance on private, out-of-pocket financing (Gupta, 2020).

A critical barrier to health equity in India is the high level of Out-of-Pocket Expenditure (OOPE) on health. This financial burden pushes millions of households into poverty each year, effectively making healthcare a source of economic hardship rather than a means to well-being (Selvaraj et al., 2021). This situation is a direct consequence of one of the lowest levels of public health spending globally, which hovers around just 1% of GDP, far below the global average and the recommendations of the National Health Policy, 2017 (World Bank, 2022).

The evidence presented by Gupta and Ranjan (2022) highlights how states like Bihar and Uttar Pradesh, with high multidimensional poverty and weak public health infrastructure, bear a disproportionate burden of communicable diseases and face catastrophic health expenditures. In contrast, states like Tamil Nadu and Kerala, with stronger public health systems and higher public spending, demonstrate better health outcomes and

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greater financial protection for their citizens. This inter-state variation underscores that health inequities are not inevitable but are shaped by policy choices, particularly in health financing.

Building on this foundation, this article argues that a quantum leap in public investment in health is the most critical pathway to reducing health inequalities and accelerating progress towards SDG-3. By synthesizing findings from recent literature and integrating the latest data from the National Family Health Survey (NFHS-5) and the National Sample Survey (NSS) on household consumption expenditure, this paper aims to:

1.Document the current state of health inequalities in India.

2.Analyze the burden of out-of-pocket expenditure and its impact on households.

3.Examine the demand and supply-side factors perpetuating health inequities.

4.Propose a concrete set of policy recommendations focused on enhanced, equitable public spending to build a resilient, inclusive, and equitable health system for all Indians.

METHODS AND MATERIALS:

This study is a descriptive analysis based on a comprehensive review of existing literature and secondary data sources. The primary foundation is built upon the critical analysis presented in the works of Gupta and Ranjan (2022) and the conceptual framework of the provided abstract.

To update and upgrade the findings, this paper incorporates the most recent large-scale, nationally representative datasets:

National Family Health Survey-5 (NFHS-5): Conducted between 2019-21, NFHS-5 provides the latest data on key health and demographic indicators, including child mortality, maternal health, nutrition, and access to health services. This allows for a contemporary assessment of health inequalities across states, rural-urban divides, and wealth quintiles (IIPS & ICF, 2021).

National Sample Survey (NSS) 75th Round (2017-18): The survey on "Health Care: Morbidity, Profile of Ailing Persons, Health Care Service Utilisation, and Health Expenditure" provides detailed insights into treatment-seeking behavior and out-of-pocket expenditure (OOPE). This data is crucial for understanding the financial burden of healthcare on Indian households (NSSO, 2019).

National Sample Survey (NSS) 78th Round (2020-21): The "Household Consumption Expenditure Survey" (HCES) data, while primarily focused on consumption, provides context for the relative burden of health spending. Analyzing the share of health in total consumption expenditure helps illustrate the regressive nature of OOPE (NSSO, 2023).

Other Secondary Data: Reports from Niti Aayog (Health Index and Multidimensional Poverty Index), the National Health Accounts (NHA), and the World Bank's Open Data repository are used to supplement the analysis on health financing, infrastructure, and outcomes.

The analysis is structured thematically, moving from documenting inequalities and OOPE to explaining the underlying factors and proposing solutions. The paper deliberately avoids complex regression modeling to maintain accessibility, focusing instead on

descriptive statistics, comparative analysis, and trend examination to present a clear and compelling narrative for policymakers and a broader audience.

FINDINGS:

Health Inequality in India

Health inequalities in India are multifaceted, manifesting across states, between rural and urban areas, and along socioeconomic lines. The latest data confirms that these disparities remain deeply entrenched.

I**nter-State Disparities:** The Niti Aayog Health Index and NFHS-5 data continue to show a wide gap between the empowered action group (EAG) states and the southern states. For instance, the under-five mortality rate (U5MR) in 2019-21 was 42 deaths per 1,000 live births in Bihar and 50 in Uttar Pradesh, compared to just 5 in Kerala (NFHS-5). Similarly, the proportion of children who are stunted (a key indicator of chronic malnutrition) was 43% in Bihar and 39% in Uttar Pradesh, against only 23% in Kerala and 25% in Tamil Nadu (NFHS-5).

Rural-Urban and Socioeconomic Divides: Within states, rural areas consistently fare worse. NFHS-5 data shows that the neonatal mortality rate is 10 points higher in rural areas (28) than in urban areas (18). Furthermore, a stark wealth gradient exists for nearly every health indicator. The poorest wealth quintile has an under-five mortality rate of 50, compared to 20 for the richest quintile. Similarly, the prevalence of stunting is 41% among the poorest, compared to 22% among the richest (NFHS-5). This indicates that a child's survival and growth prospects are heavily influenced by the economic status of the household they are born into.

The Disease Burden Divide: As highlighted by Gupta and Ranjan (2022), the disease profile itself is a marker of inequality. While non-communicable diseases (NCDs) are rising nationwide, states with higher poverty levels continue to shoulder a "double burden." The EAG states still face a significant burden from communicable, maternal, neonatal, and nutritional diseases, while states like Kerala and Tamil Nadu are dealing predominantly with NCDs. This implies that the health systems in poorer states must simultaneously combat infectious diseases and the growing challenge of NCDs, stretching their already limited resources.

State	Under-Five Mortality Rate (per 1000 live births)	Stunting (%) Children under 5	Women (15-49 years) with Anaemia (%)	Institutional Births (%)
Bihar	42	43	69	84
Uttar Pradesh	50	39	52	89
Madhya Pradesh	56	36	57	89
Tamil Nadu	19	25	55	99
Kerala	5	23	37	100
India	32	36	57	89

Table 1 (Select Health Indicators across States (NFHS-5, 2019-21)

Source: IIPS & ICF (2021). *National Family Health Survey-5*

Out of Pocket Expenditure for Health Service

Out-of-pocket expenditure remains the dominant mode of health financing in India, acting as a primary driver of health-induced poverty. The NSS 75th Round data reveals that OOPE accounts for about 48% of the total health expenditure in India (NHA, 2019-20), one of the highest shares in the world.

The Burden of Hospitalization: The financial shock is most acute during hospitalization. As Gupta and Ranjan (2022) illustrated, a significant majority of hospitalizations, even among the poor, occur in the more expensive private sector. The average medical expenditure per hospitalization case in a private hospital (₹31,845) was over four times that in a public hospital (₹7,210) (NSS 75th Round). This forces households to borrow money or sell assets to cover medical costs.

The Regressive Nature of OOPE: The burden of OOPE is not borne equally. Lower-income households spend a much larger share of their total consumption on healthcare than richer households, making it a highly regressive form of financing. Analysis of NSS data shows that the share of health in total household consumption expenditure is highest for the poorest quintile. While the absolute amount spent by the rich may be higher, as a proportion of their income or consumption, it is the poor who are crushed under the weight of health expenses.

This phenomenon is exacerbated by the low levels of health insurance coverage. Despite schemes like Ayushman Bharat PM-JAY, a large proportion of the population, particularly in EAG states, remains without any form of financial protection. Gupta and Ranjan (2022) showed that in states like Bihar and Uttar Pradesh, over 98% of the rural population reported having no health coverage in 2017-18, leaving them fully exposed to financial risk from health shocks.

3c. Factors Affecting Demand and Supply of Health Care

The persistence of high OOPE and health inequalities can be traced to a complex interplay of demand and supply-side factors within the health system.

Supply-Side Constraints: The Weak Public Sector

1.Inadequate Infrastructure and Human Resources: The shortfall in public health facilities and personnel, especially in EAG states, is a critical supply-side failure. The Rural Health Statistics (2019-20) report, as cited by Gupta and Ranjan (2022), showed massive deficits in Sub-Centres, Primary Health Centres, and Community Health Centres in Bihar and Uttar Pradesh, while Tamil Nadu had a surplus. There is also a severe shortage of doctors, specialists, and nurses in the public sector, particularly in rural areas. This lack of accessible and functional public facilities pushes people toward the costlier private sector.

2.Low Public Health Spending: The root cause of these infrastructure and personnel gaps is the chronically low level of public investment in health. As shown in Table 2, India's government health spending as a percentage of GDP is among the lowest in the world, even compared to its lower-middle-income peers.

Weak Primary Care and Public Health Focus: Public spending is also skewed towards curative services in urban hospitals, neglecting primary healthcare

Country / Group	Domestic General Government Health Expenditure (% of GDP)	Country / Group	Domestic General Government Health Expenditure (% of GDP)
High-income countries (average)	7.7	Thailand	2.7
Lower-middle-income countries (average)	1.5	China	3.0
India	1.0	Sri Lanka	1.9

Table 2 (Comparative Government Health Expenditure (2019))

Source: World Bank Open Data (2022)

and public health services like disease surveillance, sanitation, and health promotion. This is evident in the minuscule per capita spending on the public health component in states like Bihar (₹9) and Uttar Pradesh (₹17) compared to Tamil Nadu (₹55) (Gupta & Ranjan, 2022). This neglect makes it harder to prevent diseases, especially communicable ones, which disproportionately affect the poor.

DEMAND -SIDE BARRIERS:

1.Poverty and Indirect Costs: Even when public services are available and nominally free, the poor face significant indirect costs. These include loss of wages for the patient and accompanying family members, transportation costs to often distant facilities, and the cost of medicines not available in the facility's pharmacy. For a daily wage laborer, a day spent at a clinic means a day without income, creating a powerful disincentive to seek timely care.

2.Perceived Quality of Care: The perception that private providers offer better quality, more attentive care, and greater availability of drugs and diagnostics is a major driver of demand for private services, even among the poor (Vaidyanathan et al., 2022). Long waiting times, absenteeism of staff, and sometimes discourteous behavior in public facilities further erode trust and drive people towards private options, despite the high cost.

This combination of an underfunded, unreliable public supply and demand-side barriers rooted in poverty and perceptions creates a vicious cycle where households are forced into high OOPE, perpetuating poverty and inequality.

What to Do for Reducing Health Inequalities

The evidence unequivocally points to the need for a fundamental shift in India's health financing policy. Incremental changes are insufficient; a "quantum jump" in public investment is required to break the cycle of inequality and OOPE. The following multi-pronged approach is essential:

Substantially Increase Public Health Spending: The central recommendation is to increase government health expenditure to at least 2.5% of GDP by 2025, with a clear roadmap to reach 3.5% by 2030. This increase must be shared equitably between the central and state governments. The additional funds should be strategically invested in:

- Strengthening Primary Health Care (PHC): Following the Tamil Nadu model, resources must be channeled to revitalize the grassroots-level Health and Wellness Centres (HWCs) under Ayushman

Bharat. This includes ensuring adequate infrastructure, a full complement of trained personnel (doctors, nurses, community health officers), and a regular supply of essential medicines and diagnostics (Parthasarathi & Sinha, 2016).

- Bridging the Human Resource Gap: A massive, planned recruitment drive for doctors, specialists, and nurses in underserved areas is needed. This should be complemented by investments in medical and nursing education to increase the overall supply.

- Boosting Public Health Functions: A significant portion of the new funding must be earmarked for public health. This includes strengthening disease surveillance systems, laboratories, health promotion, and infection control —all critical for preventing and managing outbreaks and reducing the burden of communicable diseases.

2.Deepen and Strengthen Financial Protection: While Ayushman Bharat PM-JAY is a step in the right direction, its coverage needs to be expanded to move closer to true universality. More importantly, the scheme's focus should be expanded beyond secondary and tertiary care hospitalization to include outpatient care, which constitutes a large share of OOPE, and essential medicines. The goal should be to create a seamless system of pre-paid, pooled financing that minimizes direct payments at the point of service.

Prioritize Equity in Resource Allocation: Central government allocations to states through the National Health Mission (NHM) and other schemes should be explicitly needs-based, factoring in state-level disease burden, poverty levels, and health infrastructure gaps. This would . ensure that high-focus states like Bihar and Uttar Pradesh receive the additional support they need to catch up.

4.Improve Governance and Accountability: Increased spending alone is not enough. Mechanisms for transparency and accountability must be strengthened. This includes:

- Social Audits: Involving community-based organizations in monitoring the performance and quality of local public health facilities.

- Performance-Based Financing: Linking a portion of fund transfers to states and facilities to the achievement of predefined health outcome and equity targets.

- Data-Driven Decision Making: Regularly using data from NFHS, NSS, and administrative systems to identify gaps, monitor progress, and course-correct policies.

5. Conclusion and Recommendations

Health inequalities in India are a moral and economic crisis that undermines the nation's development and the well-being of its people. The COVID-19 pandemic has made it undeniably clear that a weak, underfunded, and inequitable health system is a threat to national security and prosperity. The high levels of out-of-pocket expenditure are both a cause and a consequence of this inequality, trapping millions in a cycle of poverty and ill-health.

The findings of this paper, consistent with Gupta and Ranjan (2022) and updated with the latest data, lead to an inescapable conclusion: India must make a massive, sustained, and equitable public investment in its health system. This is not merely a health sector issue but a fundamental prerequisite for achieving SDG-3 and inclusive growth.

Key Recommendations:

- Commit to a Quantum Jump in Funding: The Union and State governments must commit to a time-bound plan to raise public health expenditure to at least 2.5% of GDP by 2025 and 3.5% by 2030.
- Focus on the Foundations: The primary investment should be in strengthening the public primary care system (Health and Wellness Centres), ensuring they are fully functional, staffed, and stocked. This is the most equitable and efficient way to deliver care.
- Protect the Poor from Financial Ruin: Expand and deepen health insurance coverage to include outpatient services and drugs, and work towards a single-payer model that minimizes out-of-pocket payments for all, especially the most vulnerable.
- Target Resources Equitably: Direct a larger share of central funds to states with the highest burden of disease and poverty to reduce inter-state disparities.
- Foster Accountability: Implement robust monitoring systems and social accountability mechanisms to ensure that increased funding translates into better-quality services and improved health outcomes for all, leaving no one behind.

By taking these bold steps, India can transform its health system from a source of impoverishment and inequality into a pillar of resilience, equity, and shared prosperity. The path to SDG-3 is paved with public investment in health.

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A review on Origin of Life, our Existence

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ABSTRACT: Biology, perhaps consists of various interesting topics that involves our quest for existance, our origin to our present day survival through various processes of evolution and adaptive nature. This review articleinvolves a very fundamental but interesting part of life science of secondary education standard involving the origin of our life. It involves an overview of a stepwise progress of life on earth, various theories came out with time and research, the importance of evolution to adaptability for survival. Several hypothesis and theories are involved to justify the existence of living beings on cooling earth, the chemical , biochemical, biophysical and biological composition of a particle, their reactions to build new substance and thus building support system to each living origin and it is still an ongoing process with innumerable changes happening each moment.

INTRODUCTION:

Life's origins lay millions of years ago on Earth and living beings such as humans are found throughout the globe. The genesis of life is mostly a mystery since it can't actually be seen and evidence is few and far between, mostly consisting of fossils inside old rocks, that are often incomplete, illegible, or incomprehensible. Therefore researchers have proposed countless hypotheses over the years that account for the inception of life.

The Origin of Life Hypotheses:

Long before the Ancient and medieval beliefs. To the earliest humans, a process of spiritual rebirth and social rebirth.

1.1 Theory of Special Creation: This ancient hypothesis believes that an all-powerful entity created the entire living plant and all living animals. Key aspects include:

· Current living forms were all supernatural created by some supernatural force.

· The environments were a basis for the design of these organisms.

· They've been unchanged since their Pinception. For example, the biblical "Genesis" gives six days of creation:

· Day 1: Heaven and Earth.

· Day 2: Sky and Sea.

· Day 3: Dry land and Plants.

· Day 4: Sun, Moon and Stars.

· Day 5: Fish and Birds.

Day 6: Animals, humans and all animals; animals include people.

1.2 Theory of Catastrophism: On the basis of this thought, it suggests that Earth has had its own series of cataclysmic accidents after which God created new life—similar to the special creation thesis.

1.3 Theory of Panspermia (extraterrestrial origin of life): Among the theories developed on ancient Greek philosophy theory that is probably the closest analogy of life to the Special Creation hypothesis: Life, as thought, is continuous throughout the universe. Some evidence for this theory is:

· Meteorite fossil of microorganisms (1961).

· Fossils found in Mars rock.

· Liquid water detected in Europa's icy surface. Research suggests bacteria can

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survive space travel and thrive in harsh environments.

Directed Panspermia: Reanimated by Francis Crick and Leslie Orgel for the first time, this theory believes that, over a billion years ago, the world's most advanced species of extraterrestrial civilizations actively seeded other worlds with microorganisms. Supporting panspermia theory, they pointed to two biological anomalies: genetic codes and the place of molybdenum in biological systems.

1.5 Theory of Spontaneous Generation (Abiogenesis): Until the seventeenth century, it was commonly thought that living organisms could emerge from non-living matter. Prominent proponents were Empedocles, Anaximander, Xenophanes, and Aristotle.

1.6 Theory of Biogenesis: That life arises solely from life not from other biological components as proposed by abiogenesis. As Redi, Spallanzani, and Pasteur showed in experiments, microscopic organisms derive from the world around them.

Modern Hypothesis about the Origin or Biochemical Origin of Life on Earth. Modern theory was put into theory by Haeckel; he proposed that primitive organisms essentially originated spontaneously out of inorganic matter through specific outside physical forces such as electric charges or ultraviolet light. Scientists like Haldane and A.I. Oparin pioneered ground-breaking work that helped establish such a framework.

2.1 Origin of Universe (Big Bang Hypothesis): The Big Bang Hypothesis was introduced by Abbe Lemaître, Gamow and Dicke, 20 billion years ago, it was proposed that the universe was a concentrated gaseous cloud called primaeval matter made primarily of particles that collided and merged and formed hydrogen atoms that later fused to form heavier elements during a powerful expansion called the Big Bang.

2.2 Origin of Solar System: A lot of theories are out there about why Our Solar System was created, some of them are yet entirely satisfactory and some of them are incomplete, but also have no sufficient details, and five theories stand out.

- Accretion Theory.
- Protoplanet Theory.
- Capture Theory.
- Modern Laplacian Theory.
- Modern Nebular Theory.

According to Kant's nebular hypothesis conceived (alongside Laplace's ideas) five to six billion years ago, our Solar System grew out of a massive spinning cloud filled with cosmic dust, a cosmic gas, and a strong gravitational field, followed by a solar explosion and nuclear events that would illuminate the cosmos.

2.3 Earth's Origin: When nebulae rotated, the periphery formed planets such as Mercury and Neptune, all hot with the initial hot planets in a single space, cooled to stratified phases (and by density) over millions of years consisting of: i) forming of the core from planetesimals rich in iron ii) Formation of mantle from silicate-rich planetesimals. iii) Formation of crust from siliceous planetesimals. iv) Development within the atmosphere through volatile-rich accretion. v) Water reaching Earth via ice–laden planetesimals on the one side (while lightest gases escaped), forming a markedly different atmosphere than our own—Earth's current position around

148 million kilometers from the Sun has a diameter of some 12,735 kilometers weighing about (6 \times 10^{12}) tonnes.

2.4 Biochemical or Chemosynthetic Origin (Naturalistic/Oparin-Haldane Theory): Oparin joined Haldane with the view that life started to emerge three-and-a-half billion years ago when organic compounds entered Earth's rudimentary oceans via chemical interactions acting first under reducing atmospheric conditions through energy sources such as sunlight, then through volcanic activity when the gases emitted through the processes were vastly different from the conditions we are currently experiencing—they argued spontaneous generation could not have been an option at present, but could have certainly been possible in earlier situations, if the species could react with chemical evolution during long-term processes, which eventually yielded self-replicating entities like what we have nowadays known as eobionts (proto-cells with protobiontal growth) or protobionts with cellular organization, that can be found in various organisms such as prokaryotes evolving into eukaryotes that later divide into multicellular structures, thereby contributing to biodiversity we see today. [8].

· As atoms cooled down together, solidified into inorganic molecules.

· That molecule reacted giving rise to simple organic compounds: sugars and amino acids.

· Further interactions resulted in the formation of intricately organic compounds, which eventually combined to form aggregates called coacervates with the ability to grow/divide, shaped by nucleic acids acting as ribozymes catalysing essential biochemical processes supporting simple life systems evolving by diversified mechanisms into autotrophic ones and encouraging wide phylogenetic lines visible today in various ecological systems of the world. [7][8].

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Unlocking The Flavours And Nutrition of Mukhwas: Preparation And Evaluation

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ABSTRACT: Seeds are potent nutritional sources that offer significant therapeutic and preventive health benefits. This research explores the medicinal properties of six nutrient-rich seeds - watermelon, pumpkin, muskmelon, sunflower, flax, and sesame - incorporated into mukhwas, a modern twist on the traditional Indian mouth freshener. Each seed contains distinct bioactive compounds, such as lignans, omega-3 fatty acids, and phytosterols, which exhibit antioxidant, anti-inflammatory, cholesterol-lowering, and anticancer properties. These properties contribute to enhanced cardiovascular, liver, kidney, metabolic, and neurological systems. Incorporating these seeds into mukhwas not only boosts its taste and appeal but also redefines it as a functional food that bolsters overall health. By combining traditional culinary knowledge with modern nutritional science, this study highlights the potential of seed-based innovations to promote sustainable and health-conscious eating habits.

INTRODUCTION:

Mukhwas, a classic Indian post-meal breath refresher, can be considered not only as a healthy and tasty cultural creation, but also a nutritional one. As a ritual of food, it is very popular and highly recommended, since it helps the process of digestion, it freshens the breath and it brings to the client a feeling of satisfaction and joy as the end of the meal with a harmonious mix of seeds such as watermelon, pumpkin, muskmelon, sunflower, flax, sesame seeds, and herbs. Every seed is loaded with a variety of minerals and vitamins that result in a very tasty snack that supports digestive metabolism, antioxidant balance, and overall fitness. For ages, seeds were considered to be the life power of the future—small storages of sustenance and healing potential. Today science also confirms this view by calling seeds nutrient-dense suppliers of essential fatty acids, amino acids, dietary fiber, and phytochemicals with preventive medicinal properties. The rise of functional foods has turned the spotlight on edible seeds not only as gastronomic resources but also as a panacea for the regulation of chronic diseases. Mukhwas, infused with nutrient-rich seeds like watermelon, pumpkin, and sesame, bridge traditional knowledge and modern science, unlocking their collective potential for enhanced well-being.

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Watermelon seeds (Citrullus lanatus) isan abundant source of antioxidants, amino acids, and micronutrients. The main components responsible for their therapeutic activities include bioactive compounds like citrulline, lycopene, and phenolics. Various studies have proven these seeds to be beneficial for blood sugar and lipid levels control, thereby improving the state of diabetes and dyslipidemia coexisting patients and at the same time reducing oxidative stress in the liver tissues. Besides, the consumption of watermelon seed extracts is good for cardiovascular and

Keywords: mukhwas , watermelon seeds, pumpkin seeds, flaxseeds, antioxidants, bioactive compounds

renal health as a result of the improvement of the endothelial function, which leads to better blood vessel dilation and lower hypertension risk. It is further to the neuroprotective activities of arginine and lycopene that the seeds have the potential to fight against oxidative stress which is the major cause of neurodegenerative diseases such as Parkinson's and Alzheimer's.[1]

Pumpkin seeds (Cucurbita pepo) containphenolic compounds, tocopherols, sterols, and cucurbitacins. These bioactive compounds, apart from neutralizing oxidative stress, also regulate the anti-inflammatory process through the production of anti-inflammatory mediators and thus demonstrate anti-proliferative activity in the cancer cells, mainly in the breast, prostate, and colon, by apoptosis induction and angiogenesis inhibition. Their cardiovascular potential is pointed out by their cholesterol-lowering, lipid-peroxidation-preventing, and atherosclerosis-inhibiting properties. The European Medicines Agency has recognized pumpkin seeds due to their zinc and phytosterol content as a source that can be used for the treatment of benign prostatic hyperplasia. Besides this, extracts provide anti-diabetic, antidepressant, and neuroprotective effects through the enhancement of insulin sensitivity and serotonin metabolism. Similarly, their iron-rich nature makes them a perfect source of iron deficiency prevention, i.e., anaemia, particularly in the at-risk population.[2]

Muskmelon seeds (Cucumis melo) are loaded with an extremely wide spectrum of bioactive compounds that grant them. anti-inflammatory, analgesic, and antibacterial properties. These seeds aid in the reduction of swelling, relieving of oxidative distress, and the inhibition of ulcer formation through protection of the gastric mucosa against stress and medication-induced damage. The beneficial effects of the seeds also reach the lipid profile enhancement, thyroid activity regulation, and anti-diabetic mechanism support. Flavonoids and phenolic acids present in muskmelon seeds contribute to the complete inactivation of free radicals, prevention of DNA damage, and arrest of neoplastic proliferation. Thus, they represent an important resource in the treatment of inflammation, dyslipidemia, and metabolic disorders .[3]

Sunflower seeds (Helianthus annuus) are loaded with phenolic antioxidants such as chlorogenic, caffeic, and ferulic acids, which are very effective in neutralizing free radicals and strengthening the body's defence system against oxidative stress. Consuming the seeds on a regular basis will, therefore, increase the body's defence mechanism, slow down the aging process of cells, and protect the heart tissues. Besides that, their capability to protect fats from peroxidation makes sunflower seeds a potential source of food stability and shelf-life extension. These nutritive and functional characteristics make sunflower seeds indispensable in modern diets targeted at lifestyle-related diseases and long life.[4]

One of the major reasons that flaxseed (Linum usitatissimum) has been extensively researched is that it is a significant source of alpha-linolenic acid (ALA), lignans, and soluble fibre. These three components, in their cooperation, reduce the inflammation, stabilize the

heartbeat, and prevent atherosclerosis. Studies with ALA, which is an omega-3 fatty acid, have demonstrated that it can protect the heart and lower the blood pressure, while lignans—after being converted in the gut to enterodiol and enterolactone—may release hormones and fight cancer, mainly against hormone-dependent cancers, such as breast cancer and prostate cancer.The capability of flaxseed to regulate blood sugar, enhance lipid metabolism, and relieve mood changes is, therefore, a manifestation of its totalizing effect on the cardiovascular, metabolic, and nervous system health.[5]

Sesame seeds (Sesamum indicum) have been one of the top natural sources of lignans in traditional medicines for a very long time. The lignans isolated from sesame include sesamin, sesamolin, and sesamol. These organic compounds promote the activity of antioxidant enzymes that are naturally produced in the body, reduce the oxidative stress, and improve the lipid regulation. Among their cardiovascular beneficial effects, they include normalization of blood pressure, cholesterol lowering, and better endothelial function. Besides, sesame lignans exert potent anti-hyperglycemic and anti-metastatic effects by regulating apoptotic and metabolic pathways. In addition, some metabolites such as enterodiol and enterolactone originated from sesamin have protective roles against hormone-related cancers. Therefore, a regular consumption of sesame seeds supports metabolic stability and provides the body with antioxidants on a cellular level for a long time.[6]

Fennel seeds (Foeniculum vulgare Mill.) are essential elements in both Ayurvedic and Mediterranean Herbal Systems.Fennel seeds, consisting of the three major compounds such as anethole, fenchone, and estragole, are the most widely accepted to have carminative, antispasmodic, and antimicrobial effects., They are said to fix the digestive system by mending abdominal distension, gas, and indigestion, and also, their very slight estrogenic-like nature can be used for lactation and menstrual discomfort alleviation., Several scientific investigations have proven that the seeds have antidiabetic, hypolipidemic, and hepatoprotective effects, leading to the promotion of cardiovascular and hepatic health when combined. Moreover, the seeds can be the origin of a natural anxiolytic and memory enhancer, along with the metabolic advantages. Besides, they have anti-cancer potential as they inhibit carcinogenic signalling pathways, hence, turning them into a perfect wellness enhancer.[7]

Almonds (Prunus dulcis) are a plant-based food that is often confused for a seed. However, they are nutritionally similar to seeds and are highly prized for their therapeutic range. Almonds contain fibre, unsaturated fatty acids, polyphenols, magnesium, and vitamin E, all of which work together to improve lipid profiles, lower LDL cholesterol, and promote vascular health. Immune system-supporting and antioxidant properties are also involved in the process, whereby almond consumption revives the endothelial function and hampers oxidative deterioration. Among the various health benefits that have been associated with the consumption of these nuts, one that research has singled

out as being the most interesting is the role that almonds have in the improvement of insulin sensitivity, glycemia control, and satiety promotion which leads to weight management. Consequently, almonds have a beneficial impact on cardiovascular, metabolic, and neurological health, making them one of the most potent functional foods.[8]

Coriander seeds (Coriandrum sativum L.) are one of the most aromatic and most medicinally rich seeds in the world. In the past, they were mainly used for treating digestive disorders like diarrhoea, flatulence, and loss of appetite, but as per modern phytochemical research, linalool, flavonoids, and phenolics are the major compounds that regulate various bioactivities such as antioxidant, antibacterial, antidiabetic, and hypolipidemic ones. These effects result in better cardiovascular and metabolic functions, thus making coriander a dietary ingredient not only delicious but also beneficial as a preventive nutrition agent.[9]

Essentially, the makeup of mukhwas mirrors the union of taste, heritage, and science. Combining different seeds endowed with bio-functional characteristics, it thus becomes a cooling agent after a heavy meal as well as a simple way to convey health promotion and disease prophylaxis to the general body system. The blend of watermelon, pumpkin, muskmelon, sunflower, flax, sesame, fennel, almonds, and coriander seeds provides a wealth of antioxidants, polyphenols, essential fatty acids, lignans, and dietary fibers, which, when taken together, enhance digestion, metabolism, circulation, and immunity. Such a physiological synergy is an acknowledgment of the mounting scientific evidence behind the enormous therapeutic potential of traditional diet practices in the context of modern dietary therapeutics. As functional nutrition keeps on spotlighting natural sources of health, mukhwas can be considered a heritage food of India conserved in the lifestyle of the ancestors and thus a resolution to how simple daily habits, if they are rooted in nature and science, can have an unexpected, deep impact on health and life span.

METHODOLOGY:

Mukhwas Formulation (Product Modulation)

Mukhwas (mouth freshener) was formulated by combining five primary seeds, one pulse, one spice, and an almond for garnishing, based on a literature review focusing on high nutritive value and local market availability. The final proportion of ingredients for a single batch is detailed at Table 1 below.

Method of Preparation:

Roasting: All seeds (Watermelon, Pumpkin, Muskmelon, Sunflower, Flax, and Sesame) were roasted individually for a duration of 2 minutes at a controlled temperature range of 200 – 250°C.

Ingredient Preparation:

The almonds were chopped and were not subjected to the roasting process. The Indoori Sauf, Dal, and Almonds were processed according to standard preparation methods.

Note: All seeds utilized were commercially packed, though traditional cleaning and extraction methods are recognised.

Ingredient	Quantity (g)
Watermelon Seeds	13.12
Pumpkin seeds	13.12
Muskmelon seeds	13.12
Sunflower seeds	13.12
Flaxseeds	13.12
Almonds	2.89
Indoori sauf (Fennel seeds)	5.25
White sesame seeds	6.57
Black sesame seeds	6.57
Dal (roasted split coriander seeds)	13.12
Total	100

Table 1: Ingredient Proportion and Composition of Mukhwas

Mixing and Storage: All prepared ingredients were thoroughly mixed. The final Mukhwas product was stored in an air-tight container, maintaining a shelf-life of up to 6 months.

Nutritive value and RDA calculations:
The final nutritive value of all the seed combinations for 100g was calculated from the IFCT values, which are based on the ingredients used in each of the combinations. RDA for reference was taken from the recommended dietary allowances and estimated average requirements nutrient requirements for Indians – 2020 (ICMR-NIN).

RESULTS AND DISCUSSION
Table 2 below depicts the nutrient content of mukhwas prepared by the ingredients mentioned above. The Mukhwas mix that has been developed productively has accomplished the goal of a nutrient-dense functional food. The mix is likely to deliver substantial amounts of macronutrients per 100 g serving, with energy and protein being the most significant source.The increase in energy and protein is due to the incorporation of nutrient-dense seeds.

The high caloric density is basically due to the healthy unsaturated fats and protein (from seeds and almonds), thus, it is an awesome food that can be used in the battle against energy-protein malnutrition and the caloric intake is quality-driven at the same time.

Ingredients	Amount (g)	Proteins (g)	Fats (g)	Carbohydrate (g)	Energy (Kcal)
Watermelon seeds	13.12	4.47	6.9	0.59	82.39
Pumpkin seeds	13.12	3.28	5.9	1.312	72.16
Muskmelon seeds	13.12	3.28	5.25	1.968	59.04
Sunflower seeds	13.12	3.09	6.80	0.899	76.92
Flaxseeds	13.12	2.49	5.64	3.936	70.06
Almonds	2.89	0.52	1.69	0.088	17.606
Indoori sauf (Fennel seeds)	5.25	0.8295	0.78	2.746	18.11
White sesame seeds	6.57	1.183	3.28	1.577	37.449
Black sesame seeds	6.57	1.183	3.28	1.577	37.449
Total	**100**	2.624	2.624	4.33	52.48

Table 2: Nutrient Content of Mukhwas

CONCLUSION:

One of the main points in the discussion of the Mukhwas mix was actually its extremely dense bioactive compound profile. The mix is very rich with a large number of antioxidants (lignans from sesame/flax, Vitamin E from sunflower/almonds) and along with that, it contains essential omega-3 fatty acids (from flaxseed). A chemical composition of this sort positions the product as a potential one in the area of anti-inflammatory and cholesterol-lowering diseases.

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Application of Nutrigenomics among South Asian Population

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ABSTRACT: Background: Nutrigenomics is the study of how genetic variation affects nutrient processing and individual responses to diet. It helps link genetics to nutrition science. Despite the increase in interest around the globe, there has been very limited study concerning nutritional genetics in South Asian populations.
Objective: Using genome-wide association data, we aimed to identify genetic variants associated with the perception and metabolism of vitamins A, B9, C, and D in multiple South Asian populations.
Methods: The genetic variants related to the perception of taste were collected from the GWAS catalogue. Vitamin-related SNPs were extracted from the IEU Open GWAS database. We obtained allele frequencies from the GenomeAsia 100k Project dataset consisting of 1163 individuals with diverse ethnicity. We use Linux, Python, and R for filtering data, removing linked variants, and visualized MAF using heatmaps and bubble plots.
Results: Significant variations in MAFs across populations were observed. Among the SNPs contributing to taste perception, higher frequencies of rs2708377, linked to caffeine bitterness, and rs10987993 for taste sensitivity were observed in Yoruba and Chakma. Vitamin A metabolic SNPs like rs4856602 and rs9833333 had a higher MAF in the Munda and Parsi, respectively. Likewise, several vitamin B9-associated SNPs such as rs11751024 and rs1806558 had a higher frequency in the Irula and Parsi, respectively, indicating population-specific variation in folate metabolism. Vitamin C and D metabolic pathways also showed distinct allele frequency patterns, with Parsi and Tanti being the most variable populations, indicating adaptation to differential processing of these micronutrients.
Conclusion: The conclusions of the study were drawn on genetic variations associated with nutrient processing and taste perception in South Asians. The results support the use of genetic knowledge in targeted dietary and nutritional recommendations for populations at risk.

INTRODUCTION:

Nutrigenomics is a developing field which studies the relationship of diet and the human genome to health status and disease risk. It is related to nutrigenetics by investigating how genetic differences affect nutrient absorption, metabolism, and use. SNPs account for more than 90% of human genetic variation and are a major determining factor in the individualization of nutrient needs and taste sensitivity.

Most GWAS conducted so far have been in European-ancestry populations, which seriously limits the generalization of genetic findings into Asian settings. Therefore, the GenomeAsia 100k Project provides the much-needed platform for in-depth exploration of Asian genomes. GenomeAsia100K Consortium, 2019 Studying genetic variations among South Asians-who consume a wide range of diets and represent diverse cultures-allows for very important insights into tailored nutrition and disease prevention.

The aim of this study is to give an overview of the genetic variants in taste perception and vitamins A, B9, C, and D

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metabolism associated with South Asian populations using the GWAS and GenomeAsia datasets and lay the foundation for culturally appropriate nutrition genomics.

2. Materials and Methods

2.1 Data Collection

Genetic variants associated with taste perception were extracted from the GWAS catalog (GO_0050909). Variants related to metabolism of vitamins A, B9, C, and D were derived from the IEU Open GWAS database (ukb-b datasets).

We used the Genome Asia 100k dataset, consisting of genotypes for 1163 individuals from 68 Asian and global populations, including, but not limited to, representatives of PAR, TNT, IRU, MUN, and ABM, to provide population-specific minor allele frequencies.

2.2 Data Processing and Analysis

Processing of all genomic data was performed in a Linux environment. Filtration of the VCF files, using command-line tools, was performed to get the relevant SNPs, followed by removal of linked variants at $r^2 < 0.2$. Overlapping SNPs between vitamin-related variants and Genome Asia were identified using Python scripts. Population-level MAFs were computed using PLINK v1.9. We created heatmaps and bubble plots in R and Python that visually display the processed data, reflecting the MAF distribution among the populations.

2.3 Visualization

Each cell in the heatmaps was color-coded from blue, representing MAF = 0, to red, representing MAF = 1. Bubble plots of allele frequency and population variation: the size of each bubble corresponds to MAF.

3. Results and Discussion

3.1 Genetic Variation in Taste Perception

Populations with a minor allele frequency (MAF) of 0, shown by blue cells in the heatmap and small blue dots in the bubble plot, are likely more sensitive to taste. Conversely, those with MAF = 1 (red cells and large red bubbles) may have genetic variants that diminish their taste perception (**Figure 1A and 1B**).

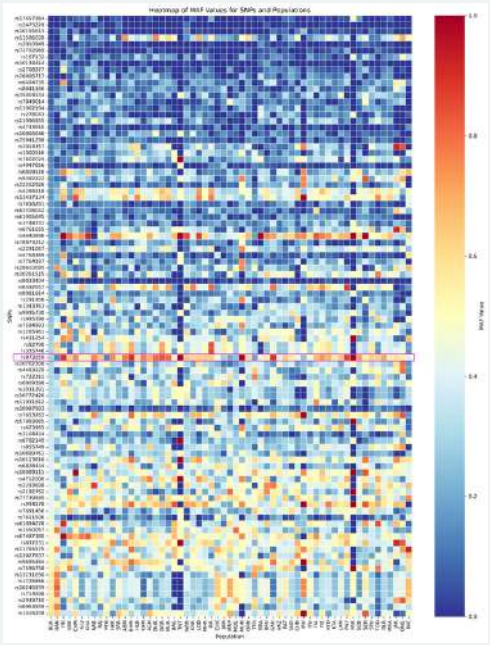

Figure 1A: Heatmap of Minor Allele Frequencies (MAF) for SNPs associated with taste perception

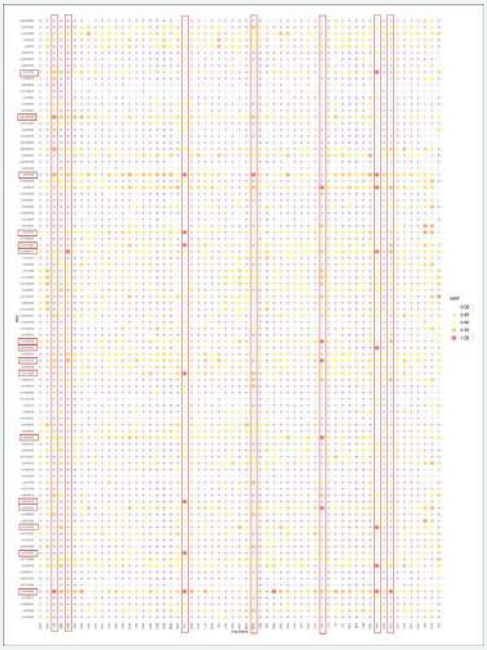

Figure 1B: Bubble plot illustrating SNP distribution across populations.

Overall, the analysis revealed that most populations had MAF values below 0.5, except for Yoruba (YRI) and Chakma (CHK), where MAF exceeded 0.5 for rs2708377 and rs10987993, respectively—variants linked to bitterness perception and taste sensitivity, with rs2708377 notably associated with reduced sensitivity to caffeine bitterness. Several SNPs related to bitter or sweet taste perception, such as rs11996955, rs3748731, rs8081814, rs17457384, and rs278043, showed low MAF (< 0.5) in nearly all populations, except Nababuddha (NAB) and Parsi (PAR). Likewise, SNPs influencing perception of glucose (rs4947856), sucrose (rs78873212), and aspartame (rs11062194, rs72702969, rs2010949), among others, displayed similarly low MAF values. Interestingly, rs873259, associated with bitter taste perception of 6-n-propylthiouracil, exhibited MAF > 0.5 in most populations but was lower in groups such as Burusho (BUR), Han (HAN), and Irula (IRU). Complete fixation (MAF = 1) was observed for rs7602024 and rs6782149 in Tanti (TNT), while rs10089111 reached MAF = 1 in Chamar (CHM) and Parsi (PAR); the latter also showed full fixation for additional SNPs linked to sweet and bitter taste perception (rs7596758, rs994178, rs2192762, rs57083985, rs431254, rs4440846). Notably, Irula individuals exhibited MAF = 1 for several sweetness-related variants (rs1416208, rs9685484, rs994178, rs7653262, rs13437134). In summary, TNT and PAR populations demonstrated the greatest variability, with several loci showing complete or partial fixation (MAF = 1 or 0.5), suggesting possible reduced taste sensitivity, whereas YRI and CHK, with predominantly low MAF values, may retain stronger taste perception abilities.

3.2 Vitamin A–Related SNPs

Populations with a minor allele frequency (MAF) of 0, represented by blue regions in the heatmap and small blue dots in the bubble plot, appear to efficiently metabolize, absorb, or utilize vitamin A, while those with MAF = 1 (shown in red with large red bubbles) may possess genetic variants that reduce their capacity to process this nutrient (Figure 2A and 2B).

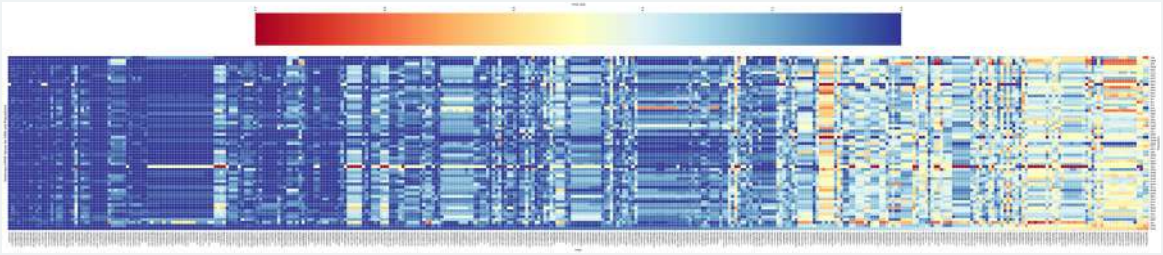

Figure 2A: Heatmap of MAF for Vitamin A-related SNPs.

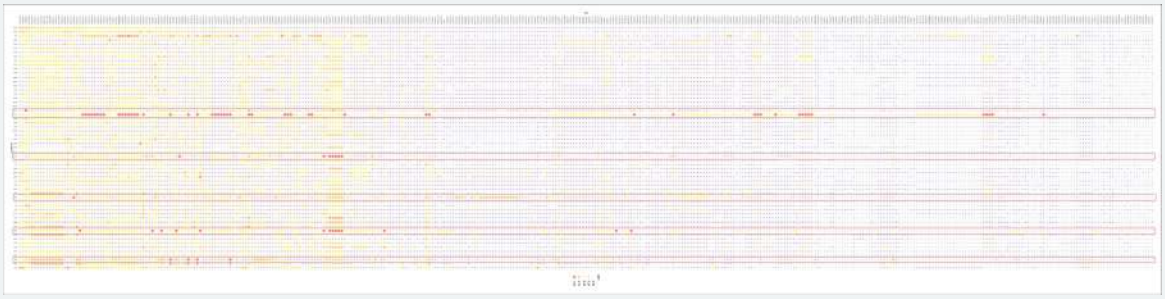

Figure 2B: Bubble plot showing population variability.

Analysis of vitamin A–associated SNPs revealed distinct population-specific patterns. The Bagdi (BAG) group displayed a complete fixation (MAF = 1) for rs10468837, whereas in the Irula (IRU) population, rs10794994 showed MAF = 1. The Munda (MUN) population exhibited MAF = 1 for multiple SNPs, including rs2630720, rs4856602, rs7623577, rs6548682, rs9833333, rs13069950, and rs502095, all of which are linked to impaired vitamin A metabolism. Notably, both MUN and Parsi (PAR) populations shared high MAF values for these same SNPs, suggesting a strong association with reduced vitamin A absorption or utilization efficiency in these groups. In contrast, most SNPs in the PAR population showed MAF = 0, except for rs35491970, rs73963238, rs4979799, rs4856602, rs7623577, rs6548682, rs9833333, rs13069950, rs502095, rs272706, rs2912466, rs2976474, rs1484220, and rs12421923, which had MAF = 1. The Harijan (HAR) population displayed MAF = 1 for only four SNPs—rs2014208, rs13193745, rs742787, and rs6905445—while the Tanti (TNT) population exhibited the greatest diversity, with numerous SNPs showing fixation (MAF = 1). Among globally compared groups such as GBR, IRU, ONG, and YRI, most SNPs—including rs4889874, rs12214063, rs3857547, and others—had MAF < 0.5, indicating a relatively efficient vitamin A metabolic capacity. Interestingly, rs4856602 had MAF > 0.5 in most populations but remained below 0.5 or intermediate (0.5) in others such as Burusho (BRU), Han (HAN), Yoruba (YRI), Gujjar (KHA), Tamil (SZH), and several South Indian and tribal groups. These findings collectively highlight substantial inter-population variability in genetic determinants of vitamin A metabolism across South Asian and global populations.

3.3 Vitamin B9–Related SNPs

Populations exhibiting a minor allele frequency (MAF) of 0, represented in blue on the heatmap and by small blue dots on the bubble plot, appear to efficiently metabolize, absorb, or utilize vitamin B9, while those with MAF = 1 (shown in red with large red bubbles) may possess genetic variants that reduce their ability to process folate effectively (Figure 3A and 3B).

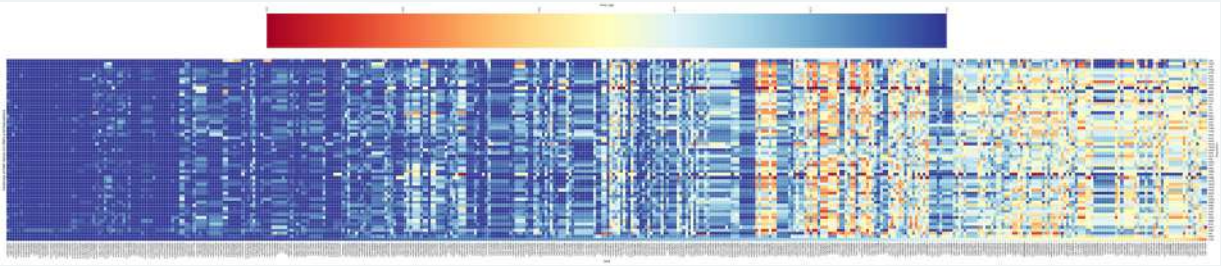

Figure 3A: Heatmap showing MAF for folate-related SNPs.

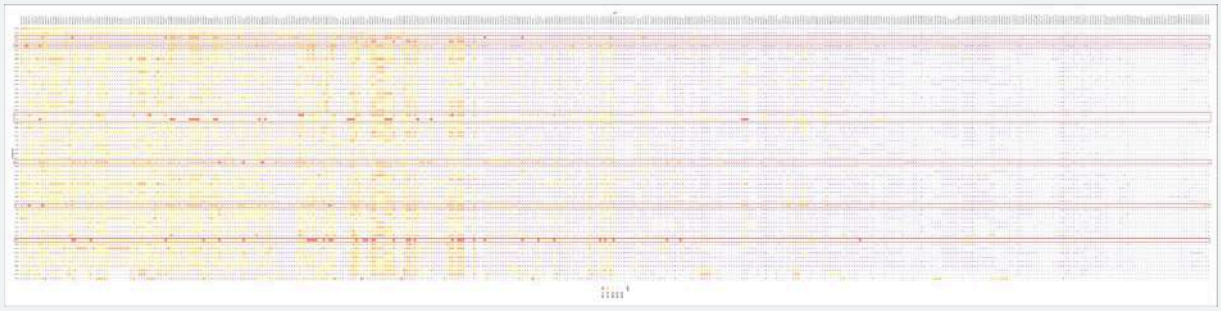

Figure 3B: Bubble plot illustrating inter-population variability.

The analysis revealed considerable inter-population variation in SNP distribution. Most populations displayed MAF values below 0.5, with exceptions such as Irula (IRU) showing higher MAF (>0.5) for rs117580883 and Nicobarese (NIC) for rs35486885, rs34710970, and related loci. Certain populations exhibited unique allele patterns: Yoruba (YRI) had elevated MAF for rs10243698, while Onge (ONG) showed higher MAF for rs78950827. Specific variants such as rs3104375 displayed MAF > 0.5 in Bison Horn Maria (BHM) but remained low elsewhere. Complete fixation (MAF = 1) was observed for rs17666735 exclusively in the Parsi (PAR) population, whereas most other groups, including Han (HAN), YRI, and Irula (IRU), exhibited MAF = 0. Similarly, SNPs rs67913607 and rs13153101 were below 0.5 in most groups except HillKorwa (HKR), IRU, Tanti (TNT), and Gaud (GAU), with TNT showing full fixation (MAF = 1). Variants such as rs11751024 demonstrated MAF > 0.5 in multiple populations, reaching 1.0 in both IRU and PAR, whereas NIC, Munda (MUN), and TNT displayed MAF = 0. Additional polymorphisms, including rs11047523, rs396090, and rs408036, were fixed (MAF = 1) in PAR and MUN, while rs1806558 and rs937878 exhibited MAF = 1 in YRI and PAR but 0 in IRU and TNT. BAG showed complete fixation for rs9268399, rs9268497, and rs9389055, while rs9273524 was fixed in Chamar (CHM) and absent in Paniya (PNY). Interestingly, IRU displayed MAF = 1 for rs1914184 and rs11158802, indicating localized variation in folate metabolism genes. Overall, the Parsi population exhibited the highest number of SNPs with MAF = 1, encompassing a wide range of variants (rs17666735, rs2582294, rs775150, rs10771099, rs6457617, among others), suggesting a strong predisposition toward reduced vitamin B9 metabolism efficiency. In contrast, the Tanti population displayed numerous SNPs with MAF = 0, implying a relatively better capacity for folate utilization. These patterns underscore significant genetic heterogeneity in folate metabolism across South Asian and neighboring populations, reflecting both evolutionary adaptation and dietary influences.

3.4 Vitamin C–Related SNPs

Populations with a minor allele frequency (MAF) of 0, shown in blue on the heatmap and as small blue dots on the bubble plot, appear to efficiently metabolize, absorb, or utilize vitamin C, whereas those with MAF = 1 (depicted in red with large red bubbles) may carry genetic variants that hinder vitamin C processing (Figure 4A and 4B).

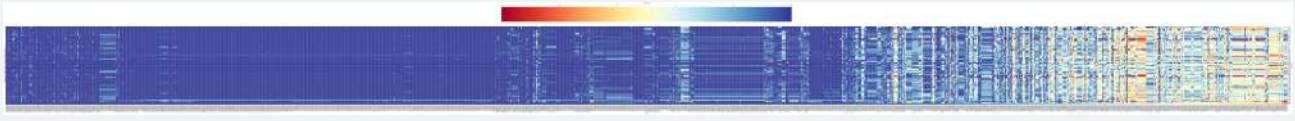

Figure 4A: Heatmap of MAF for vitamin C–related SNPs.

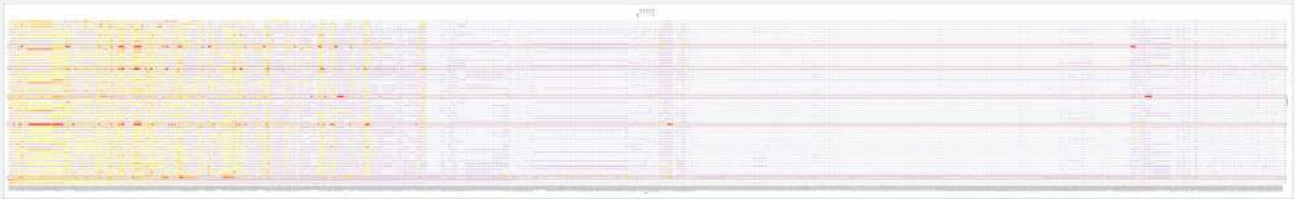

Figure 4B: Bubble plot of allele frequencies across populations.

Across the analyzed SNPs, distinct inter-population variations were observed. The SNP rs376020100 displayed MAF = 0 across all groups, suggesting a uniformly strong capacity to metabolize vitamin C. Most populations showed MAF < 0.5 for key variants such as rs3104375, rs10811067, rs12927834, and rs3131064, except for isolated cases in BisonHornMaria (BHM), Han (HAN), Hazara (HAZ), and Irula (IRU), respectively. Several SNPs, including rs115645447, rs7619966, and rs6763186, exhibited MAF < 0.5 across all populations except Munda (MUN), indicating potential population-specific allele enrichment. A few variants such as rs12518236 and rs3130477 were elevated only in Parsi (PAR) and Nicobarese (NIC) groups. Notably, South Indian (SZH), Toda (TOD), and Toto (TTO) populations showed MAF > 0.5 for select variants like rs11779480, rs11799609, and rs79785052. In contrast, Yoruba (YRI) had higher frequencies for rs9467704 and related variants. Complete fixation (MAF = 1) was recorded for multiple SNPs (rs13119490, rs4696295, rs13147021, among others) in IRU, PAR, and Tanti (TNT), suggesting impaired vitamin C metabolism in these groups. Similarly, rs4403404 and rs10803130 were fixed in Chamar (CHM) and IRU, while rs2362142 and rs12460838 reached MAF = 1 in IRU and PAR. Several other SNPs (rs7973986, rs4691382, rs1593357) showed fixation in MUN, PAR, and TNT, highlighting region-specific genomic variation. Interestingly, YRI and PAR shared complete fixation for variants such as rs10946808 and rs9358913, whereas Nicobarese (NIC), Paniya (PNY), and TNT displayed MAF = 0 for these same SNPs. The Munda group showed extensive fixation across numerous loci, while PAR exhibited a broader spectrum of high-MAF variants —including rs7713825, rs7220662, and rs811041—many of which were absent (MAF = 0) in other populations like TNT, PNY, and NIC. Conversely, TNT displayed fixation for a distinct set of variants (rs1902983, rs11748440, rs2952140, etc.) that were absent in PAR, MUN, and IRU. Overall, the TNT population demonstrated the highest number of SNPs with MAF = 1, implying greater difficulty in metabolizing vitamin C, while PAR showed predominantly low MAF values, indicating more efficient vitamin C utilization across a wide range of loci.

3.5 Vitamin D–Related SNPs

Populations with a minor allele frequency (MAF) of 0, represented in blue on the heatmap and as small blue dots on the bubble plot, appear to efficiently metabolize, absorb, or utilize vitamin D, while those with MAF = 1 (depicted in red with large red bubbles) may harbor genetic variants that impair vitamin D processing (Figure 5A and 5B).

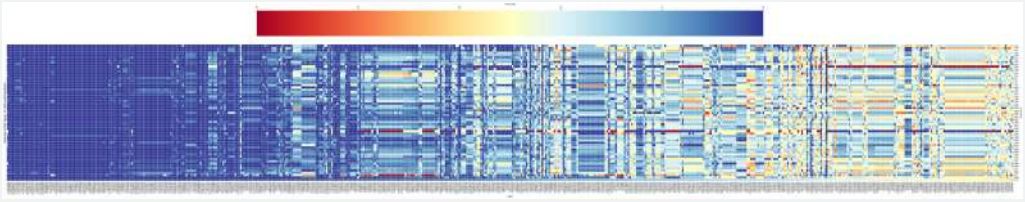

Figure 5A: Heatmap of MAF for vitamin D–related SNPs.

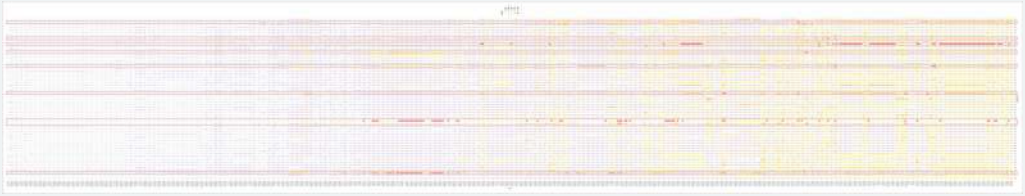

Figure 5B: Bubble plot showing population-level variation.

Across the dataset, SNPs such as rs4911389, rs4911394, rs1007090, rs2284379, rs6059639, and rs4911401 displayed MAF < 0.5 in all populations except Irula (IRU), indicating greater metabolic efficiency in most groups. Notable exceptions included rs10899605, where only Onge (ONG) exhibited MAF < 0.5, and rs28493499, where South Indian (SZH) populations showed a similar pattern. Variants rs67721434 and rs4712230 had low MAFs in all populations except Yoruba (YRI). Interestingly, rs1141362 and rs11839342 showed complete fixation (MAF = 1) in IRU and Parsi (PAR), suggesting potential limitations in vitamin D metabolism. The SNP rs14151 demonstrated widespread variation, with 29 populations showing MAF > 0.5, 23 populations below 0.5, and seven displaying intermediate values (MAF = 0.5); complete fixation was observed only in IRU and Tanti (TNT). Similarly, rs9312257 exhibited MAF = 1 in Kota (KTA) and Bagdi (BAG) but MAF = 0 in Chamar (CHM), PAR, and TNT, underscoring population-specific allele distribution. Munda (MUN) populations displayed fixation for rs10948033, rs60640681, rs12147186, rs28488425, and rs10741228, several of which were also fixed in TNT but absent (MAF = 0) in PAR, highlighting contrasting genetic profiles. Parsi populations exhibited the highest number of high-MAF variants (e.g., rs1552759, rs17410853, rs6791062, rs6442055, rs11923706), while TNT showed complementary fixation patterns, with 68 SNPs at MAF = 1 and many of these completely absent (MAF = 0) in PAR. Shared fixation of rs11068518 was observed in PAR, SZH, and TNT, while variants like rs11899456 and rs9511682 were fixed in PAR and TNT but absent in SZH. Other noteworthy loci included rs1377630 (MAF = 1 in TNT and BAG) and rs6827541, where YRI displayed fixation but PAR, SZH, ONG, and others showed MAF = 0. Similarly, rs4421020 was fixed in YRI and TNT but absent in PAR, Nicobarese (NIC), and Toto (TTO). Collectively, PAR, TNT, and YRI exhibited the highest degree of variability in MAF patterns. TNT, in particular, showed the greatest number of SNPs with MAF = 1, indicating potential genetic limitations in vitamin D metabolism, while PAR exhibited a broader spectrum with several SNPs at MAF = 0, reflecting comparatively efficient vitamin D utilization in certain loci.

3.6 Integrative Insights

Overall, the study underscores pronounced nutrigenomic heterogeneity among South Asians. Populations such as Parsi and Tanti demonstrate contrasting genetic tendencies—one toward reduced micronutrient metabolism and the other toward efficiency. These findings can inform targeted dietary recommendations, reinforcing the role of genomics in personalized nutrition and preventive healthcare.

3.7. Limitations

The present study utilized publicly available genomic datasets to investigate genetic variants associated with taste perception and vitamin metabolism across diverse populations. While these findings provide valuable insights into inter-population variability, they are based solely on secondary data and therefore warrant further validation. To achieve a more precise understanding of intra-population genetic diversity, future research in our laboratory will incorporate genotype data from real individuals. This expansion will enable a more accurate assessment of local population variation, helping to establish a clearer link between genetic polymorphisms, nutrient metabolism, and personalized dietary recommendations.

4. Conclusion

This study provides the first comparative nutrigenomic assessment of South Asian populations using publicly available GWAS and GenomeAsia data. The observed diversity in taste receptor and vitamin-related SNP frequencies emphasizes the need for population-specific dietary guidelines. Integration of nutrigenomic insights with public health nutrition policies could significantly enhance outcomes in regions with heterogeneous genetic structures like South Asia.

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Declarations:
Funding: No external funding was received for this study.
Conflicts of Interest: The authors declare no conflict of interest.
Ethical Approval: Not applicable (data derived from public repositories).
Data Availability: All datasets used in this study are publicly available via GWAS Catalog and GenomeAsia 100k Project.
Author Contributions:
I.F. – Data analysis, visualization, manuscript drafting.
R.D. – Conceptualization, supervision, review, and editing.

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From Bakehouse to Teatable: A History of the Origin and Development of the Biscuit

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ABSTRACT: This paper follows the chronological development of the biscuit since it was first experimented as a temperature gauge of ovens and how it developed to become a ubiquitous part of tea consumption today. The analysis of how the metamorphosis of a previously luxurious European snack into a daily consumption item in India reflects the overall trends in cultural contact and acculturation builds on the history of the culinary and the colonial exchange as well as the industrialization. The article places the history of biscuits in the international and local setting, relating ancient Iranian honeyed cookies, the traditions of the sea- voyages, the innovations of the war, and the Indian entrepreneurship in the end of the nineteenth century, therefore, creating a cross-cultural account of technological and culinary transformation.

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Keywords: the history of biscuits, globalization of culinary, ANZAC biscuit, colonial food culture, Indian industries, tea culture

INTRODUCTION:

Breaking tea into a daily ritual has become a byword in the major part of the world and in South Asia, predominantly, one does not feel having finished a cup of tea without its close companion, the biscuit. However, the story of the biscuit is much older and more complicated than the way in which it as become popular today suggests. The current research aims to look at the origin, development, and cultural path of this biscuit, since an experiment in the oven, to becoming a world staple food (Toussaint_-Samat, 2009).

EARLY ORIGINS :

The very first predecessor of the contemporary biscuit was not meant to be eaten. In the early European kitchen, Each time bakers used small amounts of the cake batter to test if the oven had enough heat to bake the cake (Toussaint - Samat, 2009). These early experiment pieces are considered by food historians to be the earliest biscuits. Gradually, these practices became unique culinary traditions which stressed on fast, hardy, and movable foods. Closely connected with biscuits are cookies- sweeter and softer versions of cookies. The difference between the two is mainly in terms of texture and concentration of moisture as the biscuits are crisp and firm as compared to cookies that are soft and moist. The Romans can also be said to have invented the early baked grain products; although the introduction of sugar basically changed the way this had been done (Mintz et al., 1985).

THE CASE OF THE SUGAR AND THE IRANIAN RELATIONSHIP :

The Iranian version of the sweetened version of the biscuit or cookie was the product of the introduction of sugar in Iran by the Indian subcontinent. Whereas the traditional sweetener was honey, sugar came in as a source of novel cuisine. It is even said that Alexander the great was captivated by the taste of sugarcane in India and thus helped to grow Iran (Mintz et al., 1985; Toussaint-Samat, 2009).

Out of this exchange emerged a confectionery based on sugar; the main consumer of this consisted of the upper classes. It is evident that Renaissance and Early Modern Europe are often considered synonymous as one and the same.Renaissance and Early Modern Europe Renaissance and Early Modern Europe are terms that are commonly used interchangeably. In the late sixteenth century, production of biscuits is already seen in evidence in the form of the Thomas Dawson in his The Good Housewife Jewel (1596) which contained a recipe of spiced biscuits (Dawson et al., 1596). Many renaissance cookbooks included cookie-like recipes with mixture of flour, egg yolk, butter, clove and nutmeg, which were baked on parchment papers. The recipes further affected the American culture in baking because as the European settlers crossed the Atlantic, they brought with them the recipes (Toussaint-Samat, n.d.).

SEA AND AIR ADOPTIONS:

Biscuits acquired a new significance as long-haul seafare because it became commonplace to have biscuits as a long journey food. Its durability, portability and simplicity in making it made the shelf life of sailors and explorers worthless without it (Toussaint-Samat, 2009). They were the predecessors of the hard tack biscuits that were transported on the European vessels. One of the major changes was experienced during the First World War (1914-1918). The women of Australian and New Zealand Army Corps (ANZAC) came up with a new type of biscuit made of flour, water and dried fruits. These cookies were tough, durable, and very nutritious; perfect in the case of soldiers who are stuck overseas. The ANZAC biscuit therefore symbolizes a loss of home ingenuity in regards to the need of the industrial warfare (Mintz et al.,1985).

THE BISCUIT IN COLONIAL AND POST COLONIAL INDIA:

India commercial manufacturing of the biscuits started late in the nineteenth century. Prior to this, the biscuits were considered as a European food, which was rarely eaten by Indians. And the increasing popularity of tea a colonial import, established a cultural niche of the cookie (Toussaintoup datu,2009). Tea stores became social and economic commodities as tea and cookies became identified. A light bulb can be seen in the work of two Bengali entrepreneurs, Philanthropy of the Newspaper enjoyed in at least one publication, Anandabazar Patrika (October 9, 1925): In 1897, two Bengali gentlemen at Calcutta decided to make cookies using machine labor. In keeping with this decision, they put up a factory in Dum Dum as biscuit factory whose name was V.M.Brothers. Up to that point, the biscuits were considered the preserve of the Europeans and the Anglo-Indians; the locals did not specifically like them especially. These two gentlemen can thus be considered people who have initiated the popularisation of this healthy food amongst Indians. They started with small funds and made few tastes but as the Swadeshi Movement began, arousing nationalist feelings, domestic industry had its voice. The tea shops ranked as the primary selling points of biscuits and, to their credit, tea shops were also on the rise (Anandabazar Patika, 1925). This report has captured the aspect of

indigenisation wherein the biscuit changed its status as a colonial delicacy to an Indian daily commodity, wholly tied to tea culture and nationalistic business.

CONCLUSION:

The story of the biscuit is long and is full of achievements over the continent, empires and centuries. Its history as she became Roman fire, Iranian pastry, European traveler, Indian tea-table, is but a part of larger histories of migration, commerce and acculturation. The narrative of the biscuit then gives an insight into the process through which the globalization of taste and the domestication of foreign food can be seen in Indian modernity.

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Impact of Air Pollution on Oocytogenesis and the Protective Role of Zinc

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ABSTRACT: Air pollution is a major environmental concern with significant implications for human health, particularly female reproductive health. One key area of concern is its impact on oocytogenesis, the process of oocyte development and maturation. Exposure to industrial pollutants and airborne contaminants has been linked to reproductive disruptions, primarily through oxidative stress caused by reactive oxygen species (ROS). This oxidative damage can lead to follicular atresia, impaired meiotic spindle formation, chromosomal segregation issues, and mitochondrial dysfunction, all contributing to reduced oocyte quality and ovarian reserve. Oxidative stress also induces apoptosis in oocytes, further diminishing the ovarian reserve. Understanding how air pollutants contribute to this oxidative burden is crucial for developing strategies to mitigate their negative effects on female fertility and reproductive health. A potential solution is the use of antioxidants, such as zinc. Zinc is an essential micronutrient involved in various physiological processes, including reproductive function. Studies suggest that zinc supplementation can counteract oxidative stress, preserve oocyte quality, promote follicular development, and improve reproductive outcomes. Given the increasing concern about air pollution's impact on fertility, further research and systematic analysis are essential to explore protective strategies like zinc supplementation. Addressing these challenges is crucial to safeguarding female reproductive health in polluted environments.

INTRODUCTION:

Environmental pollution is mainly caused by the presence of toxic chemical, physical and biological substances in atmospheric ecosystems. It is a pervasive issue with far-reaching consequences for human health and well-being. The rapid decreasing quality of environment has some long-term adverse effects in population. People are unveiled to too many poisonous components daily and faced acute, worst health problems. Even, some diseases due to environmental pollution, are still unknown and so that, the exact treatments are also unreachable yet (Mahala, 2024) . Likewise, air pollution poses a serious threat to the environment with extensive implications for human health and societal progress. The air we breathe is essential for our survival, but now it's also filled with pollutants like particulate matters, gases, volatile organic compounds etc. that can harm our health. A particularly important area of focus is how air pollutants affect the delicate phenomenon of oocytogenesis. It is the process through which female germ cells or oocytes, develop and mature. Exposure to different industrial toxins and airborne pollutants can lead to the negative consequences for the female reproductive system, notably interfering with the oocytogenesis process(Shulhai et al., 2024). Oocytes play a critical role in fertility and their quality & quantity directly influence the reproductive success. Air pollution can disrupt hormonal balance, induce oxidative stress, trigger inflammation and damage DNA, which follows by

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Keywords: Air pollution, oxidative stress, oocytogenesis, micronutrient deficiency, zinc

reduced fertility, irregular menstrual cycles and increased risk of miscarriage (Itziou et al., 2024).

GLOBAL & NATIONAL SCENARIO OF FEMALE REPRODUCTIVE HEALTH:

Nowadays, like any other environmental concerns, air pollution is also one of the most notable discussion among the population. But, surprisingly, except few common negative consequences, a vital drawback of air pollution in female health is completely overlooked and unnoticed. Infertility is assessed as a very negative effect of air pollution in many places of earth(Zhang et al., 2025). Infertility or sterility is a reproductive dysfunction characterized by the inability to achieve a clinical pregnancy following a duration of 12 months of consistent and unprotected conjugal intercourse. It negatively impacts 10-15% of 20-45yr old couples daily, which is approximately about 50% of the cases (Moghadam et al., 2024). Oocytogenesis is a crucial mechanism, directly related with female fertility. If there any abnormalities or defects occurred in ovulatory functions, then it can negatively impactful for the fertilization. When females regularly face the contact with environmental pollutants, it affects the oocyte development at premeiotic or early prophase stage and leads to the chromosomal aberrations in ova, which is dangerous for their reproductive system (Sakali et al., 2024).

In recent years, globally a severe downfall has been observed in human fertility rates. In 2023, WHO reported, the lifetime prevalence of infertility in modern industrialized countries, is around 17.5% approximately. It means 17.5% population has been diagnosed iwith infertility at once in their lifetime. In 2022, WHO also stated that, globally one in six people assessed with infertility or any kind of ovarian disorder, at any stage of their life. In a recent survey, 25% of the infertility cases are commonly caused by the exposure of any toxic component from the environment (Liu et al., 2025). Other causes of female infertility in advanced age, are diagnosed as endocrine damage, reproductive organ problems (vaginal, cervical, uterine, tubal or pelvic-peritoneal diseases), Premature Ovarian Insufficiency (POI), Endometriosis and Polycystic Ovarian Syndrome (PCOS), that affected more adversely by the exposure of environmental pollutants directly or indirectly. In the last few decades, adoption of unhealthy lifestyle and absorption of environmental stressors are widely recognized as the reason of 15-30% of infertility cases (Kicińska et al., 2023).

Infertility and female reproductive issues are increasingly prevalent in India as well, driven by lifestyle factors, environmental influences and biological challenges. Recent statistics highlight that nearly 28 million couples in India experience infertility, with the Total Infertility Rate (TFR) dropping to 1.91, below the replacement level of 2.1 children per woman (Amodini & Chaudhuri, 2023).

OOCYTOGENESIS:

The female mammalians live with some germ cells, known as ‘Oocytes’, which are present in their body since birth and primarily help in the development during fatal life.

Oocytes increase their number through oocytogenesis, where they are

meiotically divided and their number indicating the fertile years of an individual (Telfer et al., 2023). When premature oocytes are transformed into fully developed mature oocytes, that intricate mechanism is defined as oocytogenesis. Primordial oocytes pass through the multiplication phase to form a large pool of 'Oogonia' that act as intermediator for the primary oocytes(Zhang et al., 2025) .A single layer of flattened Granulosa Cells (GCs), surrounded the pool of primordial oocytes, in the first few days after birth in rodents and as well as in primates (Schütz & Batalha, 2024). Oogonia multiplies in the first stage of meiosis (Prophase I) and differentiates into the primary oocytes. During prophase I, primary oocytes undergo Meiosis I and II. Meiosis I is responsible for the formation of two Haploid cells, known as, a smaller First Polar Body (PB1) and a larger Secondary Oocyte, which is followed by Meiosis II. This stage is started during Metaphase II and activated until fertilization(Sou et al., 2021). During Metaphase II, the mature ovum and polar bodies were formed. The ovum is discharged during ovulation and then fertilized by sperm to form a 'Zygote'.

In meiosis, significant growth and development of embryo identified by the increased size of oocytes, follicle formation and cytoplasmic accumulation. Hormonal regulation of this phase is basically maintained by the hypothalamus- pituitary- gonadal axis.
When it is activated, estrogen and follicle- stimulating hormone production increased (Utami & Fachrul, 2023).

During the growth phase, FSH secretes to stimulate the Antral Phase, which is characterized by the appearance of an Antral Cavity contains follicular fluid (FF). In this phase, oocyte-dependent differentiation also happened in the oocyte- surrounded Cumulus Cells (CCs) and Mural Granulosa Cells (MGCs), which is a very important factor for oocyte maturation. FSH passes through a pool of antral follicles and among them, one (human) or more (polyovulatory follicles), selected as dominant follicles, according to the higher mitotic rate of GCs and elevated Estradiol (E2) secretion(Schütz & Batalha, 2024). At this point, each dominant follicle (with the Enclosed Germinal Vesicle Oocyte) has developed its maximum size. These 10 mm follicles with 120 µm diameter, are perfect for the LH Spike to regulate the ultimate meiotic maturation and ovulation (Thomas et al., 2024).

AIR POLLUTION & OOCYTOGENESIS:
Nowadays, in every single moment, people inhaling more and more pollution into their body. In industrialized countries, the whole population take in a mix of pollutants every day through the air. These industrial chemical pollutants contain particulate matters (PM; diameter: 2.5–10 µm), ground-level ozone (O3), benzo(a)pyrene (BaP), polycyclic aromatic hydrocarbon (PAH), polychlorinated biphenyls (PCBs), sulfur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), organic solvents & dioxins, which are also produced by vehicles (Maji et al., 2023).
Environmental pollutants can adversely affect the mammalian ovary through follicular degeneration or Atresia.

Generally, women can produce nearly 400 fertilizable oocytes from menarche to menopause, that considered as a very small quantity. But, when the degeneration phase occurred earlier due to the air pollution, it results the massive reduction in the number of germ follicles by more than 99.9%(Hirano et al., 2025).

The primary negative effect of air pollution is the dysfunction of human gametogenesis that leads to a significant impairment of female reproduction. The chemical toxins present in air, firstly affect the ovary and then slowly followed to disrupt the basic functions of endocrine system. It results, increased Oxidative Stress (OS) and as well as inflammation, which is the reason for the stimulation of improper MAPK (Mitogen- Activated Protein Kinase) Signaling. Due to the dysfunction of MAPK Signaling, cell cycle differentiation and immune system shattered very badly (Zhang et al., 2024). Airborne pollutants generate Reactive Oxygen Species (ROS) that significantly contribute to this phenomenon.

The OS caused by these pollutants can lead to the buildup of harmful metabolites and such effects can profoundly impact the general reproductive well-being of women (Sakali et al., 2024). A variety of research has shown that oxidative damage can interfere with vital cellular functions, including the formation of meiotic spindle, the segregation of chromosomes and the operation of mitochondria. These processes are crucial for the development and quality of oocytes. Furthermore, OS has the potential to trigger Apoptosis, which is a form of programmed cell death in oocytes (Zhang et al., 2025).

Women living in metropolitan cities or highly urbanized areas, are significantly reported to produce a very small amount of fertilizable oocytes. This amount is decreasing day by day with the severe drop of healthy reproductive rate, increased cases of PCOD (Polycystic Ovarian Disease) & ovarian cancer and also the higher rate of implantation failure during oocytogenesis. Xue and Zhang claimed that, PMs (2.5 μm) have some negative effect on the quality of sperm and oocyte. Every 10 μg/m3 increment of these micro particles can decrease fertility almost 2%(Wieczorek et al., 2024). This discussion is later supported by Gaskins & collaborators, who found a link between air pollution and reproductive ageing. They proved that air contaminants slow down the efficacy of the ovarian reserve, which leads to the early reproductive ageing (Gaskins et al., 2023). Recently, Santi et al. highlighted about the relationship between air pollution and lower fertility rate by testing the AMH serum levels frequently in women. Anti- Mullerian Hormone (AMH) is a protein hormone produced by ovarian somatic cells and used as a marker of oocyte development and ovarian reserve maintenance. But mainly it is used to find the number of fertile eggs, which can represent the potential of the ovaries(Russell et al., 2022). Elevated AMH indicates PCOD, ovarian cysts and very low AMH leads to the dysfunction of ovarian reserve and premature ovarian failure. In a survey around Modena City, women are assessed with a very low level of AMH during the higher presence of different sized PM and NO2 in air. In another recent survey, Salma et al. confirmed the worst impact of PM2.5 and NO2 on the women reproductive capacity.

He proved the association between increased PM2.5 and NO2 levels with the decreased rate of healthy, uninterrupted fertilization, especially in the first month of pregnancy (Wang et al., 2025).

ZINC SUPPLEMENTATION AS A PROTECTIVE MEASURE:

Placenta is responsible for the interconnection between the maternal and fetal circulation during pregnancy. It also acts as a regulator of nutritional transport and as well as a protector for all toxic elements. In order to protect the human fetus from all external, non-essential and harmful components & develop a healthy offspring, some essential nutrients are added through diet and supplementation (Fatima et al., 2025). Using antioxidants like zinc could be a better way to reduce the harm caused by the air pollution on oocytogenesis (Quintão et al., 2024). Like other required macro and micro nutrients, Zinc (Zn) also plays a very important role in the maternal diet for the healthy growth of fetus. Generally, for humans and especially for expecting mothers, below the level of 70-120 µg/dL Zn in blood, identified as Zn deficiency. Maternal zinc deficiency results several acute adverse consequences in pre and post pregnancy period. It included premature births, low birthweights, congenital malformation etc (Hussain et al., 2022).

If this micro mineral gets sufficient importance in pregnancy care, then it can help a lot with its unique functionalities. It can introduce some positive effects during the oocyte maturation and ovulation process, which also protect the fetus from any harmful environmental condition. This essential mineral helps to maintain reproductive hormonal (including Estrogen and Progesterone) balance, support immune functions and protect shield cells from damage caused by free radicals. Air pollutants such as PM & PAHs, induce OS by generating ROS. Excess ROS can damage oocyte DNA and cellular structures. Zinc acts as a co-factor for superoxide dismutase, an enzyme that neutralizes ROS, thereby protecting oocyte integrity(Liu et al., 2024). Chronic exposure to pollutants can trigger inflammation in ovarian tissues, that impairing oocyte maturation. Zinc modulate inflammatory responses by regulating cytokine production. It also regulates Apoptosis pathways, ensuring oocyte survival during their critical development stages. Zinc can help in protection against heavy metals like lead, mercury and cadmium, which are commonly found in polluted air. These heavy metals can disrupt oocytogenesis and impair fertility (Veselinović et al., 2025). Meiotic Arrest and Cumulus Expansion are two very important Zn-dependent ovarian processes, very important for oocytogenesis. Meiotic arrest is essential for the cell division during oocyte maturation and the healthy egg development. Zinc regulates this process through MPF (Maturation-Promoting Factor) inhibition, CDC25 (a protein phosphatase) maintenance, redox regulation & OS reduction. On the other hand, Zn helps in cumulus cell proliferation and differentiation to ensure the signaling pathways for fertilization (Quintão et al., 2024). Zn supplementation has been found to counteract the harmful effects of air pollutants on oocytogenesis. By reducing OS caused by these pollutants, zinc helps maintain oocyte quality, supports

follicular development and enhances reproductive health (Kapper et al., 2024). While zinc supplementation can help mitigate the effects of air pollution on oocytogenesis, its essential to address the root cause of pollution and minimize the exposure to toxic air pollutants. Maintaining a healthy lifestyle, including a balanced diet rich in zinc and reducing the exposure to environmental toxins can help to support the reproductive health (Yao et al., 2023).

DISCUSSION:

Female fertility primarily relies on the precise co-ordination of ovarian and hormonal functions. When any disruption occurred in these pathways, it can complicate the whole conception. While most studies focus on single pollutants to discover the root cause of the interference, women are actually exposed to a mix of toxicants daily(An et al., 2025). Even at low individual concentrations, these combined exposures, along with predisposing factors, can heighten the risk of reproductive issues. Emerging evidence suggests that environmental pollution and climate change increase the likelihood of birth defects, particularly with prolonged exposure, and may impair fetal neuro-endocrine development in a sex-specific manner. These findings underscore the importance of a healthy ecosystem for reproductive well-being. Raising awareness about the risks of toxin exposure is vital for protecting public health and preventing reproductive issues(Hajjar et al., 2024).

Understanding how environmental toxins affect reproductive health, including identifying biomarkers to assess exposure and predict outcomes, is crucial. More research should focus on strategies to reduce pollution exposure, regulate industrial practices and develop accurate treatments for infertility and miscarriages. When internal well-being is harmoniously aligned with safe external environment, then only it creates an optimal balance for everyone, particularly individuals requiring specialized care and support(Adamson et al., 2025). Women with excessive exposure require special protection and those of childbearing age should be informed of the risks to oocytogenesis and reproductive health. Lifestyle changes, such as smoking cessation and dietary adjustments, may help, and antioxidants show promise in protecting oocyte development. Antioxidants are supposed to detoxify the harmful toxins from the body and enhance the reproductive health. Apart from this, sufficient water intake, targeted therapies and specific dietary interventions are also reported beneficial to fight against infertility and air pollution (Moustakli et al., 2025).

Zinc (Zn), an essential micro nutrient and antioxidant, is particularly important for the protection of maternal and fetal health. Zinc supports reproductive health by balancing hormones like estrogen and progesterone, enhancing immune functions and protecting cells from Oxidative Stress (OS) caused by air pollutants such as PM & PAHs. As a co-factor for superoxide dismutase, zinc neutralizes Reactive Oxygen Species (ROS), which helps to prevent oocyte DNA damage. Zinc has great anti-inflammatory properties and It also regulates apoptosis pathways while

protecting ovarian tissue and supporting oocyte maturation (Quintão et al., 2024). Additionally, it mitigates the harmful effects of heavy metals like lead and mercury on fertility. Vital processes in oocytogenesis, include meiotic arrest, crucial for healthy egg development and cumulus expansion, which ensures proper signaling for fertilization are solely dependent on zinc functionalities. Zinc supplementation helps counteract air pollution's impact on oocyte quality and follicular development, promoting reproductive health. Alongside supplementation, trying to reduce pollutant exposure and maintaining a zinc rich diet are essential for supporting fertility from air pollution.

CONCLUSION:

Given the pervasive nature of air pollution, strategies to mitigate its impact on reproductive health are critical, necessitating further research into comprehensive intervention protocols beyond individual nutrient supplementation. For instance, dietary antioxidants like quercetin and essential trace elements such as zinc and cobalt have demonstrated roles in protecting ovarian function and supporting oocyte development by neutralizing reactive oxygen species and mitigating inflammation. Maintaining optimal levels of essential elements, including zinc, selenium, copper, manganese, chromium, and iron, is crucial for protecting against oxidative stress and preserving female reproductive health. Zinc deficiency, specifically, has been linked to impaired oocyte maturation, inhibited mitochondrial function, and compromised ovarian follicle development. Furthermore, an imbalance in the copper-to-zinc ratio, often exacerbated by zinc deficiency, has been shown to potentiate teratogenic effects and adverse clinical consequences such as microcytic anemia and neutropenia. Moreover, air pollutants such as nitrogen dioxide have been inversely associated with the number of mature oocytes and can influence endogenous vitamin metabolism and hormone synthesis, further impacting oocyte quality. In this context, folic acid fortification programs, widely implemented to reduce neural tube defects, also require careful consideration, as the optimal amount of folic acid can vary by country and may have unintended consequences for non-target populations

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Original Article: Humanities and Cultural Studies

Revisiting Rank-Based Data in Social Sciences: Insights from Percentile Transformation

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ABSTRACT: In social science research, researchers often overlook the importance of ordinal or Rank-Based Data collection as rank data limits the use of conventional parametric statistics.
It is true that ordinal data indicate position but when rank data is transformed into percentile, it provides intensity and parametric statistics can be used. This paper revisits the methodological and interpretive potential of rank-based data through the application of percentile transformation. The study was conducted on 271 college-going adolescents (M = 21.07 years, SD = 3.22) using the Rank-Based Rabindrik Value Preference Questionnaire (Dutta Roy & Bhaduri, 2014), which measures 14 path-oriented and 14 goal-oriented values derived from Rabindrik philosophy. Rank scores were converted into percentile scores, thereby transforming ordinal ranks into a standardized 0–100 scale suitable for descriptive and comparative analysis. Results revealed that adolescents highly valued path-oriented values such as Self-Awakening (M = 63.5, SD = 29.4), Self-Acceptance (M = 63.2, SD = 28.4), and Emotional Control (M = 61.9, SD = 27.2), while goal-oriented values like Peace (M = 61.1, SD = 31.1) and Family Security (M = 58.1, SD = 25.7) were most preferred. Percentile transformation enhanced interpretability by revealing value gradients and facilitating visual and statistical exploration without violating ordinal integrity. The findings underscore that rank-based data, when transformed into percentiles, can bridge qualitative prioritization with quantitative rigor, democratizing data analysis for social scientists through low-cost, accessible software like Excel. This methodological approach revives the significance of rank-based research in understanding human choice, value hierarchies.

INTRODUCTION:

Rank-based data are often regarded as less useful in social science research because they represent only ordinal positions rather than measurable intervals causing difficulties to use parametric statistics. As a result, many researchers prefer Likert-type or scale-based data for statistical analysis. Aim of the study is to transform the rank data into percentile and to examine the value preferences. This study considers values that were extracted from Rabindra Sangeet.

In studies of preferences, values, and attitudes, ranks reveal how individuals organize meanings rather than how strongly they agree or disagree. This makes rank-based data particularly useful in psychological, educational, and socio-cultural research, where comparative evaluation often communicates more about human behavior than absolute ratings.

This paper revisits the utility of rank-based data collection in social sciences and demonstrates how percentile transformation of ranks can enhance interpretability, comparability, and statistical analysis.

Rank Order and Percentile Transformation:

Rank Order Theory is based on the premise that human judgments are inherently comparative rather than absolute. When people evaluate a set of objects, ideas, or values, they do not assign independent magnitudes to each; instead, they order them according to

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perceived importance, preference, or relevance.

Ranks are often underutilized because they lack interval properties required for most parametric statistics. Yet, this limitation can be addressed through percentile transformation, which converts rank positions into a standardized continuous metric between 0 and 100. This transformation retains ordinal information while facilitating cross-individual and cross-group comparisons. Rank-based data offer several advantages in social and behavioral studies:

a) Cognitive hierarchy: Ranking mirrors natural human decision processes by emphasizing choice and priority.

b) Cross-cultural adaptability: Ranking is less affected by linguistic biases, making it suitable for multilingual and multicultural contexts.

c) Ease of administration: With limited formal education, users can use it as rank tasks require minimal instruction. When time is short, researchers can administer study variables through rank order scale.

d) Resistance to response bias: Unlike rating scales, rank formats reduce tendencies toward central tendency or social desirability biases.

e) Rich interpretive potential: Rank data can capture qualitative distinctions among alternatives that might appear similar on numerical scales.

These features make rank-based instruments particularly suitable for value assessment, policy preference, educational evaluation, and leadership studies—contexts where prioritization matters more than magnitude.

Percentile transformation of rank data provides a mathematical bridge between ordinal judgment and quantitative analysis. The general formula is:

$$P = (N-R)/(N-1)*100$$

In which P = percentile score, R = assigned rank, and N = total number of items ranked.

This transformation preserves the order of preferences; converts ranks into a quasi-continuous scale (0–100), allowing visualization and descriptive statistics; enables integration with correlation, cluster analysis, and graphical techniques such as correspondence analysis.

Percentile-transformed scores can be easily computed in spreadsheet software like Excel, making this approach both low-cost and accessible for social science researchers. This study examined value preferences among adolescents.

Value Theory:

Values serve as guiding principles in human development, shaping decisions, aspirations, and interpersonal interactions (Schwartz, 1992; Rokeach, 1973). Adolescence, in particular, is a critical period for the crystallization of values, as individuals negotiate identity formation, autonomy, and social expectations (Erikson, 1968). Within this framework, values may be broadly conceptualized into path-oriented values—which emphasize the means and strategies adopted in life—and goal-oriented values—which highlight the desired end states of life pursuits.

Path-oriented values represent the guiding ideals that shape a person's everyday behavior, relationships, and decision-making. In Rabindrik philosophy, these values are central to the aesthetic and ethical expression of life. They form the foundation for one's journey toward higher states of consciousness and fulfillment.

List of Path-Oriented Rabindrik values are:

1.Self-Awakening: awareness of one's inner world and surroundings through mindfulness and introspection.
2.Emotional Control: self-discipline and regulation of feelings, rooted in harmony.
3.Systematic: disciplined, organized approaches to learning and decision-making.
4.Self-Acceptance: embracing one's identity, flaws, and strengths with authenticity.
5.Fearless: moral courage to uphold truth in adversity.
6.Cleanliness: purity of body, thought, and intention.
7.No Work–Family Conflict: balance between professional duties and personal life.
8.Challenging: readiness to face difficulties as opportunities for growth.
9.Niskam Principle: selfless action without attachment to outcomes.
10.Self-Understanding: awareness of desires, motives, and capacities.
11.Confidence: belief in one's abilities to face challenges independently.
12.Free from Fear of Failure: resilience and openness without paralysis of mistakes.
13.Resolute: determination and commitment to one's values.
14.Active: purposeful engagement in life through awareness and compassion.

Goal-oriented value preferences :

Goal-oriented values, by contrast, define the aspirations or desired states of being that individuals strive for through the practice of path-oriented values. They reflect inner growth and the realization of one's full potential, contributing to personal and collective well-being.

Goal-Oriented Rabindrik values include:

1.Universalization: transcending narrow identities to embrace shared humanity.
2.Peace: inner stillness supporting reflection and self-realization.
3.Enlightenment: wisdom from the integration of intellect, intuition, and aesthetics.
4.Positive Feeling: orientation toward joy, hope, and optimism.
5.Family Security: emotional and physical stability in family life.
6.Sense of Accomplishment: achievement aligned with creativity and values.
7.Pleasure: acknowledgment of aesthetic and sensory fulfillment.
8.Inner Harmony: balanced integration of thoughts, emotions, and actions.
9.Salvation: liberation through truth and inner realization, not escape.
10. Self-Respect: maintaining dignity and self-worth.
11.Self-Empowerment: realization of inner strength and agency.
12.Security: material stability and psychological safety.
13.Significance in Life: meaning and purpose in daily existence.
14.Altruism: selfless service and moral commitment to others' welfare.

Objective:

The study examined the relative importance of path-oriented and goal-oriented values among adolescents and demonstrated how percentile transformation can deepen the interpretative power of rank-based data in social science research.

Method

Participants: The sample consisted of 271 college-going adolescents, including 112 males and 159 females. Among them, 5%

were married and 95% were unmarried. Participants' mean age was 21.07 years (SD = 3.22). Participation in the study was voluntary. Informed consent was obtained from all students, and additional consent was sought from their guardians to ensure ethical compliance.

Instrument:

The Rank-Based Rabindrik Value Preference Questionnaire was used to assess adolescents' value orientations. (Dutta Roy & Bhaduri, 2014). This self-report tool comprises two distinct sets of values, each accompanied by brief definitions. Set 1 consists of 14 path-oriented values, representing guiding principles and attitudes that influence an individual's approach to life. Set 2 consists of 14 goal-oriented values, reflecting aspirations and outcomes that individuals strive to achieve. Respondents were instructed to rank the 14 values in each set from most to least preferred, thereby creating a hierarchy of value preferences. This rank-based format emphasizes relative preference, encouraging introspection and revealing the respondent's core motivational stance. So, rank 1 indicates most preferred value and rank 14 indicates least preferred value.

In a related rating-scale version of the questionnaire, the internal consistency reliability was reported as α = 0.79 for path-oriented values and α = 0.71 for goal-oriented values (Dutta Roy & Basu, 2013), indicating acceptable levels of reliability. In another study, Dutta Roy and Singh (2020) found that internal consistency was higher for goal-oriented values (α = .77) compared to path-oriented values (α = .55). The same study also confirmed the test–retest reliability, reporting that 86% of path-oriented values and 64% of goal-oriented values achieved coefficients above 0.50 across a one-month interval.

Procedure:

Data collection was conducted in classroom settings to ensure a controlled environment. Standardized instructions were provided, and participants were asked to respond honestly by ranking the values according to their personal preferences. The administration process was supervised by trained facilitators, who were available to clarify instructions and ensure that responses were completed independently.

Data Analysis:

Rank data obtained from the questionnaire were transformed into percentile scores. In the percentile mode, each rank was transformed into a percentile score to capture the relative importance of each value across participants. Descriptive statistics (mean, standard deviation) were computed.

Results:

The study examined preferences to path and goal oriented value extracted from Rabindra sangeet (Dutta Roy & Bhaduri, 2014) among the college going adolescents. Table 1 below shows descriptive statistics.

Path oriented value preference:

Out of 14 path oriented values, adolescents demonstrated the highest endorsement for Self-Awakening (M = 63.5, SD = 29.4), Self-Acceptance (M = 63.2, SD = 28.4), and Emotional Control (M = 61.9, SD = 27.2). These indicate adolescents' distinct preference for introspection, self-regulation, and emotional balance, the core components of psychological well-being.

Path-Oriented Values	Mean Percentile Score	SD Percentile Score	Goal-Oriented Values	Mean Percentile Score	SD Percentile Score
Self-Awakening: Awareness of one's inner world and surroundings through mindfulness and introspection.	63.5	29.4	**Peace:** Inner stillness supporting reflection and self-realization.	61.1	31.1
Emotional Control: Self-discipline and regulation of feelings, rooted in harmony.	61.9	27.2	**Universalization:** Transcending narrow identities to embrace shared humanity.	51.7	30.4
Systematic: Disciplined, organized approaches to learning and decision-making.	58.8	27.9	**Enlightenment:** Wisdom from the integration of intellect, intuition, and aesthetics.	54	28.9
Self-Acceptance: Embracing one's identity, flaws, and strengths with authenticity.	63.2	28.4	**Positive Feeling:** Orientation toward joy, hope, and optimism.	58	26.6
Fearless: Moral courage to uphold truth in adversity.	55.7	25.9	**Family Security:** Emotional and physical stability in family life.	58.1	25.7
Cleanliness: Purity of body, thought, and intention.	49	27.4	**A Sense of Accomplishment:** Achievement aligned with creativity and values.	47.2	27
No Work–Family Conflict: Balance between professional duties and personal life.	49.1	26.2	**Pleasure:** Acknowledgment of aesthetic and sensory fulfillment.	50.8	25.8
Niskam Principle: Selfless action without attachment to outcomes.	42.3	26.4	**Inner Harmony:** Balanced integration of thoughts, emotions, and actions.	48.5	26.4
Challenging: Readiness to face difficulties as opportunities for growth.	44.7	26.5	**Self-Respect:** Maintaining dignity and self-worth.	53.8	28.2
Self-Understanding: Awareness of desires, motives, and capacities.	46.5	27	**Salvation:** Liberation through truth and inner realization, not escape.	40.5	26.1
Confidence: Belief in one's abilities to face challenges independently.	46.7	26.7	**Self-Empowerment:** Realization of inner strength and agency.	47.8	26.7
Free from Fear of Failure: Resilience and openness without paralysis of mistakes.	38.8	26.3	**Security:** Material stability and psychological safety.	44.5	27
Resolute: Determination and commitment to one's values.	39.2	28.4	**Significance in Life:** Meaning and purpose in daily existence.	46.6	30.9
Active: Purposeful engagement in life through awareness and compassion.	40.6	31	**Altruism:** Selfless service and moral commitment to others' welfare.	37.3	31.6

Table: 1

Goal oriented value preference:

Out of 14 goal-oriented values, adolescents demonstrated the highest endorsement for Peace (M = 61.1, SD = 31.1) and Family Security (M = 58.1, SD = 25.7), representing a strong preference for emotional stability and familial harmony.

The percentile transformation of ranks allowed clearer visualization of preference gradients. For example, Self-Awakening reached percentile means above 60, while resolute possesses 39.2.The percentile scale thus enriched the understanding of underlying motivational hierarchies without violating the ordinal nature of the data.

Discussion:

Percentile transformation enhances the analytical flexibility of rank-based data by enabling both descriptive and inferential exploration.

It retains the subjective structure of human choice while allowing objective representation through standardized scores.

It facilitates cross-sample comparison, since percentile ranges are universally interpretable.

It strengthens mixed-method research, linking qualitative prioritization with quantitative interpretation.

Most importantly, percentile-based analysis democratizes data science for social researchers, as it can be applied using simple spreadsheet tools rather than advanced statistical software.

Conclusion:

Rank-based data are far from obsolete; they embody the essence of social judgment—choice, priority, and consciousness. When transformed into percentiles, these data become analytically powerful, visually interpretable, and methodologically flexible.

The integration of rank-based data collection and percentile transformation offers a path forward for social sciences—one that respects the qualitative depth of human priorities while embracing quantitative precision. This approach not only revitalizes traditional ranking methods but also aligns with the contemporary emphasis on culturally grounded, context-sensitive research.

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'Diabetes Awareness and You (DAY)' is a not-for-profit social welfare Organization. Since its inception in 2006, we have been instrumental in conducting a slew of initiatives in building up public awareness about prevention and management of Diabetes, conducting school awareness programs, adopting and conducting diabetes camps in villages, live workshops among communities, providing free insulin /medicines/tests to those who cannot afford treatment. We have also initiated the idea to establish the role of Diabetes Educators in our society and dedicate "5th September" as International Diabetes Educator's Day (IDED) since 2016 (launched by the then IDF President) and organizing DAYDEIC (DAY Diabetes Educator's International Conference) annually. The THEME of IDED (2022-26) is: 'Access to Diabetes Education for ALL'. To establish the role of Diabetes Educators in our society and to recognize their importance, we have also instituted the award of 'Best Indian Diabetes Educator of the year' since 2019-20.This year we have completed our **19** years of glorious journey. Please visit us at www.day.org.in and at FB www.facebook.com/day.org.in.

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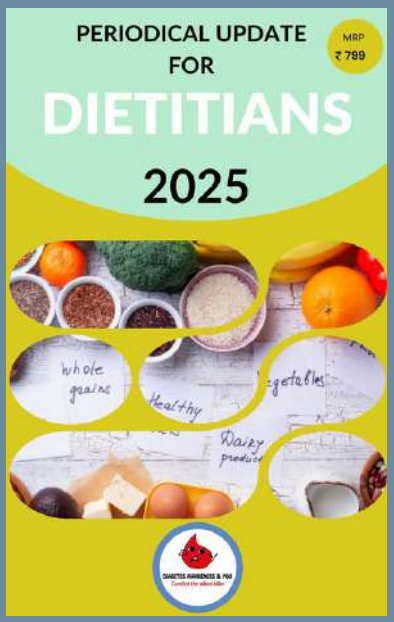

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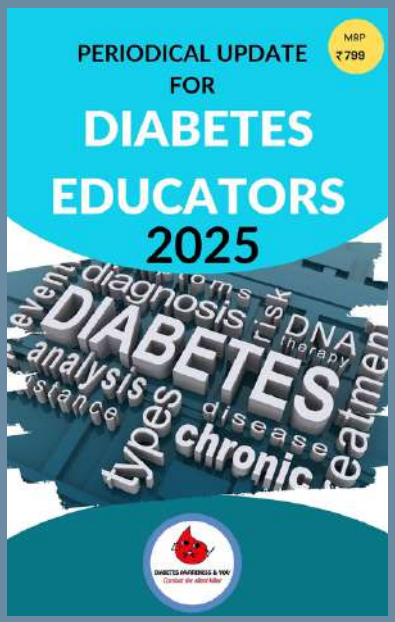

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