ISSN 0972 - 6489 - Vol 15, No. 1-4, pp. 1-112 Dec. (2022)

CONVERGENCE

A quarterly multidisciplinary journal devoted to physical and life sciences with a focus on energy and environment

Published by
Loyola Institute of Frontier Energy (LIFE)

CONVERGENCE

A quarterly interdisciplinary journal devoted to Physical, Chemical and Life Sciences with focus on Energy, Environment and Bio-ethics

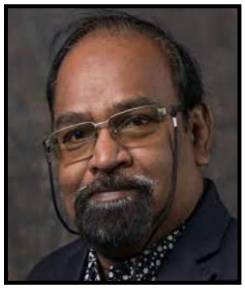
Globalization of Science and Technology coupled with the availability of sophisticated instruments of high degree of accuracy has resulted in collaborative research involving several disciplines. Today any research is multidisciplinary and the boundary and borderlines between pure research and applied research are vanishing. In the year 1999, LIFE started a new interdisciplinary journal 'CONVERGENCE' with a view of highlighting the energy and environmental issues in the research field. The editorial board invites the researchers around the globe to consider 'CONVERGENCE' as their publishing medium. We encourage scientists and research institutions to subscribe the journal.

Annual Subscription Fee

Individual	Institution
Local Rs. 300	Rs. 1000
Abroad US$ 150	US$ 500

All payments should be made by Demand Draft only in the favour of "Loyola Institute of Frontier Energy (LIFE)" payable at Chennai. All orders and change of address are to be referred to: The Editor/Associate Editor, "CONVERGENCE", Loyola Institute of Frontier Energy (LIFE), Loyola College, Chennai - 600 034, India.

EDITORIAL



We are incredibly pleased to bring out this issue of Convergence which comes to you after a short break due to the Covid-19 pandemic. As a research community, we are called to consistently focus on need-based relevant research that would bring solutions to the real-world problems of our society, such as water scarcity, environmental pollution, and energy crisis bioresource depletion.

Adding itself to the list is the COVID-19 pandemic, the outbreak of which has thrown more significant challenges to biomedical scientists and researchers. The COVID-19 pandemic has shown how our healthcare systems can become vulnerable, with grave implications for health, economical progress, trust in governments, and social cohesion.

Containing and mitigating the spread and infection rate of the virus continue to be challenging to strengthen our healthcare systems' capacity to respond swiftly to our needs. This includes the administration of COVID-19 vaccines. Praiseworthily, vaccine campaigns are rolling out in many countries after lightning-speed development and testing.

The COVID-19 pandemic had massive consequences for societies and health systems worldwide. As a result, health systems need to be more resilient. Resilient health systems plan and are ready for shocks, such as pandemics, economic crises, or the effects of climate change. They can minimize the negative consequences of problems, recover quickly, and adapt to become better performing and more prepared. Smart, targeted investments in health system resilience are needed to improve health and ensure the next shock is less disruptive and costly.

Dr. M. Selvanayagam

Editor-in-Chief & Director
Loyola Institute of Frontier Energy (LIFE)
Loyola College
Chennai - 600 034

Convergence
Vol. 15, No. 1-4, pp. 1-13, 2022

RISK AND SEVERITY OF COVID-19 IN RELATION TO EGG YOLK AND SUNLIGHT IN AN URBAN SETTING

Shamima Parvin Lasker[1]*, Shah Md Mahfuzur Rahman[2], Md Jafurullah[3], Md Abdul Jalil Ansari[4], Arif Hossain[5] and Md Ruhul Amin[6]

[1]*PhD, MPH, MPhil, EMMB, MSc, Professor & Head of Anatomy, Shahabudddin Medical College, Gulshan, Dhaka, Bangladesh. Email: splasker04@yahoo.com, ORCID ID: https://orcid.org/0000-0002-3484-9526

[2]PhD, FRSPH, MSc, MBBS, DPH, Dip. Management, Former Head, Academic Wing, Institute of Public Health, Mohakhali, Dhaka, Bangladesh. Email: smahfuzbd@gmail.com, ORCID ID: https://orcid.org/0000-0002-5069-6718

[3]MBBS, MD, MBBS, Principal & Professor of Biochemistry, Shahabuddin Medical College & Hospital, Dhaka, Bangladesh. Email: jafarullah2020@yahoo.com, ORCID ID: https://orcid.org/0000-0001-7946-5270

[4]MCPS (Medicine), MD(EM), MBBS, Principal and Professor of Endocrinology, MH Samorita Medical Hospital & College, Dhaka, Bangladesh. Email: ansariabduljalil@hotmail.com, ORCID ID: https://orcid.org/0000-0003-0882-6512

[5]PhD, MS, Professor & Course Co-coordinator, International Affairs and Human Rights, Etrat University, Vice President, Bangladesh Bioethics Society, Email: ahosssainbbs@yahoo.com, ORCID ID: https://orcid.org/0000-0001-6410-099X

[6]MD, MBBS. Professor of Endocrinology, Dhaka Medical College, Email: capruhulamin@gmail.com ORCID ID: https://orcid.org/000-0002-9758-3438

***Corresponding Author Email**: splasker04@yahoo.com

Abstract: A cross-sectional study was done on 385 respondents who survived from COVID-19, and residing in the capital city of Dhaka, Bangladesh, to assess the relationship between previous egg yolk consumption and exposure to sunlight with the risk and severity of COVID-19. Results suggested that those who ate eggs for 6 months before being infected by COVID-19 had suffered a lower rate of severe 40 (10.39%) type of COVID-19 symptoms than those who did not eat eggs for 6 months before being infected by COVID-19. Nevertheless, they suffered a high rate of moderate 223 (57.92%) followed by mild 62 (16.10%) types of symptoms of COVID-19 than those who did not like egg yolk. Though, this difference was not statistically significant (*p=0.154*). Those respondents eat eggs during lunch and dinner had a significantly lower rate of severe and moderate type of symptoms of COVID-19 than those who eat eggs during breakfast or anytime (*p=0.001*). However, those who walked in the noon and afternoon had a significantly lower rate of severe 1(0.2%) and moderate 9 (2.8%) symptoms of COVID-19 than those who walked in the morning and late evening *(p >0.026*). In conclusion, egg yolk reduces the severity of COVID-19. Although respondents consume an egg yolk regularly but they did not walk in the noon and afternoon, which is the better time to produce vitamin D through cholesterol by the skin from sunlight.

Keywords: COVID-19, Eating habit of egg, Egg yolk, Sunlight, Urban.

Introduction

COVID-19 has affected 188 countries in the world and infected 673,506,825 patients, death toll of 6,748,110 patients worldwide. Bangladesh infected 2,037,408 patients; death toll of 29,441 patients, respectively, reported until 24th April at 10 am [1]. People with compromised immune systems are at greater risk of a novel coronavirus [2].

However, several clinical trials showed that vitamin D supplementation reduces acute respiratory tract infections by 12% to 75%, including both seasonal and pandemic flu caused by the H1N1 virus [3]. Supplementation of vitamin D also has a beneficial effect on preexisting chronic illnesses [4)]. Those who were infected by the flu had fewer symptoms or recovered earlier if they received doses of vitamin D greater than 1000 IU [2]. Micronutrient deficiency may be improved by vitamin D for resistance to infection and faster recovery [5].

Vitamin D is normally produced by the skin in the presence of cholesterol when exposed to sunlight. Therefore, vitamin D is known as the sunshine vitamin. Staying indoors and longtime sedentary indoor work tend to reduce blood vitamin D levels [6]. Research also shows that vitamin D insufficiency affects almost 50% of the population worldwide, including young women and the elderly population linked to a reduction in outdoor activities, increased use of sunscreen, wear of heavy clothing during most of the time of the year where the temperature is low or live in northern climates where the little sun is seen [7].

A single egg yolk presents all vitamins (except vitamin C) and other components to increase immunity. A lot of coronavirus quarantine facilities around the world and patients in recovery are offered eggs on their daily meals. Authorities also provide eggs to healthcare workers and frontline heroes daily to boost up their immunity. Physicians also advise consuming vitamins D, C and Zink to boost up their immunity. However, people have a misconception that egg yolk is full of fat and cholesterol, anticipating heart disease, diabetes, and weight gain. Actually, egg yolk contains 50% of yolk proteins and less than 10% of yolk lipids. It also contains vitamins A, D, E K and vitamin B complex (thiamine, vitamin B6, folate, vitamin B12 and pantothenic acid) except B3-Niacin, IgY (ImmunoglobinY), lecithin, xanthophyll (responsive for vision), calcium, potassium, iron, phosphorus, zinc and selenium [8, 9].

Egg yolk may have a relation to early recovery or not being infected with COVID-19. No data is available relationship between previous egg yolk consumption and staying in sunlight with the risk and severity of COVID-19 to date so far. Therefore, the present study was undertaken to evaluate the previous food habit of egg yolk and sunlight on the risk and severity of COVID-19.

Methodology

A descriptive, cross-sectional study was done on 385 people who survived from COVID-19, aged between18 years and above, and resided in Dhaka city, Bangladesh, over a period of 6 months between July to December 2021 during the second wave of the corona to evaluate the effect of previous egg yolk consumption and sunlight on the risk and severity of COVID-19.A self-administered, structured questionnaire was used to collect the data. Data were collected by purposive techniques from Corona units of a private

hospital (Shahabuddin Medical College Hospital) and a government hospital (Dhaka Medical College Hospital) and as well as general people taking treatment at home stayed in Dhaka city. COVID-19 patients confirmed by RT-PCR protocol were recruited in this study.

Ethical clearance was obtained from the National Research Ethics Committee (NREC) of the Bangladesh Medical Research Council (BMRC), Dhaka. Before beginning the interview, the participants signed an informed consent form. To ensure anonymity, no names or identifying information was included in the questionnaire. All informed permission papers and surveys were kept secure and under lock and key. Participation in this study was entirely voluntary. They had the right to refuse to respond to any question or withdraw from the study at any time.

The statistical basis of the sampling technique was estimated by Raosoft, where marginal error-5%, CI-95%, and response distribution-50% were considered. Data were analyzed by using SPSS version 25.0 software. Demographic and other variables were analyzed by frequency and percentage distribution. A comparison of egg yolk consumption and time required for recovery and risk and severity of COVID-19 was done by using a chi-square test (X^2 test). A p value < 0.05 was considered statistically significant.

Results

The present study was undertaken to evaluate the previous food habit of egg yolk and sunlight on the risk and severity of COVID-19. In our study, females suffered a little more moderate and severe form of symptoms than males. However, there was no significant difference in the risk and severity of COVID-19 between males and females (p=694).

Egg Eating habit: All (91.4%) of the respondents who suffered from COVID-19 ate eggs 6 months before being infected by COVID-19 in our study. Those who ate eggs for 6 months before being infected by COVID-19 had a significantly lower 42 (10.91%) rate of severe types of symptoms of COVID-19 than those who did not eat eggs 6 months before being infected by COVID-19. Nevertheless, most of the respondents had a significantly higher rate of moderate 235 (61.04%) followed by mild 59 (15.32%) symptoms of COVID-19 those who ate eggs for 6 months before being infected by COVID-19 (*p=0.028*) (Table 1).

Eggs Yolk: On the other hand, egg yolk was liked by most of the respondents (84.4%) in our study. Of those who ate egg yolk, few suffered severe 40 (10.39%) type of COVID-19 symptoms than those who did not like egg yolk. However, who ate egg yolk suffered a high rate of moderate 223 (57.92%) followed by mild 62 (16.10%) types of symptoms of COVID-19 in our study. Though, this difference was not statistically significant (*p=0.154*). (Table 1). Nevertheless, those who believed that taking eggs yolk was good for health, suffered a significantly high rate of moderate, 161 (41.8 %), severe, 33 (8.57%), and mild 44 (11.43%) forms of a symptom of disease than those who felt eggs with yolks were full of fat causes heart disease, diabetes and weight gain They suffered significantly less moderate 41 (10.85%), severe 6 (2.0%), and mild 17(4.4%) types of symptom of COVID-19 than those who (*p=.0.038*). (Table 2).

Preference of the cooking types and the number of eggs consumed did not have

any significant relationship between the risk and severity of COVID-19. Although half of the respondents liked boiled eggs followed by poach or omelet in our study (not shown). However, the time of eating eggs had significant relationships. More than half of the respondents preferred egg during breakfast and a quarter preferred it at any time.

The respondents who liked eggs during lunch and dinner had a significantly lower rate of moderate type of symptoms of coronavirus than those who liked eggs during breakfast and anytime (*p=0.001*) (Table 3).

Table 1. Symptom Pattern of COVID-19 and Likeness of Egg and Sunshine (n=385)

Pattern	Symptom	Yes	No	Total	*P*
Like Egg	Mild	59	13	72	0.006**
	Moderate	243	17	260	
	Severe	50	3	53	
	Total	352 (91.4%)	33 (8.6%)	385 (100%)	
Eating Eggs 6 month before being infected by COVID-19	Mild	59	13	72	0.028*
	Moderate	235	25	260	
	Severe	42	11	53	
	Total	336 (87.3%)	49 (12.7%)	385 (100%)	
With egg yolk=yes without egg yolk=No	Mild	62	10	72	0.154
	Moderate	223	37	260	
	Severe	40	13	53	
Total		325 (84.4%)	60 (15.6%)	385 (100%)	
Like sunshine	Mild	63	9	72	0.047*
	Moderate	212	48	260	
	Severe	50	3	53	
Total		325 (85.23%)	60 (15.6 %)	385	
Like to walk in the sun	Mild	52	20	72	0.026*
	Moderate	183	77	260	
	Severe	33	20	53	
Total		268 (69.6%)	117 (30.4%)	385	
Knowledge: sunlight provides vitamin D	Mild	72	0	72	0.024*
	Moderate	241	19	260	
	Severe	52	1	53	
Total		365 (94.8%)	20(5.2%)	385	

Cross tabulation between symptom pattern and some parameters of the likeness of egg and sunshine. Aster risk** is considered moderately significant if p<0.01.

Table 2. Knowledge about Egg Yolk and Risk and Severity of COVID-19 (n=385)

		Eggs with yolks are full of fat	Taking egg with yolk causes heart disease	Taking egg with yolk causes diabetes	Taking egg with yolk causes weight gain	Taking egg with yolk does not cause any disease	Taking egg with yolk is good for health	Total	*p*
Knowledge about egg yolk	Mild	4	2	0	5	17	44	72	0.038*
	Moderate	18	29	1	10	41	161	260	
	Severe	2	11	1	0	6	33	53	
Total		24	42	2	15	64	238	385	

Cross tabulation between symptom patterns and knowledge about egg yolk. Aster risk* considered significant if p<0.05

Table 3. Time Preference of Eggs and Risk and Severity of COVID-19 (n=385)

		During breakfast	During lunch	During dinner	At any time/ always	During lunch and dinner		*p*
Symptom pattern	Mild	42	4	6	19	1	72	0.001***
	Moderate	161	3	18	73	5	260	
	Severe	16	2	5	30	0	53	
Total		219	9	29	122	6	385	

Symptom pattern and time preference of egg cross-tabulation. Aster risk*** is considered highly significant if p≤0.001

Relation between sunlight with COVID-19: In our study, a significant member of the respondents (85.23%) liked sunshine (*p=0.047*), and a significant number of respondents 268 (69.6%) liked to walk in the sunlight (*p=0.026*) (Table 1). Three-quarters of respondents liked to walk in the morning followed by evening. Very few liked to walk afternoon and noon, respectively. Table 5 showed that those who walked in the noon and afternoon had significantly less COVID-19, having less moderate 9 (2.8%) and severe 1(0.2%) forms of COVID-19 symptoms *(p >0.026*).

Almost all respondents 365 (94.8%) knew that vitamin D was produced by sunlight (Table 1) (*p=0.024*). A little above half of the respondents 268 (69.6) felt vitamin D was produced from morning sunshine and less than a quarter replied in the evening. Only a few answered at noon and afternoon (Table 4). Those who replied to vitamin D produced in the morning

suffered a significantly high rate of moderate 144 (37.40%), followed by mild 47 (12.21%) and severe 21 (5.41 %) of COVID-19 than those who replied noon and afternoon. Those who replied that vitamin D was produced at noon and afternoon suffered highly significantly less number of mild, moderate, and severe types of COVID-19 (*p=0.001*) (Table 5).

Table 4. Relation between Time Walk in the Sun and Risk and Severity of COVID-19 (n=385)

		Morning	Noon	Afternoon	Evening	Not applicable	Total	*p*
When like to stay in the sun	Mild	57	0	5	6	4	72	0.02*
	Moderate	166	9	17	29	39	260	
	Severe	31	1	0	10	11	53	
Total		254 (66.0%)	10 (2.6%)	22 (5.7%)	45 (11.7%)	54 (14.0)	385 (100%)	

Table 5 Relations to Time to Produce Vitamin D and Risk and Severity of COVID-19 (n=385)

		Morning	Noon	Afternoon	During sunset	Total	p
Symptom pattern	Mild	47	11	0	14	72	0.001***
	Moderate	144	48	16	52	260	
	Severe	21	8	2	22	53	
Total		212 (55.1%)	67 (17.4%)	17 (4.4%)	88 (22.8)	385 (100%)	

Discussion

Egg yolk and risk and severity of COVID-19: In our study, those who ate eggs and eggs yolk for 6 months before being infected by COVID-19 both had a significantly lower rate of severe types of symptoms of COVID-19 than those who did not eat eggs 6 months before being infected by COVID-19. However, half of them suffered a moderate type of symptoms. We did not find any reports to compare as this was the first study to examine the previous food habit of eggs in patients who survive from COVID-19. Those who believed that taking an egg with yolk is good for health and does not cause any disease suffered significantly higher rates of moderate 161 (41.8%), severe 33 (8.57%) and mild 44 (11.43%) types of symptoms of CIVID 19 than those who felt eggs with yolks are full of fat causes heart disease diabetes weight gain (*p*=0.038).

No research has been found to compare with this result. In 2009, during the Spanish flu caused by the H1N1 virus, studies showed that vitamin D supplementation lowers the developing acute respiratory tract infections by 12% to 75%, including both seasonal and pandemic flu [3]. Evidence from several clinical trials showed that people infected by flu symptoms and recovered earlier who received vitamin D greater than 1000 IU [2]. Actually, egg yolk contains vitamins D2 and D3 at an amount of 0.91 8mcg or 44 IU [9]. However, heat in the cooking process slightly alters the egg's nutritional profile. For example, 50 g of scrambled egg reduces the nutritional value of protein and vitamin D to 4.99 g and 36 IU, respectively [10]. People of Bangladesh, India, and Pakistan, usually like a more done way of egg which means a little more cooking than in other parts of the world. This may cause more vitamins to be destroyed. This could be a cause of why moderate-type of symptoms was higher in our study even they ate eggs with yolk.

However, an in vitro experiment showed that the anti-Spike-S1 immunoglobulin had a significant neutralizing function against SARS-CoV-2 [11].

In our study, most of the respondents liked boiled eggs followed by poach or omelet. Most of the respondents in the world like boiled eggs, followed by omelets, scrambled eggs, and mixed eggs with other ingredients [12]. In our study, most of the participants ate eggs during breakfast and a varying number of respondents ate eggs at any time a day. The study also revealed that most respondents preferred eggs at breakfast and others preferred at any time of day in the world [13]. Our results of preference for eggs were consistent with other parts of the world. It was interesting that those respondents who liked eggs during lunch and dinner suffered a significantly lower rate of severe and moderate type of symptoms of corona than those who liked eggs during breakfast. In Bangladesh, the egg cooking process is different during lunch and dinner. They cook the boiled egg in a curry with spice. Spice may have added impact on the less moderate type of symptoms of COVID-19 in our study. We did not find any reports to compare as this was the first study to examine the previous food habit of eggs and time preference of eggs with yolk and the risk and severity of COVID-19.

In our study, maximum participants felt egg yolk was good for health and it did not increase weight or disease. The education level of most of the respondents in our study was graduated and above (not shown in the results). The education level of our respondents reflects their knowledge of egg yolk and that egg is good for health as the egg contains protein, vitamins, and minerals. Egg consumption results in an increase in serum cholesterol and weight gain has been found elsewhere even though this thought has not been sufficiently demonstrated [13].

Sunshine and risk and severity of COVID-19: Our study found that sunlight had a relation to COVID-19. Those who walked at noon and afternoon had highly statistically less risk and severity of COVID-19 than those who walked in the morning.

Vitamin D is normally produced by the skin in the presence of cholesterol when exposed to sunlight. The best time to soak the sun to get the maximum vitamin D is between 10 am to 3 pm. At this time, the UVB rays are intense and it is also said that the body is more efficient in making

vitamin D at this time [13]. Our study was consistent with this study. This time is also considered safer for getting exposed to the sun as it was said that getting the sun during the latter part of the day also increases the risk of certain types of cancer [13].

In our study, those who replied vitamin D produce in the morning suffered significantly moderate 166 (43.1%) followed by mild 57 (14.8%) and severe 31 (11.2%) types of COVID-19 than those replied noon and afternoon. The study showed that those who stay indoors and longtime sedentary indoor work reduce blood vitamin D levels [6]. vitamin D insufficiency affects almost 50% of the population worldwide linked to a reduction in outdoor activity, an increase in the use of sunscreen among children and adults, wearing clothing that covers most of the skin in winter-prone countries, or living in northern climates where little sun is seen [7]. In the UK, sunlight does not contain enough UVB radiation in winter (October to early March) to be able to make enough vitamin D [14]. Ultraviolet B (UVB) rays even cannot reach the body to make vitamin D if sitting indoors by a sunny window as UVB cannot get through the glass [14]. Therefore, those who walked in sun in the morning probably had a higher rate of moderate type of symptoms in our study. Our study population was based on permanent residents of the capital city Dhaka. Although they ate an egg with yolk regularly and understood the egg was good for health, but they did not walk in the noon and afternoon, which is the better time to produce vitamin D. Therefore, most of our study respondents who ate an egg with yolk suffered from a higher rate of moderate and severe type of symptoms of COVID-19 even though they ate eggs for 6 months before infected by COVID-19.

Limitation: There were certain limitations in the present study. The research was a questionnaire-based survey and hence the results relied upon the reply of the participants received. All questions have not been explored to the same extent. However, this study was done on permanent residents of the capital city that did not reflect the whole population of Bangladesh. Furthermore, most of the participants were female, this study may also have been subject to the limitation of gender bias.

Hence, it needs to be validated by further studies with larger sample size, both in urban and rural, all economic groups and balanced gender in Bangladesh shortly.

Conclusion

Eating an egg with yolk had a relationship with the risk and severity of COVID-19 in this study. Those who ate eggs for 6 months before being infected by COVID-19 had suffered a lower rate of a severe type of COVID-19 symptoms than those who did not eat eggs for 6 months before being infected by COVID-19. Nevertheless, they suffered a high rate of moderate 223 (57.92%) followed by mild 62 (16.10%) types of symptoms of COVID-19 than those who did not like egg yolk. This difference was not statistically significant (p=0.154). Those respondents eat eggs during lunch and dinner had a significantly lower rate of severe and moderate type of symptoms of COVID-19 than those who eat eggs during breakfast or anytime (p=0.001). However, those who walked in the noon and afternoon had a significantly lower rate of severe and moderate symptoms of COVID-19 than

those who walked in the morning and late evening (p >0.026). In conclusion, egg yolk reduces the severity of COVID-19. Although respondents consume an egg yolk regularly, however, they did not walk in the noon and afternoon, which is the better time to produce vitamin D through cholesterol by the skin from sunlight.

Recommendations

Education and awareness regarding the relationship between exposure to sunlight and egg yolk cholesterol to produce vitamin D is needed to reduce the risk and severity of COVID-19.

Financial support: We are grateful to Bangladesh Medical Research Council for funding this research under Health, Population and Nutrition Sector Programme [HPNSP] Memo no: BMRC/RP/Revenue/2020-2021/928 (9-28) date 03.02.2021 for the fiscal year of 2020-2021.

Acknowledgment: I acknowledge the support of the authority of the Research Unit, Medical Education Shahabuddin Medical College to perform this research work.

Conflict of Interest: There is no conflict of interest reported by any author

Author Declaration: The 1st author conceived the idea, conducted the research, wrote the manuscript, and checked the manuscript meticulously. The 2nd author reviewed the methodology and checked and edited the manuscript meticulously. The 3rd author did the laboratory work and checked the manuscript meticulously. The 4th author did the laboratory work and the 5th author wrote the manuscript and checked the manuscript meticulously. The 6th checked the manuscript meticulously.

References

[1] Worldometer. https://www. worldo meters. info/coronavirus/ (Access on December 18, 2021).

[2] Zhou, J., Du, J., Huang, L., Wang, Y., Shi, Y., Lin, H. 2018. Preventive effects of vitamin D on seasonal influenza A in infants: a multicenter, randomized, open, controlled clinical trial. The Pediatric infectious disease journal 2020;37(8):749-54. DOI: https:// doi.org/10.1097 /INF.0000000000001890.

[3] Martineau, A.R., Jolliffe, DA., Hooper, R.L., Greenberg, L, Aloia, J.F, Bergman P et al.. Vitamin D supplementation to prevent acute respiratory tract infections: systematic review and meta-analysis of individual participant data. British Medical Journal 2017;356: i6583. DOI: https://doi.org/10.1136/bmj.i6583.

[4] Arihiro, S., Nakashima, A., Matsuoka, M., Suto, S., Uchiyama, K., Kato, T., Mitobe, J., Komoike, N., Itagaki, M., Miyakawa, Y., & Koido, S. Randomized trial of vitamin D supplementation to prevent seasonal influenza and upper respiratory infection in patients with inflammatory bowel disease. Inflammatory bowel diseases 2019;25(6):1088-95. DOI: https://doi.org/10.1093/ibd/izy346.

[5] Maggini, S., Pierre, A., Calder, P.C. Immune Function and Micronutrient Requirements Change over the Life Course. *Nutrients*. 2018;10(10):1531. DOI:https://doi.org/doi:10.3390/nu10101531.

[6] Harvard, T.H. Chan School of Public Health. 2020. Food safety, nutrition, and wellness during COVID-19. https://www.hsph.harvard.edu/nutritionsource/2020/03/25/food-safety-nutrition-and-wellness-during-covid-19/ (Access 2nd July 2020).

[7] Clifford, J., & Kozil, A.. Fat-Soluble Vitamins: A, D, E, and K – 9.315 Colarado state University 2020. https://extension.colostate.edu/topic-areas/nutrition-food-safety-health/fat-soluble-vitamins-a-d-e-and-k-9-315/ online directory (Access 3rd July 2020).

[8] Zamora, R., Hidalgo F.J. Egg Yolk Lipoproteins. In Encyclopedia of Food and Health, Science Direct. 2016. https://www.sciencedirect.com/topics/medicine-and-dentistry/egg-yolk (Access in 3 July 2020)

[9] Huizen, J. All you need to know about egg yolk. Medical News Today 2019. https://www.medicalnewstoday.com/articles/320445 (Access in 3 July 2020)

Nall, R. How many calories do eggs contain? Medical News today 2019 Medical News Today 2019. https://www.medicalnewstoday.com/articles/320445 (Accessed on 3 July 2020)

[10] Wei, S., Duan, S., Liu, X., Wang, H., Ding. S., Chen, Y., et al. Chicken Egg Yolk Antibodies (IgYs) block the binding of multiple SARS-CoV-2 spike protein variants to human ACE2. Int Immunopharmacol. 2021;90:107172. DOI:https://doi.org/10.1016/j.intimp.2020.107172

[11] Bejaei, M., Wiseman, K., Cheng, K.M. 2011. Influences of demographic characteristics, attitudes, and preferences of consumers on table egg consumption in British Columbia, Canada. Poult Sci. 2011; 90(5):1088-95. https://doi.org/10.3382/ps.2010-01129 .

[12] Akonor, A., Akonor P.T. Egg consumption: patterns, preferences and perceptions among consumers in Accra metropolitan area. International Food Research Journal 2014;21(4): 1457-1463. http://www.ifrj.upm.edu.my /(Accessed on Jan 18, 2022).

[13] NHS. How to get vitamin D from sunlight? https://www.nhs.uk/live-well/healthy-body/how-to-get-vitamin-d-from-sunlight/(Access November 18, 2021).

Table 1. Symptom Pattern of COVID-19 and Likeness of Egg and Sunshine (n=385)

	Pattern	Symptom	Yes	No	Total	P
Like egg		Mild	59	13	72	0.006**
		Moderate	243	17	260	
		Severe	50	3	53	
		Total	352 (91.4%)	33 (8.6%)	385 (100%)	
Eating Egg 6 month before being infected by COVID-19		Mild	59	13	72	0.028*
		Moderate	235	25	260	
		Severe	42	11	53	
		Total	336 (87.3%)	49 (12.7%)	385 (100%)	
With egg yolk=yes		Mild	62	10	72	0.154

without egg yolk=No					
	Moderate	223	37	260	
	Severe	40	13	53	
Total		325 (84.4%)	60 (15.6%)	385 (100%)	
Like sunshine	Mild	63	9	72	0.047*
	Moderate	212	48	260	
	Severe	50	3	53	
Total		325 (85.23%)	60 (15.6 %)	385	
Like to walk in the sun	Mild	52	20	72	0.026*
	Moderate	183	77	260	
	Severe	33	20	53	
Total		268 (69.6%)	117 (30.4%)	385	
Knowledge: sunlight provides vitamin D	Mild	72	0	72	0.024*
	Moderate	241	19	260	
	Severe	52	1	53	
Total		365 (94.8%)	20(5.2%)	385	

Cross tabulation between symptom pattern and some parameters of likeness of egg and sunshine. Aster risk** considered moderately significant if p<0.01.

Table 2. Knowledge About Egg Yolk and Risk and Severity of COVID-19 (n=385).

		Eggs with yolks are full of fat	Taking egg with yolk causes heart disease	Taking egg with yolk causes diabetes	Taking egg with yolk causes weight gain	Taking egg with yolk does not cause any disease	Taking egg with yolk is good for health	Total	p
Knowledge about egg yolk	Mild	4	2	0	5	17	44	72	0.038*
	Moderate	18	29	1	10	41	161	260	
	Severe	2	11	1	0	6	33	53	
Total		24	42	2	15	64	238	385	

Cross tabulation between symptom patterns and knowledge about egg yolk. Aster risk* considered significant if p<0.05

Table 3. Egg and Sunlight Preference before being Infected by COVID-19 (n=385)

Item	Specification	Frequency /Percentage	p
How like to take egg	Poached egg	42 (10.9%)	0.200
	Egg omelet	22 (5.7%)	
	Half boiled	23 (6.0%)	
	Boiled	197 (51.2%)	
	Likes all	11 (2.9%)	
	Poached and boiled egg	85 (22.1%)	
	Omelet and poached egg	4 (1.0%)	
	omelet and boiled egg	1(0.3%)	
When like to take egg	During breakfast	221(57.4%)	0.001***
	During lunch	9 (2.3%)	
	During dinner	29 (7.5%)	
	At any time/always	122 (31.7%)	
	During lunch and dinner	4(1.0%)	
Frequency of taking egg	Everyday	200 (51.9%)	0.387
	Once in a week	19 (4.9%)	
	2 to 3 times in a week	157 (40.8%)	
	2 to 3 times in a month	9 (2.3%)	
Knowledge about egg yolk related to nutrition and disease	Eggs with yolks are full of fat	24 (6.2%)	0.038*
	Taking egg with yolk causes heart disease	42 (10.9%)	
	Taking egg with yolk causes diabetes	2(0.5%)	
	Taking egg with yolk causes weight gain	15 (3.9%)	
	Taking egg with yolk does not cause any disease	64 (16.6%)	
	Taking egg with yolk is good for health	238 (61.8%)	
Diet before infected COVID-19	Black tea/ other spices	7 (1.8%)	
	Black tea/ other spices and milk	1(0.3%)	
	Egg with yolk and milk	18 (4.7%)	
	12	2 (0.5 %)	
	Egg with yolk	13 (3.4%)	
	Egg without yolk	3 (0.8%)	
	Black tea/ other spices and egg with yolk	140 (36.4%)	
	Black tea/ other spices, egg with yolk and milk	144 (37.4%)	
	Black tea/ other spices and egg without yolk	39(10.1%)	
	Black tea/ other spices, egg without yolk and milk	12 (3.1%)	
	Egg without yolk and milk	6 (1.6%)	

Aster risk*** considered highly significant if p≤0.001

Table 4. Time preference of eggs and risk and severity of COVID-19 (n=385)

		During breakfast	During lunch	During dinner	At any time/ always	During lunch and dinner		*p*
Symptom pattern	Mild	42	4	6	19	1	72	0.001 ***
	Moderate	161	3	18	73	5	260	
	Severe	16	2	5	30	0	53	
Total		219	9	29	122	6	385	

Symptom pattern and time preference of egg cross tabulation. Aster risk*** considered highly significant if p≤0.001

Table 5. Relation between Time Walk in the Sun and Risk and Severity of COVID-19 (n=385)

		Morning	Noon	Afternoon	Evening	Not applicable	Total	*p*
When like to stay in the sun	Mild	57	0	5	6	4	72	0.02*
	Moderate	166	9	17	29	39	260	
	Severe	31	1	0	10	11	53	
Total		254 (66.0%)	10 (2.6%)	22 (5.7%)	45 (11.7%)	54 (14.0)	385 (100 %)	

Table 6. Relations to Time to Produce Vitamin D and Risk and Severity of COVID-19 (n=385)

		Morning	Noon	Afternoon	During sunset	Total	p
Symptom pattern	Mild	47	11	0	14	72	0.001 ***
	Moderate	144	48	16	52	260	
	Severe	21	8	2	22	53	
Total		212 (55.1%)	67 (17.4%)	17 (4.4%)	88 (22.8)	385 (100%)	

Convergence
Vol. 15, No. 1-4, pp. 14-22, 2022

IMPACT OF COVID-19 ON EDUCATION IN INDIA - ISSUES AND INTRICACIES

Alluri Venkata Nagavarma[1]* and Akula Ramesh[2]
[1]Professor in Economics, P G. Courses & Research Center, D. N. R. (Autonomous) College, (Estd. 1945), Bhimavaram-534 202, W.G. District, Andhra Pradesh.
[2]Assistant Professor in Economics, P.G. Courses & Research Center, D.N.R.(Autonomous)College, (Estd. 1945), Bhimavaram-534 202, W.G. District, Andhra Pradesh.
***Corresponding Author Email**: avnvarma@gmail.com

Abstract: Educational institutions (schools, colleges, and universities) in India are currently based only on traditional methods of learning, that is, they follow the traditional set up of face-to-face lectures in a classroom. Although many academic units have also started blended learning, still a lot of them are stuck with old procedures. The sudden outbreak of a deadly disease called COVID-19 caused by a Corona Virus (SARS-CoV-2) shook the entire world. Around 32 crore learners stopped to move schools/colleges and all educational activities halted in India. The outbreak of COVID-19 has taught us that change is inevitable. It has worked as a catalyst for the educational institutions to grow and opt for platforms with technologies, which have not been used before The World Health Organization declared it as a pandemic. This situation challenged the education system across the world and forced educators to shift to an online mode of teaching overnight. Many academic institutions that were earlier reluctant to change their traditional pedagogical approach had no option but to shift entirely to online teaching–learning. The article includes the importance of online learning and Strengths, Weaknesses, Opportunities, & Challenges (SWOC) analysis of e-learning modes in the time of crisis. This Research paper also put some light on the growth of EdTech Start-ups during the time of pandemic and natural disasters and includes suggestions for academic institutions of how to deal with challenges associated with online learning. The Research paper will attempt an analysis of Origin of COVID-19, its impact on education, Role and importance of Internet during COVID-19, internet barring in Kashmir, and more importantly this paper will through a shift of light to the important scenarios of COVID-19.

Keywords: Origin of COVID-19, positive and negative impact of COVID-19 on education, internet connectivity in J@K, Life of Private school teacher.

Introduction

The COVID-19 pandemic has graphically illustrated the importance of digital networks and service platforms. Digital networks that deliver the internet to our homes, and the services that ride on those networks have leapt from an ancillary "nice to have" to something that is critical to economic activity and our daily lives [1]. It is time to consider whether these companies are too important to be left to make the rules governing their behaviour themselves. There is a new public health crises threatening the world with the emergence and spread of 2019 novel corona virus (2019-nCoV) or the severe acute respiratory syndrome corona virus 2 (SARS-CoV-2). The virus originated in bats and was transmitted to humans

through yet unknown intermediary animals in Wuhan, Hubei province, China in December 2019 [2]. There have been around 96,000 reported cases of corona virus disease 2019 (COVID-2019) and 3300 reported deaths to date (05/03/2020). The disease is transmitted by inhalation or contact with infected droplets and the incubation period ranges from 2 to 14 d. The symptoms are usually fever, cough, sore throat, breathlessness, fatigue, malaise among others. The number of confirmed COVID-19 cases in India crossed 80 lakh on October 28, according to data collated from various State Health Departments. As of 7 p.m. on October 28, the figure stood at 80, 01,583 with 1, 20,185 deaths. India's COVID-19 tally crossed the 20-lakh mark on August 7, 30 lakh on August 23 and 40 lakh on September 5. It went past 50 lakh on September 16, 60 lakh on September 28 and crossed 70 lakh on October 11.We may be social distancing physically but mentally and emotionally we are all still so connected [3]. A pandemic like the COVID-19 may have restricted any form of outdoor activity and we are not complaining about it as much. There are two reasons for this: Surviving is a priority for all (of course!) and social media is not letting us miss out on anything! While we also spend most of our time on streaming platforms such as Netflix, Hot star, and Prime, there has been a definite change in the way we use social media. If there is one thing that we will remember in years to come about this pandemic is how we used social media to its full capacity.

Impact of COVID-19 on Education

Corona virus that originated in china, spread at an alarming rate throughout the world, took lives in thousands and put its adverse effects on millions [4]. Every advanced country has knelt before it bewilderingly. The endeavours of every developed country in terms of health system have resulted in failure. The world is in bafflement, failing to get its cure. Benjamin Franklin, one of the founding fathers of United States of America has wisely analyzed that an investment in education pays the best interest. This analysis of Franklin about investment should be an eye-opener for policy makers or rulers. As education a basic right of an individual is in pitiable form in our country India especially in its union territory 'Kashmir'. The new entry of COVID-19 has changed the scenario once again [5]. The world is facing the Grasim gibbets of Corona virus. It has become so affreux that people fear it more than the tutelary deity of death. Lockdown is pivotal and effective step taken by the rulers. But at the same time around more than 2 hundred countries in the world, majority of them are investing huge amounts of money in education sector to uplift their countries by boosting diligent ones who yearn to prove their valour in any field. In our country unfortunately this sector is run by bureaucrats selected by ruling parties who have no experience. The more we bureaucratize the education system the more it will fall down. The trauma can be solved only by establishing modern systems equipped with scientific technologies and scrupulous teachers. This will definitely yield paramount mountains and help in solidification of education system. Without investing there will be no change and if done it should be utilized in a proper-proper manner. Internet the attention grabbing blessing of science is crippled in the India's paradise named union territory Kashmir [7]. As from last 9 months 4G internet service is still switched

off in the valley. One can guess how adversely it had affected the education sector. Some zealous teachers started to teach on Google class room, Tube but it too needs fast internet speed, on 2G services it pinches and creates frustration. Moreover not everyone in the valley can afford smart phones to attend u Tube lectures, so an act of segregation is created. We believe education is crucial for spawning societies which are impartial and are free from regionalism, dogmas and paroissial notions about others. We believe the world has started moving like leopards speed from breaking up to oneness [8].

India's Response

• Dish portal contains e-Learning content for students, teachers, and parents aligned to the curriculum, including video lessons, worksheets, textbooks and assessments. Under the guidance of its national boards of education (CBSE) and NCERT, the content has been created by more than 250 teachers who teach in multiple languages. The app is available to use offline. It has more than 80,000 e-Books for classes 1 to 12 created by CBSE, NCERT in multiple languages. The contents can also be viewed through QR codes on textbooks [9]. The app can be downloaded from IOS and Google Play Store. Website: https://diksha.qov.in or https:// seshaqun. qov.in/shaqun.

• E-Pataskala is an e-Learning app by NCERT for classes 1 to 12 in multiple languages. The app houses books, videos, audio, etc. aimed at students, educators and parents in multiple languages including Hindi, Urdu, and English. In this web portal NCERT has deployed 1886 audios, 2000 videos, 696 e-Books and 504 Flip Books for classes 1 to 12 in different languages. Mobile Apps is available. Website: http://epathshala.nic.in or http://epathshala.qov.in.

• National Repository of Open Educational Resources (NROER) portal provides a host of resources for students and teachers in multiple languages including books, interactive modules and videos including a host of STEM-based games [10]. Content is mapped to the curriculum for classes 1-12, including aligned resources for teachers. It has a total of 14527 files including 401 collections, 2779 documents, 1345 interactive, 1664 audios, 2586 images and 6153 videos on different languages. Website: http:// nroer.qov. in/ welcome.

Positive Impact of COVID-19 on Education

Though the outbreak of COVID-19 has created many negative impacts on education, educational institutions of India have accepted the challenges and trying their best to provide seamless support services to the students during the pandemic. Indian education system got the opportunity for transformation from traditional system to a new era. The following points may be considered as the positive impacts [11].

• Move towards Blended Learning: COVID-19 has accelerated adoption of digital technologies to deliver education. Educational institutions moved towards blended mode of learning. It encouraged all teachers and students to become more technology savvy. New ways of delivery and assessments of learning opened immense opportunities for a major transformation in the area of curriculum development and pedagogy. It also gives access to large pools of learners at a time.

Negative Impact of COVID-19 on Education

Education sector has suffered a lot due to the outbreak of COVID-19. It has created many negative impacts on education and some of them are as pointed below [12]:

• Educational activity hampered: Classes have been suspended and exams at different levels postponed. Different boards have already postponed the annual examinations and entrance tests. Admission process got delayed. Due to continuity in lockdown, student suffered a loss of nearly 3 months of the full academic year of 2020-21 which is going to further deteriorate the situation of continuity in education and the as students would face much difficulty in resuming schooling again after a huge gap.

• Impact on employment: Most of the recruitment got postponed due to COVID-19 Placements for students may also be affected with companies delaying the on board of students. Unemployment rate is expected to be increased due to this pandemic. In India, there is no recruitment in Govt. sector and fresh graduates fear withdrawal of their job offers from private sectors because of the current situation. The Centre for Monitoring Indian Economy's estimates on unemployment shot up from 8.4% in mid-March to 23% in early April and the urban unemployment rate to 30.9% (Educationasia.in). When the unemployment increases then the education gradually decreases as people struggle for food rather than education [13].

• Unprepared teachers/students for online education- Not all teachers/students are good at it or at least not all of them were ready for this sudden transition from face to face learning to online learning. Most of the teachers are just conducting lectures on video platforms such as Zoom, Google meet etc. which may not be real online learning without any dedicated online learning platform.

• Reduced global employment opportunity- Some may lose their jobs from other countries and the pass out students may not get their job outside India due to restrictions caused by COVID-19. Many Indians might have returned home after losing their jobs overseas due to COVID-19. Hence, the fresh students who are likely to enter the job market shortly may face difficulty in getting suitable employment. Many students who have already got jobs through campus interviews may not be able to join their jobs due to lockdown. The Indians who have been doing their jobs abroad may lose their jobs. Recent graduates in India are of also fearing for withdrawal of job offers from corporate sectors because of movement restriction in the current pandemic situation [14].

Why There is Still Limit Connectivity in Kashmir

Why Shackles and fetters is only for Kashmir "The Internet is becoming the town square for the global village of tomorrow. We are all now connected by the Internet, like neurons in a giant brain. The percentage of netizens is tremedenoulsy increasing day by day and percentage is expected to increase. How will Bharat achieve the Digital India plan of making the Internet available to everybody if we curb access to it in some parts of the country? In today's time, access to the Internet is a democratic right, and it should not be taken away from citizens on the pretext of law and order. Continued curbs on Internet here are devoid of any merit and logic and rationale

today, but the authorities, for some unknown reasons, are refusing to heed countless appeals for a review of current impasse. The students of Kashmir are not able to enjoy online classes just because of internet barring which was imposed before eight months ago due to reason of abrogation of article 370. The article had been abrogated but very sad the internet is still on 2g or in snail's pace. In the modern era internet is like the oxygen and blood for people and government is snatching this fundamental right from Kashmiri people now and then. Why Shackles and fetters is only for Kashmir "The Internet is becoming the town square for the global village of tomorrow. We are all now connected by the Internet, like neurons in a giant brain. The percentage of bedizens is tremedenoulsy increasing day by day and percentage is expected to increase. How will Bharat achieve the Digital India plan of making the Internet available to everybody if we curb access to it in some parts of the country? In today's time, access to the Internet is a democratic right, and it should not be taken away from citizens on the pretext of law and order. Continued curbs on Internet here are devoid of any merit and logic and rationale today, but the authorities, for some unknown reasons, are refusing to heed countless appeals for a review of current impasse. Even as the measure has attracted lot of bad press, including open criticism from many western nations and even admonitions from the Supreme Court of India, and the rights bodies like Amnesty International, about the denial of Internet connectivity being a violation of peoples' fundamental rights, the government has remained visibly opposed and resistant to any change in its stance.

Life of Private School Teachers and His /her Sufferings

Teachers are a special blessing from God to us. They are the ones who build a good nation and make the world a better place. A teacher teaches us the importance of a pen over that of a sword. They are much esteemed in society as they elevate the living standards of people. They are like the building blocks of society who educate people and make them better human beings. A teacher does not merely stick to the role of a teacher. They adapt into various roles as and when the need arises. They become our friends when we are sad, they care for us like our parents when we are hurt [15].

Thus, we see how great a teacher impacts a student's life and shapes it but very unfortunate that most teachers in our society are feel the marginalized, underappreciated and underpaid; this statement is more accurate for teachers working in the private sector. Teachers in private schools are facing exploitation similar in nature to the exploitation suffered by manual labourers in our textile mills and brick kilns, and yet very few people realize the extent and scale of this exploitation. During the ongoing pandemic i...e COVID-19 first time the parents and students realized the utmost importance of a teacher. Once the COVID-19 hit the road all the school teachers tighten their belts and impart online education to their students through various online study applications. Infact Private school teachers are playing an important and titanic role during this ongoing pandemic in terms of online education. They don't left any stone unturned in order to provide online education to the students.

From time to time private schools principles are providing orders to their teachers and teachers are fallowing their orders from heart and spirit. The orders are like online examination, checking of papers , preparing of assignments for students, call parents regarding fee etc. etc. The school principal never takes the life of their teachers into consideration. Do you know why during the imposition of section 144 private school teachers receives call in the morning from their heads to reach at school and do the different tasks. These principals never think that there is an imposition of section of 144 and how these teachers will come to school. Infect private school teachers can't utter a word because they know that if they will say anything to their heads they will be kicked out or disengaged from school. However it's reality that these teachers don't have any other source of income except this teaching. From March 2020 to till date private school teachers don't take a single penny from the school. Just imagine how will they survive and fill their stomach. Hence, private school became a sector of imperialism in Kashmir. During this ongoing pandemic only the sector of education and life of private school teachers gets much affected in all aspects. May God have mercy on all private teachers and helps all these private school teachers to come out from the mental torture and traumatic situation. The government decided to give some level of financial relief to the private teachers. But till date nothing has been done and life of private school teachers is persistently burning. Let's assume the role of government school teacher they are taking huge salary from the government exchequer every month without performing any duty and online class.

Virtual Learning: Can it Replace Teachers?

When COVID-19 is threatening the very existence of humankind, and has forced on the people world-over a secluded existence within the walled cast is of their homes, Internet has become a sole window of hope. It is a vital tool for the people to maintain social contacts in virtual world when physical connections are discouraged for their potential and ability to aid and facilitate dangerous transmission of novel corona virus. Internet connectivity is also the only aid for the health practitioners to keep themselves abreast with latest happenings – in terms of medical research about containment and treatment of the corona virus infections, as well as effective preventive strategies that ordinary people are encouraged to educate themselves about, and adopt so as to keep the disease at bay, both for its physical dangers and its psycho-social impacts. E learning in the rapidly evolving world, knowledge is considered to be just a click away.

The traditional books have given way to e books and the brick and mortar classrooms have given way to virtual classrooms. The term virtual learning stem from the concept of virtual learning environment also known as e learning or Ed tech. A virtual learning environment is a set of teaching and learning tools, which incorporate the computers and the internet as important components of the education process. They are in a way designed to enhance the learning experience of the student. instant messaging, wikis and weblogs, discussion forums, audio and video conferencing, email, smart boards, online games and activities, internet and computer software's all come under the umbrella of VLE. This concept is slowly gaining popularity owing to the benefits it

others. Virtual learning has completely revolutionized the education sector in India. A student is no longer dependent on a teacher and the classroom teaching has transcended the four walls of the classroom. Weaker students can escape from the shame of facing a classroom full of students and can work on improving their scores [16]. Virtual leaning thus improves their confidence and provides positive motivation for learning. The student cantered teaching approaches of virtual learning reduces student's dependence on teachers and makes them more confident. Virtual learning also offers pedagogical benefits like increasing confidence of students, providing reinforcement and positive motivation. Virtual learning has come as a breeze of fresh air for all those, which found it difficult to relate to the concept of classroom teaching. It leads to understand online discussion and further understanding of the topic at hand. All said and done, never ever can technology substitute a teacher in a student's life? Over the years, the schools have been the learning grounds for the students. Right from interacting with the people and learning the art of socializing.

The schools have much more to offer. During the growing years of one's life, it's the teacher who is always there as friend, guided, mentor and support for the students. E learning can never replace a teacher. In the case, system suddenly suffers from one software to hardware breakdown; it's the teacher who will come to their rescue. The complete arena of the virtual learning is based on the fact that the computers and the internet are used to teach the student. This somehow defies the basic principle of education. In an online world, there is nobody to guide, teach and make the students learn the social skills, which are of Paramount importance. Virtual learning is an emerging concept which can greatly help to bridge the learning gap and prove to be an excellent teaching aid in the classroom. Some students are very comfortable in working with technology while the less techno savvy students have the problem of getting left behind. Thus it became the responsibility of the teacher to use technology to her advantage and cater to the needs of every student. The teachers have played the role of mentors, guides, leaders and facilitators in the lives of the students. They have encouraged, motivated and inspired the students to aspire, dream and fulfil their desires. This is something which no robot or artificial intelligence machinery can do. This type of warmth and personal care offered by the teacher can in no way be substituted by a machine. Thus we can say that virtual learning resources can revolutionize the teaching learning process, but they can't completely replace the teacher.

Suggestions

1. India should accept the Full technology for development of education.
2. The Indian govt should enact sound laws for private schools so that there will be no exploitation with the teachers.
3. Internet is a fundamental right of citizen so it should be open for all without any discrimination.
4. India must invest more and more on education.
5. The schools should start casework of internet for students so, that during any crisis they can use it well for education. 6. The teachers should take training of accessing internet and electronic devices.

References

[1] T. Abel, D. McQueen the COVID-19 pandemic calls for spatial distancing and social closeness: not for social distancing! Into J Public Health (2020), 10.1007/s00038-020-01366-7Google Scholar.

[2] D.K. Abhors, C.-Y. Lin, V. Omani, M. Safari, M.D. Griffiths, A.H. PakpourThe fear of COVID-19 scale: development and initial validation Int. J. Mental Health Addiction (2020), 10.1007/s11469-020-00270-8 Google Scholar.

[3] S.K. Brooks, R.K. Webster, L.E. Smith, L. Woodland, S. Wessely, N. Greenberg, et al.The psychological impact of quarantine and how to reduce it: rapid review of the evidence The Lancet, 395 (10227) (2020), pp. 912-920, 10.1016/S0140-6736(20)30460-8 Article Download PDF View Record in Scopus Google Scholar.

[4] A. Schimmenti, J. Billieux, V. StarcevicThe four horsemen of fear: an integrated model of understanding fear experiences during the COVID-19 pandemic Clan Neuropsychiatry, 17 (2) (2020), pp. 41-45 View Record in Scopus Google Scholar.

[5] Centers for Disease Control and Prevention. (2020). Corona virus disease 2019 (COVID-19): Stress and coping. from https://www.cdc.gov/ coronavirus /2019-ncov/about/coping.html Google Scholar.

[6] M.A. Mamun, M.D. Griffiths First COVID-19 suicide case in Bangladesh due to fear of COVID-19 and xenophobia: possible suicide prevention strategies Asian J Psychiatry, 51 (102073) (2020), 10.1016/j.ajp.2020.102073 Google Scholar.

[7] B.K. WiederholdSocial media use during social distancing Cyberpsychol Behav Soc Netw, 23 (5) (2020), 10.1089/cyber.2020.29181.bkw Google Scholar.

[8] K.R. Kaufman, E. Petkova, K.S. Bhui, T.G. SchulzeA global needs assessment in times of a global crisis: world psychiatry response to the COVID-19 pandemic BJPsych Open (2020), 10.1192/bjo.2020.25.

[9] World Health Organization. (2020a). #HealthyAtHome. from https://www.who.int/news-room/campaigns/connecting-the-world-to-combat-coronavirus/healthyathome Google Scholar.

[10] M.D. Blasi, A. Giardina, C. Giordano, G.L. Coco, C. Tosto, J. Billieux, et al.Problematic video game use as an emotional coping strategy: evidence from a sample of MMORPG gamers J Behav Addict, 8 (1) (2019), pp. 25-34, 10.1556/2006.8.2019.02 CrossRefView Record in Scopus Google Scholar.

[11] D.F. Jacobs general theory of addictions: a new theoretical model Journal of Gambling Behaviour, 2 (1) (1986), pp. 15-31, 10.1007/BF01019931 CrossRefView Record in Scopus Google Scholar.

[12] E.J. KhantzianAddiction as a self-regulation disorder and the role of self-medication
Addiction, 108 (4) (2013), pp. 668-669 CrossRefView Record in Scopus Google Scholar.

[13] O. Király, R. Urban, M.D. Griffiths, C. Gaston, K. Nagygyörgy, G. Kökönyei, et al.Psychiatric symptoms and problematic online gaming: the mediating effect of gaming motivation J Med Internet Res, 17 (4) (2015), Article e88, 10.2196/jmir.3515 CrossRefView Record in Scopus Google Scholar.

[14] J. Billieux, A. Schimmenti, Y. Khazaal, P. Maurage, A. HeerenAre we overpathologizing everyday life? A tenable blueprint for behavioural addiction research J Behav Addict, 4 (3) (2015), pp. 119- 123, 10.1556/2006.4.2015.009 CrossRefView Record in Scopus Google Scholar.

[15] D.L. King, P.H. Delfabbro, J. Billieux, M.N. Potenza Problematic online gaming and the COVID-19 pandemic J Behav Addict (2020), 10.1556/2006.2020.00016 Google Scholar.

[16] C.H. KO, J.-Y. Yen, Impact of COVID-19 on gaming disorder: monitoring and prevention (2020) Journal of Behavioural Addictions. [in press] Google Scholar.

Convergence
Vol. 15, No. 1-4, pp. 23-36, 2022

ETHICAL IMPLICATIONS OF COVID-19 VACCINE

Dennis Soosai[1]*, Xavier Savarimuthu[2] and Ravindhran Ramalingam[3]

[1]* Research Scholar, Department of Plant Biology and Biotechnology, Loyola College (Autonomous), Chennai - 600034.
[2]Research Director, St. Joseph's Research Institute (SJRI), St. Joseph's University, 36, Lalbagh Road, Bengaluru - 560027.
[3]Associate Professor, Department of Plant Biology and Biotechnology, Loyola College (Autonomous), Chennai - 600034.
***Corresponding Author Email**: dennisdarj@gmail.com

Abstract: The Corona pandemic has caused a severe damage to the humanity. It has affected the life of everyone living on this earth. A lot of lives were lost in almost all the regions of the world. Apart from following a Special Operating Procedures (SOP), developing the vaccine was the only way to save the human lives. Though many vaccines have been developed for the use, no single vaccine is seeming to be having total efficacy. Further, only the affluent and technologically advanced countries have the know-how of developing a vaccine. What happens to the rest of the poor and the marginalized people for vaccine? World leading countries are taking efforts for equity in producing and administering vaccines. This pandemic challenges the humanity at its best. A global concerted efforts are being taken to fight this pandemic. Many developed nations are coming forward to help the low-income countries by donating vaccines through various organizations. Businesses need to take a human centric approach. Generosity and human values should outdo all the other concerns. Ubuntu, the African philosophy which explains 'I am what I am because of all who we are,' should be the mind of everyone. Vaccination also reminds that 'No-one is safe until everyone is safe'

Keywords: COVID-19 vaccine, Ethical value, Human life, Equity, Intellectual Property Rights **(**IPR), COVID-19 Vaccine Global Access (COVAX)

Introduction

The corona pandemic which started in Wuhan, the capital city of Hubei province of China -in December 2019, spread around the world very quickly. As of June 30, 2021, COVID-19 cases per million people are in Seychelles- 1393.13, Namibia- 707.51, Colombia- 600.72, Mongolia-559.92, Argentina-456.03, Kuwait-397.67, Uruguay-374.36, and India- 34.04 [1]. The Pandemic resulted in a total lockdown in countries around the world. The use facial masks and sanitizers increased manyfold among the people. It increased a huge demand of these supplies. Companies and few countries made huge profits on them. But in spite of the following Special Operating Procedures (SOP), there was a great loss of lives. The Case Fatality Rate (CFR) as on June 30, 2021, (is the confirmed cases and deaths per million people) are as follows: United Kingdom- 2.67% Colombia 2.50%, Spain- 2.12%, Argentina- 2.11%, Namibia- 1.69% and Botswana-1.61% [2]. A report in Washington Post says that there were hundreds of bodies found floating in

India's Ganges River. Some of the relatives of the victims were too poor to give a decent cremation for their loved ones. The dead bodies were abandoned in the river [3]. There was an undeniable undercounting in many regions of the world. In India, according to the Civil Registration System (CRS), during the months of second wave of April and May 2021, in particular, far in excess of the official COVID-19 occurred. Madhya Pradesh (reported deaths-3,48,708 and official COVID-19 toll-4,461) and Andhra Pradesh (reported deaths-2,72,910 and official COVID-19 toll-3,822) under reported the toll between 30 to 40 times. [4] Many other Indian states too had under reported COVID-19 deaths. But for the lack of availability of official data, the real COVID-19 deaths are not able to be calculated. It gives a very sad picture of the state of affairs. One wonders that who will take responsibility for these deaths?.

Many countries rushed to develop vaccine for COVID-19. By January, 2021 there were at least nine different vaccines being developed which were at various clinical trial stages of development by different companies. The use of Vaccine had an impact on the COVID-19 infection and recovery rate. The use of facial mask and social distancing norms were imposed in India and elsewhere. In a affidavit filed before Gujarat High court in response to a Public Interest Litigation (PIL), the state government stated that 37.42 lakh Gujaratis paid Rs. 252 Crore between June 24, 2020 and June 28,2021[5]. This fine money could be used for free vaccination as it will definitely help to curb the COVID-19. The use of Vaccine reduced the death rate. India needs around 1.3 billion doses between August -December 2021 says epidemiologist expert Dr. Chandrakant Lahariya [6]. As of July 2, 2021, the number of deaths related to COVID-19 India has risen to over 400,000 only next to US and Brazil [7]. Vaccination is the only way to save people.

We are to raise certain questions. Was the necessary procedure followed in the development of vaccine? How was the COVID-19 vaccine distributed? What about those poor countries who neither have the facilities to produce vaccine nor money to buy them? What were the priorities of the local governments? What about those people who died after taking the vaccines? What about those frontline workers who died in hundreds during pandemic? What about those 12.6 heart inflammation cases per million doses for both Pfizer and Moderna COVID-19 Vaccines? [8]. Though vaccines outweigh any risk but how do we justify those who are affected by it? There are instances where people conducted fake vaccination camps [9]. We try to enter in to discussion into these areas.

Materials and Methods

As the COVID-19 pandemic began, information, happenings that are around the world was collected through news reports, editorials, analysis from around the world. The major data that were collected were from websites like Our World in Data, World health organization. The International dailies like, The Washington Post, New York Times and the National dailies like The Hindu, Times of India, The Indian Express were regularly checked for updates on the topic. The news channels like BBC news, CNBCTV18, NDTV were also referred during this period. The various websites of

The Jesuits global, The Guardian were also taken as reference points.

Results and Discussion

Vaccines and It's Various Developmental Stages

The vaccine to be developed is subjected to a standard procedure. First, it goes through the **Preclinical Testing.** Here the vaccine is administered to different cell lines and also tested on the animals for the desired Immune responses. Depending on the immune response it is moved to the next stage of development. Second, it is subjected to **Phase 1 safety trials.** Here the vaccine is administered to a small group of people are tested for safety, dosage and to confirm that if it stimulates immune response. Third, the vaccine goes through the **Phase 2 Expanded Trials.** Here the vaccines are administered to hundreds of people in groups like children, adults and observe their immune responses according to their categories and further safety trials are also done. Finally, it goes through the **Phase 3 Efficacy trials** [10]**.** Here the scientists administer the vaccines to thousands of people to see that how many become infected as compared with the volunteers who received the placebo (people in one group get the tested drug, while the others receive a fake drug, or placebo, that they think is the real thing) [11]. At this stage we can determine if the vaccine protects them from the corona virus measuring what efficacy rate is. It is only at this stage the people are observed for any side effects. According to Shahid Jamel, virologist and Director, Trivedi school of biosciences, Ashoka University says, 'Every product must be safe and efficacious for everyone to take. And that data is still lacking for Covaxin' [12]. The Covaxin was administered to the public in India from the First day of Vaccination which is 16th of January, 2021. Is it ethical to use Covaxin when the efficacy data was not available? May be another vaccine which meets all requirements like Covishield could have been used. What happens to all those health care workers, who were denied this choice of vaccines? The restricted use approval for Covaxin could have been given after the efficacy data was available says Dr. Anant Bhan, a researcher in global health and bio ethics [13]. As per the updated report, the Central Government has submitted an affidavit at the supreme court mentioning the detailed of the vaccine availability to the Indian public. The Government of India (GOI) plans to vaccinate the entire adult population by December 2021 [14]. The GOI has also categorically said that it is not going to entertain any death resulting in vaccinations. The government cannot be held liable to pay compensation for deaths due to the administration of COVID-19 vaccines, the Centre has told the Supreme Court [15]. According to the government sources, the following vaccines are in the pipeline in the making in India (Table 1). The exemption of Goods and services Tax (GST) on vaccines were requested by the state governments, yet the GST council of India has not come with any GST exemption plans. However, the GOI has made a policy in procurement of the vaccines. Further, there are many more plans are in the pipeline for procuring more vaccines (Table 1) [16].. This could address the issue that are ahead of us.

Need for Administering Vaccines

COVID-19 has been declared as a global Pandemic. The need for a vaccine is the last resort to protect the people from this

onslaught of the COVID-19. Vaccines, primarily has dual purposes. **First** it should be able to produce immunity by producing antibodies in the individuals who has been administered this. Thus, the individuals will be able to overcome COVID-19. **Second**, the vaccine also should lead to developing a herd immunity by ensuring a threshold coverage[17]. When this happens, a thresh hold coverage of the population will be reached. Whom should be vaccines administered first? Many governments had their priority or target groups listed. 'In India, first the 3 crore frontline workers were to get the vaccine. This will be followed by people who are 50 years and above, considered high risk category will be vaccinated' [18]. However, the Indian health ministry's advisory says that only those above 18 years and above could be administered vaccine except pregnant women and those on blood thinners. What clearly the advisory says that 'other vaccine specific contradictions may apply as new information becomes available [19]. This implies that we do not have full information available as the 3rd phase efficacy trials are not sufficiently done in different group of people and region to see get a wider, better data on the efficacy of a vaccine. Dr. Vineeta Bal, immunologist and Faculty, Indian Institute of Science Education and Research (IISER), Pune and former scientist in an interview to Jacob Koshy says that use of a vaccine without knowing its protection potential is unethical [20]. This is because though there are some safety and immunogenicity data but absolutely no efficacy data which is essential for a vaccine to be administered publicly.

The priority of the governments sometimes gets misplaced. When the Pandemic was raging in the country, the Union Government was focussing on the building the Central Vista project at Delhi [21]. At the same time, the government had told the states and Union territories to fund their own vaccination plans. But later changed the plans and proposed for centrally funded schemes with conditions [22].

Vaccine- Variety and Efficacy

Below are the details of 9 vaccines as displayed in Table:2 along with their efficacy data [23]. Efficacy of the vaccine is known in the 3rd phase of the vaccine trial. According to the above data only 6 vaccines have some efficacy data. The Pfizer-BioNTech's Comirnaty has the highest 95% of efficacy. Covishield has 62-90% of efficacy [Table:2]. Bharat Biotech's Covaxin's efficacy data was not available when the first vaccination drive began on January 16, 2021. The Indian government recommended both Covishield and Covaxin to be administered. A group of 13 scientists in India are of the opinion on the immunogenicity data available for Covaxin, say that "it is imperative that relevant data from the larger phase-3 (efficacy) trial become available before administering the vaccine to large number of people" [24].

The scientists are working on a Super Vaccine for all COVID-19 variants at the University of North Carolina Gillings School of Global Public Health [25]**.** This promising vaccine is in trial stage. This vaccine will be effective against multiple variants of SARS-CoV-2. They hope that this will be available by next year. The scientists at the centre also believe that a possible SARS-CoV-3 could also be dealt with in case it appears in the future [26]**.**

Vaccines and Co-morbidity

Co-morbidity is a condition in a person with an acute disease, due to infections, inflammations, nutritional, metabolic, vascular or neoplastic (tumours, benign or malignant) disorder. Co-morbidity, when combined with COVID-19 make it a lethal combination leading to death of an individual. The SARS-CoV-2 has the viral surface spike protein that attaches to humans (endothelial cells in vascular tissues) cells with the help of 'angiotensin converting enzyme 2' (ACE2), a human cell surface protein [27]. Endothelial cells are found in all arterial, venous and capillary blood vessels and on smooth muscles that surround them. Once the SARS-CoV-2 gains entry to these cells with the help of ACE2, they destroy them using the viral replicating mechanism. This in turn affects the blood supply to the tissues and eventually to the organs. Thus, when someone with co-morbidity gets COVID-19, the severity of the disease increases manyfold.

Vaccines, given at an early stage of infection may reduce the risk of COVID-19 death combined with co-morbidities. Though vaccines will not help the damage already done but will reduce the risk of further multiplication of virus. Thus, emergency use of COVID-19 vaccine could be justified to the elderly. Pancreas which are studded with ACE2 are easy target for SARS-CoV-2. Sometimes people develop high blood sugar level after recovering from COVID-19 infection. Those who recover from COVID-19 are also prone to developing chronic diseases. For the elderly, it is evident that prevention is better than cure. Morally it is important that the elderly is given the priority in administering the COVID-19 vaccine. Poor people with Co-morbidity are at higher risk of death if not vaccinated in time.

Vaccines and Pricing

Vaccines comes at a cost. Since the production of vaccines involves preclinical trials, and other 3 different phase of trials (as mentioned earlier) which involve larger group of people as volunteers, documenting and analysing the date involves a reasonable expense. The Covishield produced by Serum Institute of India and Covaxin produced by Bharat Biotech are two approved vaccines in India. Oxford University and AstraZeneca on April 30,2020 signed an agreement for the development and manufacture and distribution of the COVID-19 vaccine (ChAdOx1nCoV-19) on a non-profit basis with cost of production and distribution covered [28]. However, there are already signs that they are going back on their promises. By July 2021, the presumed end of pandemic they will revise their price of vaccines. Not only AstraZeneca but also the Pune based Serum Institute of India has said that the first hundred million doses for Rs.200 (about $2.74) per dose. After this there will be a fresh tendering process and different prices will be available as mentioned by CEO of Serum Mr. Adar Poonawalla. 'When the government permits to sell the vaccines in the private market, the vaccine will be priced Rs.1000 per dose' [29]. When this happens what will happen to the low- and middle-income countries of the world? Already the price of the Serum Institutes vaccine has been sold for higher price. In case of Bangladesh, the vaccines have been priced at $4 a dose about 47% more than what India pays for the vaccines. And in case of South Africa, the Serum will be supplying vaccines at $5.25 a dose, which

is much higher than the price under the African Union agreement for Covishield and also what European countries have agreed to pay AstraZeneca [30]. In fact, AstraZenca conducted its phase-3 trials in South Africa. This already indicates the abuse by the companies. The price comparison of these vaccines with other available vaccine around the world as follows [31][32]:

Though the vaccine made by Bharat Biotech, seems to be cheapest but it is yet to be cleared in the third phase of the trial. Overall, the prices of COVID-19 vaccines are costlier than other vaccines which are available in the market. The comparison of the COVID-19 Vaccine with other vaccines are as follows [33][34].

When the governments sponsor the vaccines, the poor are able to get the vaccine. If not, the vaccines will become dearer. The poor and the marginalised will be neglected.

The Indian government though announced free vaccine for all in the year 2019, by May 2021 has changed the vaccine policy. Of the total requirement of vaccines 75% will procured by the central government and the 25% will be procured by the private operators. This splitting "splitting" of vaccine orders only ended up benefitting private manufactures [35]. One dose of Covishield cost around ₹900-950 in private hospitals while Covaxin costs ₹1200-1300 [36]. At this cost the needy and the poor will not get the vaccine at the right time when they need it. Leaving the vaccination policy to market forces is neither ethical nor practical [37].

Vaccines and Intellectual Property Rights (IPR)

The world needs a huge quantity of vaccines in a short period to overcome the COVID-19 pandemic. This can happen when the owners of vaccine producing units voluntarily licensing their products to other companies more in particular to India where it has large vaccine manufacturing facilities and it could produce at low costs. While upholding the WTO backed functioning of Trade Related Aspects of Intellectual Property Rights Agreement (TRIPS), still by voluntary licensing, the world demand for vaccines could be met in the required time [38]. The European Union (EU) lawmakers back a patent waiver for vaccines. So far, this suggestion did not go well with other key member states. Germany and France defend patents and argue that the companies must be rewarded. 'EU trade commissioner Valdis Dombrovskis told the lawmakers that Brussels would put forward its own proposal at the WTO focussed on boosting production and freeing up exports'[39]. "Without the waiver, low- and middle-income countries don't have the ability to manufacture vaccines, and they will have to rely on pharmaceutical companies and wealthy countries for charity or go without access to lifesaving medicines and technology" affirms the Canadian Jesuit International[40].

Vaccination in Different Countries

As of 4th July,2021, the total population vaccinated are as follows (in Millions): India -351.23, United States- 330.6, United Kingdom-79.08, Germany-77.33, Japan-50.87 and Canada-39.7 [41]. Different countries have used different strategy in administering vaccines. When we look at the share of the total populations that received vaccination per 100 people, the details are as follows: United Kingdom-116.49, Canada- 105.19, United States-98.85, Germany-92.3, Japan-40.22 and

India-25.45 [42]. Up to May 23, 2021, only 10.9% of the Indian population had received one dose and only 4% had been fully vaccinated with two doses [43]. The countries of the world have to work at war footing to contain the further spread of the SARS-CoV-2.

Though the vaccines need to be approved by concerned regulatory bodies before it could be put for public use, there are other issues arise. So far Covaxin is accepted by 9 countries outside India. India also says that it won't accept EU vaccine certificates unless it considers Covishield and Covaxine for green passport [44]. The students who go abroad for studies will be affected the most.

Vaccination and Gender Gap

Vaccination is also affected by the gender in different cultures and regions of the world. In India as the vaccination progress steadily, vaccination rate (people vaccinated per 1000 individuals) also differs. As per the study on July 4, 2021, 349 per every 1000 women aged above 18 years and 390 per every 1000 men aged above 18 have received at least one dose. [45]. 'Women are not seen as important part of the family, community or society structure. The vaccine gap is generally a reflective gap of gender inequality in India, and internationally,' says Bhagyashree Dengle, executive director of Asia Pacific and gender transformative policy and practice for Plan International [46].

Vaccine Wastage and Hesitancy

Vaccines are sensitive to the changes in the temperature in which they are stored. The potency of the vaccine depends on the optimum temperature that it should be stored throughout the supply chain. The optimum temperature varies from vaccine to vaccine. Pfizer-BioNTech vaccines needs to be stored at -60^0 C to -90^0 C. Moderna needs to be stored at -20^o C. AstraZeneca-Oxford needs to be stored at $+2^0$ C to $+8^0$ C and Sputnik needs -18^0 C [47]. When people do not turn up for the vaccination, a lot get wasted. A lot of people still hesitate to get vaccinated for various reasons. It could be ill information about the available efficacy data, wrong information about the effects it causes on the receiver of the vaccines. In some cases, correct information is not shared by the concerned authorities. So, these lacuna needs to be addressed, so that people make well informed choices. The religious groups and the community leaders could be used to spread the awareness about the need to be vaccinated. This will also help in more vaccination and will also reduce the vaccine wastage. According to the Indian government data, Jharkhand wasted 33.95%, Chhattisgarh 15.79% and Madhya Pradesh 7.35% [48]. Later, the Jharkhand government refuted the union governments' above data.

Vaccines and Equity

Most of the countries around the globe administer the COVID-19 vaccine free of cost to its citizens. The countries who are affluent and who had the know-how of manufacturing vaccines took care of their citizens. Some of the countries even paid a higher price for the vaccines and got them administered in record time. The fate of the poor countries is really a concern. India has among the highest out-of-pocket (OOP) expenditures of all the countries in the world, i.e., money that people spend on their own at the time they receive health care. The WHO estimates that 62% of the total health expenditure in India is OOP, among the highest in the world [49]. In

such cases the government should help the poor by supplying free vaccines.

The process of vaccine development, efficacy, pricing, and administering raises a number of scientific and moral questions. What are the criteria on which the beneficiaries of the vaccine be decided? It also raises the concerning the freedom given to the people in choosing the vaccines as per their need. The world leaders and countries need to follow a sustainable path of development by including the people who are under privileged. Certain governments did not give the choice to people in choosing their vaccine. Some poorer nations did not even offer vaccines even by end of May 2021.

The U.S. proposed to work with COVID-19 Vaccine Global Access (COVAX) the largest delivery platform in the world, along with other partners to deliver 80 million doses of vaccine to other needed countries [50]. Thus, the low income and low-middle income countries population will be catered to. The Quad partnership which includes India, the U.S., Australia and Japan aims to manufacture in India at least 1 billion vaccine doses by the end of 2022 [51]. The US has committed to 13% of its 80 million doses by the end of June,2021 to other countries [52]. "At least 75% of these doses- nearly 19 million -will be shared through the COVAX, including approximately 6 million doses for Latin America and the Caribbean, approximately 7 million for South and southeast Asia, and approximately 5 million for Africa. The remaining 6 million will be distributed as per the surging crises including Canada, Mexico, India and the Republic of Korea," says Mr. Joe Biden [53].

The EU Leaders agree to donate 100 million doses for equitable access to doses. Gathered in Brussels for a two-day summit, the 27 leaders backed a text in which they pledge to continue efforts "to increase global vaccine production capabilities to meet the global needs" [54]. The COVAX platform is used for the equitable distribution of the dosses. Although the effort is taken globally, still there are regions and countries around the world where their autocratic governments take least efforts to administer vaccines for its citizen. Also, another fact to note that COVAX programme was established to purchase vaccine dosses and donate them to low-income countries but does not involve in modifying patent rights [55]. Dr. Tedros Adhanom Ghebreyesus, the Director General of WHO has warned that people in the lowest-income countries might have to wait until 2022 to get vaccinated through this COVAX programme [56]. But the good news is that COVAX has shipped around 68 million doses so far[57]. The UNICEF while quoting the world leaders on Equitable vaccine distribution is a humanitarian imperative says, 'No-one is safe until everyone is safe'[58].

The G 7 leaders gathered at the summit at Cornwell, promise one billion doses for the poorer nations by the end of 2021[59]. They have promised to work along with the private players, the EU, COVAX, Global Alliance for Vaccine and Immunization (GAVI) to support the poorer nations with COVID-19 vaccines.

Conclusion

Vaccine for COVID-19 has been playing a major role in slowing down the death rate in many countries. Some of the countries have taken utmost care in developing the vaccine. Many more vaccines have been at various development stage.

Looking at the available data, the vaccines have been approved for emergency use. As of now no single vaccine seems to be having 100 percent efficacy. But on account of emergency situation, vaccines with minimum trials or without proper efficacy data have been allowed for use which is unethical. The affluent and technically advanced countries have been vaccinating its population. Some others were not able to vaccinate many due to the lack of planning for the vaccine. However, ethical aspects of vaccines still remain to be answered. For example, the efficacy-based approval doesn't happen always. Who is responsible for those who die after vaccination? There are cases who got infected in spite of taking COVID-19 vaccine? No one could tell us the duration of the immunogenicity of the vaccine. We do not know the long-term side effects of vaccine. For now, saving the lives seems to me the topmost priority. When survival of the person in question, vaccination is a better option. Governments and organisations are putting their best foot forward to make the vaccines available at the earliest for the low-income countries. When the efforts are made globally, vaccines could be produced economically and administered equitably. Thus, the humanity will be saved by overcoming this pandemic successfully.

References

[1] Max Roser, Hannah Ritchie, Esteban Ortiz-Ospina and Joe Hasell (2020) - "Coronavirus Pandemic (COVID-19)". *Published online at OurWorldInData.org.* Retrieved from: https://ourworld indata.org/coronavirus' [accessed July 3, 2021].

[2] Max Roser, Hannah Ritchie, Esteban Ortiz-Ospina and Joe Hasell (2020)- "Coronavirus Pandemic (COVID-19)". *Published online at OurWorldInData.org.* Retrieved from: https://ourworld indata.org/coronavirus [accessed July 3, 2021].

[3]. https://www.washington post.com /world/asia_pacific /india-coronavirus-ganges-river-bodies/2021/05/21/73cbced6-b811-11eb-bc4a-62849cf6cca9_story.html accessed May 23,2021

[4] https://epaper. thehindu.com/Home /ShareArticle?OrgId=GQ18O53U9.1 [accessed July 7,2021].

[5] https://times ofindia. india times.com /city/ ahmedabad/rs-252cr-mask-fine-collected-in-state/ articleshow/ 84047788. cms [accessed July 2, 2021].

[6] Jacob Koshy, The Hindu, "1.3 billion doses a realistic estimate" 21st May,2021. https://epaper.thehindu.com/Home/ShareArticle?OrgId=G6I8JP0B7.1 [accessed June 23, 2021].

[7] COVID-19: India logs 400,000 deaths amid vaccine ramp -up https:// www. bbc. com/news/world-asia-india-57676223 [accessed July 3, 2021.

[8] "Emma Newburger, 'FDA adds warning about rare heart inflammation to Pfizer, Moderna COVID-19 vaccines" https://www.cnbc.com/2021/06/26/fda-adds-warning-of-rare-heart-inflammation-to-pfizer-moderna-vaccines.html [accessed July 01, 2021].

[9] https://epaper. thestatesman. com/ 3148925/ Kolkata-The-Statesman/03RD-JULY-2021#clip/ 61562608/d015 6f63-4b57-4610-8df0-3738d47fc9bc /801.078 50961 56923:779. 3438906021415 [accessed July 3, 2021].

[10] https://www.nytimes. com/ interactive /2020/science/coronavirus-vaccine-tracker.html [accessed January 21, 2021].

[11] https://www. health. harvard.edu/ mental-health/the-power-of-the-placebo-effect [accessed April 7, 2021].

[12] Jacob Koshy, The Hindu, 10th January,2021, Pg-8 'A Vaccine is a Vaccine… regulators never approve a back-up'. https://epaper.thehindu.com/Home/ArticleView [accessed January 10, 2021]

[13] R. Prasad, The Hindu 15th January,2021. https://www. thehindu. com/sci-tech/health/vaccine-dilemma-to-take-or-not-to-take-covaxin/ article33577223.ece [accessed June 26, 2021].

[14] 'India's Vaccine Roadmap: 216 Cr Doses likely by Year- End, Enough for Entire Populace' https://www. news18.com/news/india/deals-underway-how-india-will-vaccinate-entire-populace-with-216-doses-by-year-end-3898253.html [accessed June 28, 2021].

[15] https://www. thehindu.com/sci-tech/ health/government-not-liable-to-compensate- for-covid-19-vaccine-deaths-injury-centre-tells-sc/article66202106.ece [accessed November 30 ,2022].

[16] 'India's Vaccine Roadmap: 216 Cr Doses likely by Year- End, Enough for Entire Populace' https://www. news18.com/news/india/deals-underway-how-india-will-vaccinate-entire-populace-with-216-doses-by-year-end-3898253.html [accessed July 2, 2021].

[17] George, Mathew 'The purpose of Vaccine "The Hindu, 3rd December,2020, p.7 https:// epaper. thehindu.com /Home/ArticleView [accessed January 30, 2021].

[18] COVID-19 Vaccination To Start In India On January 16; 3 Crore Healthcare, Frontline Workers To Get Shots First https://swachhindia.ndtv.com/covid-19-vaccination-to-start-in-india-on-jan-16-3-crore-healthcare-frontline-workers-to-get-shots-first-55117/ [accessed January 31, 2021].

[19] Bindu Shajan Perappadan, 'who should not take COVID-19 vaccines' https://epaper.thehindu.com/Home/ArticleView [accessed January 31, 2021].

[20] https://epaper. thehindu.com/Home /ShareArticle?OrgId=GOC85DL2S.1 use of a vaccine without knowing its protection potential is unethical , Hindu, 9th Janaury,2021 [accessed June 26, 2021].

[21] https:// scroll.in /latest/994774/ coronavirus-give-free-vaccines-halt-central-vista-project-12-opposition-leaders-tell-pm-modi [accessed July 7,2021].

[22] https://www. livemint.com /news /india /centre-should-use-central-vista-project-funds-for-vaccination-against-covid-19-yechury-11620923874115.html [accessed July 7, 2021].

[23] https://www. nytimes.com/ interactive /2020/science/coronavirus-vaccine-tracker.html [accessed January 21, 2021].

[24] G.S. Mudur, The Telegraph 'COVID-19 Vaccine fissures among scientists' https://www.telegraphindia.com/india/covid-vaccine-fissures-among scientists /cid/ 1803736 [accessed January 15, 2021].

[25]. https://www.cnbctv18.com/healthcare/scientists-working-on-super-vaccine-for-covid-variants-human-trials-likely-next-year-9770101.htm [accessed July 7,2021].

[26]. https://www.indiatimes.com/news/india/scientists-are-developing-a-universal-super-vaccine-to-fight-all-new-covid-19-variants-543435.html [accessed July 7,2021].

[27] John Jacob T. & Seshadri M.S. 'How co-morbidities make COVID-19 severe' https://epaper.thehindu.com/Home/ShareArticle?OrgId=GIQ86CD2U.1 [accessed January 19, 2021].

[28] Prasad R. The Hindu, 'Reneging on the 'no-profit pledge' to supply Oxford vaccine' p.10, https:// www.thehindu.com/sci-tech/science/reneging-on-the-no-profit-pledge-to-supply-oxford-vaccine/article33705151.ece [accessed January 31, 2021].

[29] Prasad R. The Hindu, 'Reneging on the 'no-profit pledge' to supply Oxford vaccine' p.10, https:// www.thehindu.com/sci-tech/science/reneging-on-the-no-profit-pledge-to-supply-oxford-vaccine/article33705151.ece[accessed January 31, 2021].

[30] Prasad R. The Hindu, 'Reneging on the 'no-profit pledge' to supply Oxford vaccine' p.10, https://www.thehindu.com/sci-tech/science/reneging-on-the-no-profit-pledge-to-supply-oxford-vaccine/article33705151.ece , [accessed January 31, 2021].

[31] https://epaper. thehindu. com/ Home/ShareImage?Pictureid=G1586C04N.1[accessed January 19, 2021].

[32] https://epaper. thehindu.com /Home /ShareImage?Pictureid=G1586C04N.1 [accessed January 19, 2021].

[33] https://epaper. thehindu.com /Home /ShareImage?Pictureid=G1586C04N.1 [accessed January 19, 2021].

[34] https:// epaper. thehindu.com /Home /ShareImage?Pictureid=G1586C04N.1 [accessed January 31, 2021].

[35] https:// epaper. thehindu.com /Home /ShareArticle?OrgId=GTK8KIMRG.1 [accessed June 23, 2021].

[36] The Hindu, May 25, 2021 'No free Vaccination for 18-44 age group for the second day' https:// epaper.thehindu.com/Home/ShareArticle?OrgId=GU58K4QIE.1 [accessed June 23, 2021].

[37] Thomas George, Kang Gagandeep & Muliyil Jayaprakash, The Hindu, May 20,2021 'The basics of an effective vaccine policy https://epaper.thehindu.com/Home/ShareArticle?OrgId=GD68JH5ON.1 [accessed June 23, 2021].

[38] Hallibuton Murphy, The Hindu, May 22,2021, 'The AIDS fight offers a COVID-19 vaccine patent pathway' https://epaper.thehindu.com/Home/ShareArticle?OrgId=GAO8JN1QA.1 [accessed June 23, 2021].

[39] The Hindu, May 20,2021, 'EU lawmakers back patent waiver for vaccines' https:// epaper. thehindu. com/Home/ShareArticle?OrgId=GG28JLA0V.1 [accessed June 23, 2021].

[40] https:// www.sjesjesuits. global /2021 /06/28/global-campaign-for-vaccine-equity / [accessed July 01, 2021].

[41] Max Roser, Hannah Ritchie, Esteban Ortiz-Ospina and Joe Hasell (2020) - "Coronavirus Pandemic (COVID-19)". *Published online at OurWorldInData.org.* Retrieved from: https://ourworldindata.org/ coronavirus [accessed July 5, 2021].

[42] Max Roser, Hannah Ritchie, Esteban Ortiz-Ospina and Joe Hasell (2020) - "Coronavirus Pandemic (COVID-19)". *Published online at OurWorldInData.org.* Retrieved from: 'https://ourworldindata.org/coronavirus' [Online Resource] [accessed July 5, 2021].

[43] Britto Joseph, The Hindu, May 26, 2021, 'Vaccination is our only weapon'

https://epaper.thehindu.com/Home/ShareArticle?OrgId=GU58K4SA1.1 [accessed June 23, 2021].

[44] https://economic times. india times.com /news/india/india-requests -eu-member-states-to-consider-covishield-covaxin-vaccines-under-green-passport-scheme/articleshow/83991728.cms [accessed July 01, 2021].

[45] https://www.theguardian.com/global-development/2021/jun/28/india-covid-gender-gap-women-left-behind-in-vaccination-drive [accessed July 7,2021].

[46] https://www.theguardian.com/global-development/2021/jun/28/india-covid-gender-gap-women-left-behind-in-vaccination-drive [accessed July 7,2021].

[47] https://indian express.com /article /explained/covid-19-vaccine-storage-optimal-temperature-cold-chain-india-explained-quixplained-7063369/ [accessed July 7,2021].

[48] https:// www. ndtv.com /india-news/coronavirus-vaccine-wastage-busting-myths-centre-explains-1-covid-vaccine-wastage-policy-2461646 [accessed July 7, 2021].

[49] Deshpande Ashwini, The Hindu, May 21, 2021 'The fault line of poor health infrastructure' https:// epaper. thehindu.com /Home /Share Article? OrgId= GMB8JK60K.1[accessed June 23, 2021].

[50] Lakshman Sriram, The Hindu, May 19, 2021 'U.S. to work with COVAX to allocate 80 mn vaccine doses' https://epaper.thehindu.com/Home/ShareArticle?OrgId=G3A8JICPD.1 [accessed June 23, 2021].

[51] Lakshman Sriram, The Hindu, June 03, 2021 'Modi, Harris discuss nitty-gritty of U.S. offer on vaccine doses' https://epaper.thehindu.com/Home/ShareArticle?OrgId=GRE8KUGA0.1 [accessed June 23, 2021].

[52] Lakshman Sriram, The Hindu, June 03, 2021 'Modi, Harris discuss nitty-gritty of U.S. offer on vaccine doses' https://epaper.thehindu.com/Home/ShareArticle?OrgId=GRE8KUGA0.1 [accessed June 23, 2021].

[53] Lakshman Sriram, The Hindu, June 03, 2021 'Modi, Harris discuss nitty-gritty of U.S. offer on vaccine doses' https://epaper.thehindu.com/Home/ShareArticle?OrgId=GRE8KUGA0.1 [accessed June 23, 2021].

[54] The Hindu, May 25, 2021 'EU leaders agree to donate 100 mn dosses of vaccines' https:// epaper.thehindu.com /Home/ShareArticle?OrgId=GRM8K4DU8.1 [accessed June 23, 2021].

[55] Hallibuton Murphy, The Hindu, May 22,2021, 'The AIDS fight offers a COVID-19 vaccine patent pathway' https://epaper.thehindu.com/Home/ShareArticle?OrgId=GAO8JN1QA.1 [accessed June 23, 2021].

[56] Hallibuton Murphy, The Hindu, May 22,2021, 'The AIDS fight offers a COVID-19 vaccine patent pathway' https://epaper.thehindu.com/Home/ShareArticle?OrgId=GAO8JN1QA.1 [accessed June 23, 2021].

[57] Hallibuton Murphy, The Hindu, May 22,2021, 'The AIDS fight offers a COVID-19 vaccine patent pathway' https://epaper.thehindu.com/Home/ShareArticle?OrgId=GAO8JN1QA.1 [accessed June 23, 2021].

[58] https://www. unicef.org /press-releases/no-one-safe-until-everyone-safe-why-we-need-global-response-covid-19 [accessed July 5, 2021].

[59] https://www.reuters.com/world/g7-provides-1-billion-covid-vaccine-doses-will-work-give-more-communique-2021-06-13/, [accessed July 7, 2021].

List of Tables

S. No.	Manufacturer	Vaccine	Supply estimated July-December'21	Supply assured Aug-December '21
1	Serum Institute of India	Covishield	75 Crore	50 Crore
2	Serum Institute of India	Novavax	20 Crore	Not mentioned
3	Bharat Biotech	Covaxin	55 Crore	40 Crore
4	Bharat Biotech	Nasal Vaccine	10 Crore	Not mentioned
5	Biological E	Corbevax	30 Crore	30 Crore
6	RFID Russia	Sputnik V	15.6 Crore	10 Crore
7	Zydus Cadila	ZyCoV-D	5 Crore	5 Crore
8	Genoa	HGC019	6 Crore	Not mentioned
			216.6 Crores	135 Cores

Table 1. Details of Different Vaccines by the Respective Companies and Their Deadline for Disbursement [15]

S. No.	Name of the Company	Name of the Vaccine	Efficacy %	Country Wise Use
01	Pfizer-BioNTech	COMIRNATY	95	USA, MANY OTHERS
02	Moderna	mRNA-1273	94.5	USA & EU
03	Oxford-AstraZeneca	AZD1222 or Covishield	62-90	Britain, India Mexico
04	Johnson & Johnson	Ad26.COV2.S,	NA	-
05	Gamaleya	Sputnik V or Gam-Covid-Vac	91	Russia, Belarus
06	Novavax	NVX-CoV2373	NA	
07	Sinopharm	BBIBP-CorV	79.34	China, Bahrain and the United Arab Emirates
08	Sinovac	CoronaVac	50	China. Trials in Brazil
09	Bharat Biotech	Covaxin	NA	India

Table 2. Different Vaccines and Their Efficacy [22]

Manufacturer	Pricing Per Dose (in ₹)
Pfizer-BioNTech	₹1431
Moderna	₹2348-2715
Sinopharm	>₹5650
Sinovach Biotech	₹1027
Novavax	₹1114
Gamaleya Centre	>₹734
Johnson & Johnson	>₹734
Bharat Biotech	₹206.5 -295
Serum Institute of India.	₹200-1000

Table 3. Different Vaccines and Their Price (in ₹) [31]

Vaccine	Price Per Dose (in $)
Pneumococcal Conjugate Vaccine (PCV)	$ 3.3
COVID-19	**$3.1**
Pentavalent vaccine	$2.11
Rotavirus	$1
Japanese encephalitis (JE)	$0.18
Measles	$0.16
Oral Polio	$0.06
Bacille Calmette-Guerin (BCG)	$0.05
Hepatitis B	$0.05
Tetanus	$0.02

Table 4. Prices of Other Vaccines in Comparison to COVID-19 Vaccines

Convergence
Vol. 15, No. 1-4, pp. 37-45, 2022

THE CENTRALITY OF THE CONCEPT OF EUBIOS (GOOD LIFE) TO BIOETHICS

Darryl R. J. Macer[1]*
[1]*Director, Eubios Ethics Institute, New Zealand, Japan and Thailand & President, American University of Sovereign Nations, https://ausovereignnations.org.
***Corresponding Author Email**: darryl@eubios.info

Abstract: This paper presents the concept of a good life ("eu-bios") that has guided the work now in its fourth decade of Eubios Ethics Institute. The Eubios Declaration on International Bioethics (2002) and over efforts have promoted planetary health and an integrated and holistic approach to bioethics. The is a particular analysis of our relationships to animals and programs for bioethics education included amongst other topics.

Keywords: Bioethics, Eubios, Animal rights, Education, Good life.

A Good Life

I coined the term "eubios" from the Greek words for good "eu" and life "bios" in 1990 after spending some years reading about the popular topics of eugenics (good genes) and euthanasia (good death) which dominated bioethics discourse. Both these terms are usually reductionist [1]. Eugenics is linked to concepts of genetic determinism, i.e., a predominance of DNA as the explanation of why beings are made the way they are, and act the way they act [2]. As a molecular biologist it would be too easy to focus on the central dogma, that DNA leads to RNA leads to protein in a one way flow [3]. Three decades later we can see that the information flow is multidirectional, and both nature and nurture shape our life [10]. While there is a lot of attention surrounding ethical decision making at the end of life, and euthanasia is an important topic, our journey through life (Macer, 2022), has a lot more to celebrate than the last days. Eubios offers a more holistic approach to life, and the Eubios Ethics Institute has been widely influential because of the need to promote a holistic approach to bioethics.

As agreed in the Eubios Declaration on International Bioethics (2002): *"Life as a Whole* We recognize the dependence of all life (biota) on intact, functioning ecosystems, and the essential services that ecosystems provide. We urge action to halt environmental damage by humans that reduces biodiversity or degrades ecosystem processes.

Whereas wildlife provide numerous free services that make our life possible and pleasant, cleaning the air, water, and the soil of pollutants, providing food, medicines and a beautiful place to live, wildlife are in grave danger from the loss of habitat, the spread of exotic species, pollution, and direct consumption by humans. Wildlife often cannot protect themselves from humans, so without our help they cannot survive. The presence of humans greatly reduces the usefulness of a habitat to wildlife. Wildlife reserves act as sources for replenishing our supplies of animals and plants. Therefore, we urge all nations and peoples to make the protection of wildlife and wildlife habitat a top priority. In particular we urge them to set aside a large portion of their territory,

interconnected by the wildlife travel corridors, for the exclusive use of wildlife, off limits to humans."

Our Life

The new leaves emerge from the fig tree outside my window. Our space is the width of the wondrous tree that provides delicious figs in the summer months. Occasionally shared with the squirrel who also loves figs. My dear pair of love doves has flown back again this year to enjoy the spring fragrance and warmth, and to decide where to build their nest this year. I will postpone to cut the sprawling bougainvillea until their nesting is complete, as I had to live with regret over their early departure last year when my pruning disturbed their home. Dear crow comes by to start to gather twigs to build her nest. Last month the wax eyes and occasional hummingbird enjoyed the nectar of the cherry blossom in this space where I do most of my writing these days - Our Space. Now the intense perfume of the jasmine fills the air, and the first blooms of lilac are emerging. Blessed again from a self-sown tomato plant from my compost. Thank you all for your love and sharing time and space in our journey together.

The highest love is "Ours" and shared - not mine or yours. Not just the fig tree, the farmer who eats the fig, the bees who feast on the flowers, nor the crow who travels to bring her wisdom as she takes a brief respite from her mission to look into my eyes and soul. Can any human couple share the steadfast love of birds who mate for life? This perspective sheds a different vision of the multiple "Ours" that each of us are parts of, and all sets of "ours" that will merge in our life!

We directly enter the environment when we become a human "(in) being", and from that minute until the minute we pass away, our journey of environment education continues. Some of that education is informal and some formal. The gift that we receive when we are born into this world is love. This is the essential human value for the 21st century, as it was for every century in the past. While love is a gift that few are deprived of, a deprivation that is in itself an insult to the humanity that our flesh embodies, it is a norm for all forms of life for the new life to be given a good start [11]. The ultimate gift that we can share with others is also love.

Each human person is composed of about 100 different species, and at least 17 of these species are the same between all human individuals. Our world is diverse with more than 10 million species, and more than 4 thousand indigenous groups. This linguistic, cultural, and religious diversity is a great resource yet it is generally under-utilized. The concept of eubios attempts to suitably broaden our life ethos.

Let us consider two quotes about love (Macer, 2022):

"It is certain that associated animals have a feeling of love for each other, which is not felt by non-social adult animals. How far in most cases they actually sympathize in the pains and pleasures of others, is more doubtful, especially with respect to pleasures."

-Charles Darwin, *The Descent of Man* (England, 1875)

"How do you spell 'love'?" - Piglet

"You don't spell it...you feel it." - Pooh"

- A.A. Milne

Relationships with Animals and Animal Rights

All living organisms are biological beings, and share a common and intertwined biological heritage. Humans are members of the species *Homo sapiens*, one of the millions of species alive on the planet Earth. Fundamentally when it comes to the use of other animals by humans, we must ask whether that particular use of animals raises ethical issues and how we might want to assess such ethical issues because we are moral beings.

Throughout human evolution people have been in relationships with other animals around them as companions, sources of food, labor, security and clothing. If we use more economic language we can say that "consumers", both human beings, as well as members of other species, have used other animals to provide both goods and services. All our relationships have ethical implications, and the use of animals by human beings has a long social, biological and spiritual heritage [11] .

Some other voices, especially among the bioethics community, ask questions such as whether humans are a special form of life, different from other living creatures that generally only harm others when they need to for their survival? Although annoyed hippopotamuses reportedly kill about five hundred humans globally every year, making them one of the most deadly large animals, most sentient animals only kill for self-protection or food.

For this second group of people, they may consider that the use of the pelts of animals that were being killed for food, might become ethical by a utilitarian calculation that it was better not to waste parts of the animal. Some may also accept the rationale of ecological balance used by the fur trappers above. Some argue from a deontological perspective may place particularly high moral status on certain species and encourage the use of alternative sources of fibre to make clothes.

The concept of "do no harm" or non-maleficence, which has a basis at a more fundamental level - the level of being alive, argues against hurting any living organism. If we are going to harm life, a departure from the ideal of doing no harm and love of life, it must be for a good motive [11]. Such a motive might be survival, and we can see this as natural - all organisms consume and compete with others. Plants compete with each other for space to grow, animals eat plants or other animals, bacteria and fungi also compete for resources and space - sometimes killing other organisms and other times competing without direct killing.

Destruction of nature and life by humans is caused by two human motives - necessity and desire. Basically, it is more ethically acceptable to cause harm if there is necessity for survival than if it is only desire. This distinction is required ever more as human desire continues to destroy the planet.

Intrinsic values are something that exist without another person assigning value to something. We could also consider intrinsic value as some experience which has value in itself without any instrumental reference by others. To perceive something of intrinsic value we need to have an object of value, whether it is the bone thrown to a dog or a ball thrown to a child, the object becomes of value. It becomes of value even if we cannot

be conscious of the value or talk about it, as you can see from the reaction of the animal to the removal of the object that they have interest in.

A particularly important source of fibre for clothing is wool, which is shorn from sheep in the spring so that they will be cooler in the summer and it naturally grows back for winter months when they need it as a thermal protection themselves. Sheep farming has a long tradition, being also mentioned by Ovid in the quote cited above. I have not made a calculation of the amount of wool that could be harvested from the pelts of animals killed for food as opposed to just shearing of sheep. The pelts of sheep are also fashionable and used as rugs in a number of both ancient and modern societies. It seems to be ethically justified if you're going to kill the sheep for meat that you also make the sheep skin as a useful product.

However, vegans will prefer to use a fibre from plants such as cotton or hemp, as opposed to one made from animals, such as wool or silk (Choi and Lee, 2021). Vegan materials used in so-called vegan fashion include acrylic, bamboo, cotton, emp, jute, linen, modal, nylon, ramie, rayon, and spandex. Sometimes the environmental consequences of use of vegan materials in fashion and food may not be ideal, as seen for example in the environmental costs of production of almond milk in water scarce environments compared to cow's milk. Having said that, the wool scouring industry does use a lot of water. More thorough environmental impact assessment, including analysis of the harms to animals, should be research priorities in these areas.

The leather industry relies on animals such as cows, buffalo, sheep, deer and kangaroo, for example. Around 95% of the leather used globally is a side product of the meat and dairy industries. The tanning industry will be discussed later. Basic footwear in many parts of the world has used leather for centuries and continues to do so. Unless people will give up eating beef, which is against the global trends which clearly predict significant global increases in beef consumption [8], our focus should be on making the tanning industry more environmentally sustainable.

The motive for using animals also alters the morality of their use in some religions, suggesting these concerns have a long history. All religions display examples of the use of cosmetics and even particular fashion codes are used for priests, nuns and monks [9]. Animal sacrifice for worship is used in Islam, but they would generally condemn scientific research or battery farming. Vivisection is allowed under circumstances where there is no pain or disfigurement and if other animals benefit. The use of animals in science is under the same moral codes as applied to humans. Even though the animals possess a lower consciousness, Islam says animals know their own mode of prayer and psalm, a voluntary act of praise. The killing of any breathing beings, except for food or religious sacrifice, is high on the list of deadly sins. Hindus, Jains and Buddhist believe that we will be reborn as another living animal, which creates their bond of caring and compassion for animals. So they will reject animal sacrifice, even though the sacrifice of an animal won't kill what is

essential, in the reality, the soul, of that animal.

Christian scriptures and traditions accept animals do have valid claims upon us. Animals cannot be viewed simply as expendable raw materials for our designs, they do not exist simply to serve us, the doctrine of creation is opposed to anthropocentric notions. The use of animal sacrifices does not mean animals should be sacrificed for the selfish pursuits of humans, the practice of animal sacrifice was to bring God into the focus of human hearts in place of their own selfish desires, and was not necessary after the birth of Christ. The tradition of the Roman Catholic church is to regard animals as means to human ends, and the moral objections to cruelty on animals are more concerned with fear that those inflicting pain will contract habits of cruelty, something also seen in Kant [11]. The contrasting attitude of St. Francis of Assisi, to talk of sister cows or brother dog, is a picture which is appealing to those with a more biocentric view.

Who should judge whether a practice is a need or a desire? If we live in cold climates the use of an animal fur as warm clothes is a need rather than a desire. If we go outside in the cold catching food, gathering fuel for the fire, or water, and so on, it is usually a necessary excursion [12]. Can we then criticize a socialite who likes to venture out in the cold winter to attend parties? If it is a business dinner, necessary for employment and gathering an income is this more justifiable compared to a birthday party? Is wearing a fur coat a necessity for a homeless person on the streets at night, but not for someone who lives in a warm house? What about in times of natural disaster? A fur coat can be a life safer. The principles of balance and context seem critical here, but even more fundamental is whether anyone can limit our autonomy [13].

Animals such as ostrich, peacocks, doves, geese and turkeys are some of the few species that have been involved in the feathers trade [4]. These are not all from dead animals, and a percentage of the world's supply derives from birds plucked alive. The plucking of feathers is painful and damaging for the animal, and it may be repeated every six weeks. The brutality in which these feathers are plucked can lead to serious wounds that are usually taken care off without anesthesia and dirty materials [5].

Some indigenous tribes find particular spiritual meaning in some feathers, and in USA use of bald eagle feathers, a protected species, is limited to Native Americans, on the grounds of religious freedom. Thus not all feathers are produced through industrial processes, and these are retrieved from dead or molting eagles.

Legal Evolution and Recognition of Animals

Modern legal systems developed in Europe during the eighteenth and nineteenth centuries. These systems resulted from the capital market economy, together with the ideologies such as individualism and liberalism, unified state power and modern bureaucracy as its foundations. Technological innovations require a re-examination of the fundamental legal concepts of humans and nature which have formed the premises of the modern law up until now [9]. The debates on cosmetic

industry, endangered animals, and research on animals have also been important in the evolution of laws to protect animals.

Under modern law, persons are treated equally as legal personalities, each possessing the capacity to hold rights. The modern law regards the person's intention and activities as the most significant element of law. Contracts and wills are built based upon such a presupposition. Land, resources, animals and plants are all conceived of as things which, as the object of a subjective right, may be owned by a person. Attention should be paid to the legal ramification of the conception that animals and plants are viewed as "things" in law. All creatures except humans are categorized as "things." This dichotomy is an unbridgeable one under the modern law. Kitazawa (1998) and others argue that the time has come for us to introduce a new concept called a "life unit" which is, in the world of microorganisms, the fundamental element of the third legal order and which is an addition to the existing legal dichotomy of "persons" and "things." Upon successful building of the "life unit" concept, it becomes feasible for us to begin constructing the new legal system of the "life unit." In this new legal order, a "life unit" will not necessarily be recognized as a new subject of a right, nor as a new thing. This legal order for the "life unit" and its constituents may require a complexity of new legal norms. When our intention is not to sacrifice other beings in order to safe our life or the life of a sick child, but only to look good at a party, the legal justifications weaken substantially. Although it took some decades, the evolution of laws to reject cosmetic safety testing in animals in the USA does represent a significant milestone in the balancing of human need and desire.

The so-called "moral" and social acceptance of a technology evolves over time (Tortora, 2015). Fashion and cosmetics also evolve over time, and what is "normal" changes over time. There are some fashion brands that promote their policy of not using fur from animals, for example Stella McCartney's "Fur-free fur" (Ferreira, 2016). While they do use silk and wool, they reject animal testing and use of fur and leather. Some other mass market brands promote reduction of animal products in fashion, such as Bodyshop and H&M, for example. Many exotic products are still used in the luxury fashion and cosmetic industries.

Although some proponents against the use of animal products in the fashion industry argue that we should all wear either plant based products or synthetic clothes. There are not just a few bioethically minded persons who would consider it more ethical to wear natural fibre compared to synthetic fibers and products. CITES and education against the use of endangered animals has been successful to reduce the use of some species. What we may all agree upon is that we need to protect our environment and find a better ethical balance in the use of animals in the fashion industry, but the recovery of the fur industry in recent years suggests that animal products will continue to be widely used in fashion in this millennia, as they have been in past millennia.

Eubios Bioethics Education Project

The global trends in education are transformational and critical to address issues for the 21st century as countries

emerge through the COVID-19 pandemic and confront increasing climate change. We need to consider the variety of viewpoints from anthropocentric, biocentric, ecocentric and/or cosmocentrism [14]. Critical thinking capacity is essential for empowering persons to cope with changing times. How do we promote the creation of ideas and individuality in an era of globalization? Rapid progress of technology has led to challenges in the way that we live. The systems and patterns that are seen in the relationships between people and the environment, and in society in general, have changed.

The pursuit of a good life is a goal that all persons can hope for. A good life (eu-bios) should be understood in a holistic sense, and is clearly more than just a contented life, free of want and fear. At the international level this is what the United Nations was established to help provide. This is also the duty of all governments to provide to their citizens, and those with the abilities to provide to those in need [15].

This project aims to increase the amount of free on-line teaching materials for bioethics education in different countries. The main products so far have been:

Production of cross cultural materials. Improvement via expert meetings. Adapted and translated in different languages to teach school and university classes about bioethics [16].

A network of teachers in different countries that have tried the materials, and created bioethics curricula for their local school, bioethics clubs and other endeavors. (Network now 18 years old) Development of a Statement (Eubios Declaration of Bioethics, 2002) and joint action plan with UNESCO (July 2006) Testing of evaluation methods Sharing of museum displays and teacher training strategies Moral games and participatory methods Teacher training workshops and government support Curriculum review and development Launch of dedicated Degree programs (founding of American University of Sovereign Nations (https://www.ausovereignnations.org) a decolonized University). The Eubios Declaration on International Bioethics (2002)[1] stated:

"Bioethics Education

To work towards a social consensus requires participation of informed citizens, which requires education about issues of bioethical importance. We applaud the public discussion on bioethics that has started to emerge in a number of countries, but these efforts need further support.

In order to achieve the above goals, greater effort is required to educate all members of society about the scientific and clinical background, and the ethical principles and social and legal problems involved, in the life and medical sciences. This will enable the active collaboration of all individual members of society, many academic disciplines, and the international community.

Education of bioethics is to empower people to face ethical dilemmas. Ethical challenges come to everyone.

The process of debate and discussion is important for developing good minds to face bioethical dilemmas. It also develops tolerance and respect of others. In these

[1] **http://www.eubios.info/eeidec.htm**

troubled international times, it is very important to develop tolerance of others, and to learn that everyone as a human being is the same regardless of race, sex or religion. Same in this sense means equally diverse, it does not mean identical [17].

The process of debate and discussion in classrooms is particularly valuable and we urge all persons, organizations, institutions and countries [18] to take appropriate measures to promote the principles set out in the Declaration, through promotion of education in bioethics."

Conclusion

How do we form a loving and mature society full of well informed and balanced persons? Bioethically mature means a person, or a society that can balance the benefits and risks of alternative options, and make well-considered decisions, talk about it, and love! Every person has a lifelong responsibility to develop his or her own bioethical maturity and values.

Our Oneness with Nature is the True Love that is a foundation of Environmental Conservation and Action together. Bioethics truly is the bridge to the future (Potter, 1971), the foundation of human responsibility to plants and animals [7] and is the result of our love of life. As we shift from awareness of the environmental issues, we will have a greater appreciation for biophilia and a greater sense of our duties of stewardship of this planet, and ourselves.

References

[1] Bosworth, A., Chaipraditkul, N., Cheng, M.M., Gupta, A., Junmookda, K., Kadam, P., Macer, D.R.J., Millet, C., Sangaroonthong, J. & Waller, A. (2012). *Ethics and Biodiversity*. Bangkok: Regional Unit for Social and Human Sciences in Asia and the Pacific (RUSHSAP), UNESCO Bangkok.

[2] Cavusoglu, L. & Dakhli, M. (2017). The Impact of Ethical Concerns on Fashion Consumerism: Case-based Evidence, Markets, Globalization & Development Review, 2(1), Article 4. DOI: 10.23860/MGDR-2017-02-01-04 Available at:https://digitalcommons.uri. du/mgdr/vol2 /iss1/4 Choi, Y.-H.; Lee, K.-H. (2021).

[3] Ethical Consumers' Awareness of Vegan Materials: Focused on Fake Fur and Fake Leather. *Sustainability 13:* 436 (2021). https://doi.org/10.3390/ su13010436 .

[4] Ferreira, B. (2016). *The Use of Animals Inside the Fashion Industry*. Barcelona: Barcelona Escola Superior de Disseny (IED).https://management.iedbarcelona.org/ portfolio/animals/.

[5] Humane Society International (2021). https://www.hsi.org/news-media/fur-trade/ (Accessed 5 November 2021).

[6] Jacob, C.T., Azariah, J., Appasamy, P. & Jack, G. (1997) Ethical Implication of Industrial Pollution on the Ground Water Quality At Tiruppur, Tamil Nadu, India. In: J. Azariah, H. Azariah, & D.R.J. Macer (Eds.) *Bioethics in India: Proceedings of the International Bioethics Workshop in Madras*: Biomanagement of Biogeoresources, 16-19 Jan. 1997, University of Madras. (pp. 288-293), Christchurch, NZ: Eubios Ethics Institute.

[7] Jahr, Fritz. "Bio-Ethik. Eine Umschau ueber die ethichen Beziehungen des Menschen zu Tier und Pflanze." *Kosmos. Handweiser fuer Naturfreunde* 24 (1; 1927) 2-4.

[8] Kanaly, R.A., Manzanero, L.I.O., Foley, F., Panneerselvam, S. & Macer, D.R.J. (2010). *Energy Flow, Environment and Ethical Implications for Meat Production.* Bangkok, Regional Unit for Social and Human Sciences in Asia and the Pacific (RUSHSAP), UNESCO Bangkok.

[9] Kitagawa, Z, (1998), The Law of "Life Units" as a New Legal Order. In: N. Fujiki & D.R.J. Macer (Ed.) *Bioethics in Asia: Proceedings of the UNESCO Asian Bioethics Conference, 3-8 Nov 1997, Kobe and Fukui, Japan* (pp. 56-58), Christchurch, NZ: Eubios Ethics Institute.

[10] Macer, Darryl R.J. (1990) *Shaping Genes,* Christchurch: Eubios Ethics Institute.

Macer, Darryl R.J. (1998) *Bioethics is Love of Life: An Alternative Textbook,* Christchurch: Eubios Ethics Institute.

[11] Macer, D.R.J. (1998). *Bioethics is Love of Life: An Alternative Textbook,* Christchurch. NZ: Eubios Ethics Institute.

Macer, Darryl R.J. (2022) *Love is Ours: A living journey through love and life across the world*.

[12] Porter, D.G. (1992). Ethical scores for animal experiments *Nature* 356 (1992), 101-2.

[13] Potter, Van Rensselaer**.** *Bioethics: Bridge to the Future*. New York: Prentice-Hall, 1971.

[14] Rai, Jasdev Singh Rai; Thorheim, Celia; Dorjderem, Amarbayasgalan and Macer, Darryl R.J. 2010. *Universalism and Ethical Values for the Environment.* Bangkok: UNESCO.

[15] Regan, T. (1983). *The Case For Animal Rights,* London: Routledge & Kegan Paul.

Rollin, B.E. (1982). *Animal Rights and Human Morality.* Buffalo NY: Prometheus Books.

[16] Rollin, B.E. (Chapter 41. The Moral Status of Animals and Their Use As Experimental Subjects. In: H. Kuhse, P. Singer (Ed.), *A Companion to Bioethics* (pp. 495-501), 2nd edn. London: Blackwell.

Singer, P. (1976). *Animal Liberation.* London: Jonathan Cape 1976).

[17] Sivakami, A. (2019). Animal Rights and Animal Cloning. In: T. Takahashi, N. Ghotbi & D.R.J. Macer (Eds.), *Philosophy and Practice of Bioethics across and between Cultures* (pp. 90-101),

[18] Christchurch. NZ: Eubios Ethics Institute. van der Ploeg, J., Cauillan-Cureg, M., van Weerd, M. & Persoon, G. (2011). Why must we protect crocodiles? Explaining the value of the Philippine crocodile to rural communities. *Journal of Integrative Environmental Sciences,* 8(4), 287-298 (2011). https://doi.org /10.1080/ 1943815X.2011.610804.

Convergence
Vol. 15, No. 1-4, pp. 46-49, 2022

A STUDY ON PROBLEM SOLVING ABILITY IN THE NEW NORMAL ERA

V. Lincy Pushpa[1]* and K. A. Sheeba[2]

[1]*Research Scholar, Stella Matutina College of Education, Ashok Nagar, Chennai - 600083.
[2]Assistant Professor of Physical Science, Stella Matutina College of Education, Ashok Nagar, Chennai - 600083.
*__Corresponding Author Email__: lincymat31@gmail.com

Abstract: The new normal era after covid-19 scenario has changed the whole functioning of the world and it has a huge impact on education as well. The new normal era has changed the barriers, borders, perspectives, views, vision and thought process of each and every individuals as well as it has also enhanced deep thinking of the educationalist beyond traditional methods, which intend had a great effect on education system. Hence we are now focusing more on quality outcome based education system. Topic of the paper is a study on problem solving ability in the new normal era. Main purpose of the study is to find the difference in problem solving ability among high school students owing to the difference in family type. Tool used for the study is Problem Solving Inventory (PSI) which was constructed and standardized by P. Paul Heppener (1988). Stratified random sampling method was used. The sample size is 498. The finding is there is no significant difference in problem solving ability of students owing to the difference in family type.

Keywords: Problem solving ability, Family type, High school students.

Introduction

The new normal era after covid-19 scenario the whole functioning of the world has changed and it has a huge impact on education as well. The new normal era has changed the barriers, borders, perspectives, views, vision and thought process of each and every individuals as well as it has also enhanced deep thinking of the educationalist beyond traditional methods, which intend had a great effect on education system. Hence we are now focusing more on quality outcome based education system [1]. Now a days after the covid-19 era there is a phenomenal increase of the problems in the society in terms of social and financial issues which impacts the life of every individual and the research topic is study on problem solving ability among high school students [2]. Now a day after the new normal era the problem solving ability is considered to be a core quality everyone should have and only the person with high problem solving ability can survive the problems of the society and be successful in their life and moreover now a day's students are facing lot of pressure from the family and the society as well and without the

ability of problem solving one cannot withstand the challenging of the society. Hence the main variable of the study is problem solving ability.

Need and Significance of the Study

Problem solving ability is known to be most significant quality for students in any critical situation. Critical thinking is a vital part of problem solving ability and it gives the student to understand the present problem and find a solution to the problem even in crisis time. Students are exposed to a new situation after covid. They have almost spent their two years along with their family inside their Home and have continued their education through online and then students have shifted to hybrid method and more over now the students have shifted to face to face atmosphere. Education in the past two academic years have faced a lot of challenges and the students and their family has also faced the same. Hence to find out if the problem solving ability differs among the student from the joint family and the nuclear family, the researcher has chosen the family type as a personal variable [3].

Objectives of the Study

The objective of the study is finding the difference in problem solving ability among high school students living in different type of family.

Hypothesis

There is no significant difference in problem solving ability of IX standard students owing to the differences in Family Type.

Methodology

In order to get information from the high school students for this study, the researcher used survey method (descriptive research). A survey is a highly organized questionnaire that is used to gather data from a large number of respondents that are representative of certain demography. The tool used to study the problem solving ability of students is Problem Solving Inventory (PSI) which was constructed and standardized by P. Paul Heppener [4].

Analysis of Data

Data was collected from 498 students drawn from standard IX of different school type. The variable studied in present investigation is Problem Solving Ability with reference to the selected variable family type. After the data was collected it was classified according to various categories and sub categories of the above mentioned variable and ‘t’ test was carried out to find the significance difference between the family type [5].

Interpretation of Data

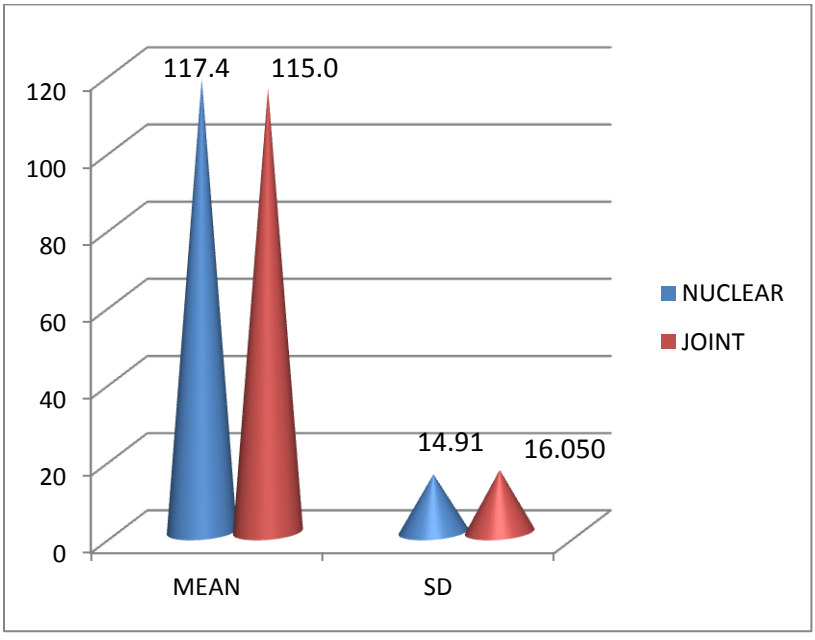
There is no significant difference in problem solving ability of IX standard students owing to the differences in Family Type.

Table 1.0
Table showing the difference in problem solving ability of IX standard students owing to Family type

Variable	Family Type	N	Mean	SD	t Value	df	Significant level
Problem Solving Ability	Nuclear	331	117.47	14.915	1.681	496	0.102
	Joint	167	115.02	16.050			

From the table 1.0, since the p value is greater than 0.05 at 95% of confidence level, the null hypothesis is accepted. Hence it is concluded that there is no significant difference in problem solving ability of IX standard students owing to difference in Family Type.

Figure 1.1. Bar Diagram Showing the Mean Difference and Standard Deviation in Problem Solving Ability of IX standard Students owing to Family Type



Findings of the Study

There is no significant difference in problem solving ability of IX standard students owing to the differences in family type.

Educational Implication

The COVID era has lots of positive implication on education such as involvement of technology in the field of education; one can learn any education according to his need from anywhere in this world without moving from where the student is and also this has made the cost of learning a bit cheap and also it has broken the barriers like time, place, language etc. According to the recent observation this had also increased the potentials of the teacher as well as the learner [6]. This period after covid era was a golden era in the field of education and the whole perspectives about education has changed to outcome based education system. Now a days the education system slowly shifts from scoring and getting mark/ranking system to problem solving method and in other hand the students should be given more practice towards activating skills [7] relates to solving the problems and they ought to be trained to strengthen the physical and mental skills in order to get the full potential output from the students and on the other side the teachers have to be well-equipped according to the latest development and also the skill development [8] training has to be given in order to handle and guide the students to solve the problems and enhance the ability to solve the problem.

Conclusion

According to the present investigation the new normal era has a great impact on education. It has changed the pedagogy and the learning style and also the focus of education has shifted to modern technical methods from traditional method. Hence this era shall be considered as the golden era in the field of education.

References

[1] Aruna Mohan, G. (2012). Educational Psychology. Neelkamal Publications pvt.ltd. Educational publishers.

[2] Chaube,S.P. Akhilesh Chaube.(2011). Handbook of Education and Psychology Volume I. Neelkamal publications pvt.ltd. Educational publishers.

[3] David Yonggi Cho.(1998). Solving life's problems. Ben publishing.

[4] P. Paul Heppner & Lee, D. G. (2002). Problem-solving appraisal and psychological adjustment. Handbook of positive psychology, 288-298.

[5] Leela Gnanalet. S. (2012). General Psychology. Saratha pathipagam.

[6] Nagarajan,K. Deva Seetharaman.(2015). Psychology of learners and learning. Sriram Publishers.

[7] 7 Steps to an Effective Problem Solving Process.(2016). Retrieved from https:// crestcom. com/ blog/2016/09/01-steps-to-effective-problem-solving/.

[8] Problem solving skill/SkillsYouNeed. Retrieved from https:// www. skills youneed.com/ips/problem-solving.html.

Convergence
Vol. 15, No. 1-4, pp. 50-65, 2022

A STUDY ON THE ENVIRONMENTAL FACTORS INFLUENCING TEACHING PERFORMANCE AND STUDENT'S ATTITUDES TOWARDS E-LEARNING DURING PANDEMIC

M. Kalyana Sundari[1]* and J. Jayasankar[2]
[1]*Research Scholar, P.G. and Research Department of Commerce, Dwaraka Doss Goverdhan Doss Vaishnav College (Autonomous), Chennai - 600106.
[2]Associate Professor (Retd), Head Research Supervisor & Guide, P.G. and Research Department of Commerce, Dwaraka Doss Goverdhan Doss Vaishnav College (Autonomous), Chennai - 600106.
***Corresponding Author Email**: kalyanasundari2010@gmail.com

Abstract: E-learning has become the mandatory component of all educational institutions like schools, colleges, and universities in and around the world due to the pandemic crisis of COVID-19. This deadly situation has flipped out the offline teaching process. E-learning provides an effective teaching method that brings out the best in students. To find out the student's attitude towards e-learning, primary data has been collected from national and international wise through Google forms which include the student community from various schools, colleges, and universities. This research paper aims to study the E-learning process among students who are familiar with web-based technology. It also helps to find out solutions to improve the self-study skills of students. The stratified sampling method has been adopted in this study and the sample size is 120. The findings of the study reflect the impact of E-learning, students' interest in using E-learning resources, and Teaching performance in E-Learning. In conclusion, this study shows that E-learning has become quite popular among the students all over the world particularly, the lockdown period due to the COVID-19 pandemic.

Keywords: E-learning, Web-based technology, Self-study skill, COVID-19 pandemic, Teaching performance.

Introduction

The motivation behind education is to shape an individual to be great. Education provides the pathway to arrive at their fate. Education helps in instilling social duties too. The fundamental center of Education is to learn. Learning is a cycle of procuring information or abilities through investigation, experience, or being instructed [1]. Any monstrosity mishap that occurs on the planet will consistently leave its effect on Education. Thus the scourge of COVID 19 has its impressions on training.

The flare-up of this perilous infection over the globe has constrained instructive organizations to close down to control the spread of this infection. This event made the training experts consider elective techniques for educating during this lockdown. What's more, subsequently it makes ready towards electronic learning or e-learning or web based learning. In the present situation learning has ventured into the advanced world [2]. In which encouraging experts and understudies are practically associated. E-learning is very easy to comprehend and execute. The utilization of a work area, PC, or cell phones and the web shapes a significant segment of this learning system.

E-learning gives fast development and end up being the best in all areas, particularly in teaching staff and students during this lockdown [3].

Review of Literature

A study conducted by Al-Araibi [4], which puts the technological issues as the main criteria for the success of e-learning system, indicated that 45% of e-learning projects in developing countries are total failures, 40% are partial failures, while only 15% are successful. Therefore, based on these findings, along with other studies, many researchers in the field of IS/IT have conducted researches in order to look into the challenges to the successful implementation of e-learning system initiatives [4].

Wei Bao [5] in this study to concludes with five principles of high-impact teaching practice to effectively deliver large-scale online education, through the case analysis of Peking University's online education. First, the principle of appropriate relevance. The quantity, difficulty, and length of teaching content should match with the academic readiness and online learning behavior characteristics of students. Second, the principle of effective delivery. Due to students' characteristics of low concentration in online learning, it is essential to adjust the teaching speed in order to ensure the effective delivery of teaching information. Third, the principle of sufficient support. Faculty and teaching assistants need to provide students with timely feedback, including online video tutoring and email guidance after class. Fourth, the principle of high-quality participation [5]. They necessary to adopt some measures to improve the degree and depth of students' class participation. Last, the principle of contingency plan preparation. In view of the extraordinarily large scale of online education, they necessary to make contingency plans in advance for addressing possible problems such as the traffic overload issue of the online education platform. Furthermore, since this online teaching "migration" is implemented quickly during the outbreak of COVID-19, students' anxiety needs to be relieved in various ways to ensure that they can actively and effectively engage in online learning.

Gonzalez [6] compared students' performance in two academic years and they found that students improved their performance during COVID-19 confinement. Even though I did not analyze students' performance in a specific course, in this study the majority of the participants did not report changes in their grades. Contrary to what Gonzalez [5] found, in this study, cognitive engagement (knowledge, concentration, engagement, attendance, and interest) among students decreased after the stay-at-home orders due to COVID-19. The studies were very different, but more research is needed to have an accurate sense of the impact of confinement measures over students' performance [7].

Significance of the Study

This study will help to find out the teaching performance and students' attitudes towards e-learning during COVID – 19 Pandemic. This study was done for the students who are studying in various colleges and universities and even schools to gain additional information regarding the contribution of e-learning during this pandemic. It can be a learning paradigm in educational institutions to enhance the student's knowledge and skills through digital technologies. Government and Educational Department has to provide better infrastructure for e- learning for the betterment of students.

Objectives of the Study

1. To know the global trend of using E-learning resources among students.
2. To identify the Teaching performance and attitude of students towards using E-learning resources in study area.
3. To suggest prospects in using E-learning resources by students in Chennai City.

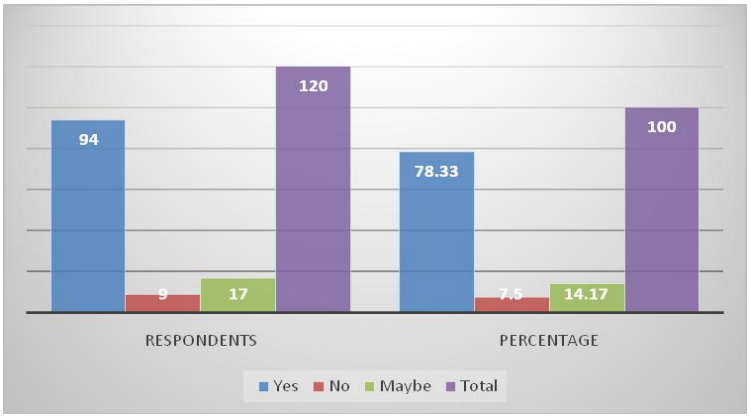
Methodology

This study is based on primary data. The data have been collected from students, who are currently pursuing their undergraduate degrees in different colleges and universities. The online questionnaire through Google Forms has been prepared for collecting data. Among the students, only 120 samples are scrutinized based on the stratified sampling method [8]. The Periods of study from August to September 2020. **Analysis Willingness towards the E-learning**

The revolution of information availability of technology has a major impact on contemporary education. It is playing a major role in all new pedagogical skills in education at all levels. There are many available sources online to learn from wherever you need it. Digital devices and gadgets do not only provide students to engage in entertainment, but also make more opportunities for them to engage in learning activities. In this context, student's willingness towards e-learning is Presented in table-1.

Table 1. Student's Willingness towards E-learning

Response	Respondents	Percentage
Yes	94	78.33
No	9	7.5
Maybe	17	14.17
Total	120	100



Among 120 respondents, around 78.33 percent of students reported their willingness to learn from e- sources. Around 14.17 percent of them were opined in somewhat they are learning from e-sources because there are no other alternatives. Since the classes and education institutions are stand to closed due to Corona, they have only depended on e-learning, most majority of the institutions, where the students have participated in this survey are have

encouraged to learn through e-sources. And only 7.5 percent of them were not willing to learn because of a lack of connectivity. It is evident from the Table-1; a maximum number of respondents are engaged to learn from e-based learning [9].

Improvement of Student's Self-study Skill through E-learning

Today's learner's expectation is very different from the past after globalization education has become more associated with digital and mobile paced. Students have wanted learning materials that are accessible through online mode in mobile phones and computers [10]. The main reason for e-learning is that the students can learn at their comfort and requirement. In this context, the improvement of student's self-study skills through e-learning is presented in table-2.

Table 2. E-learning Improves Your Self-study Skill

Classification	Respondents	Percentage
Yes	90	75
No	8	6.67
Maybe	22	18.33
Total	120	100

Among 120 respondents, around 75 percent of students have reported their self-study skills to improve because of e-learning [11]. Around 18.33 percent of them were opined in somewhat they are learning from e-sources because there are no other alternatives. Since the classes and education institutions are stand to closed due to Corona, they have only depended on e-learning, most majority of the institutions, where the students have participated in this survey are have encouraged to learn through e-sources. And only 6.67 percent of them were not supposed that the e-source alone can improve their self-study skills. It is evident from the Table-2, a maximum number of respondents are viewed that, e-based learning improves their self- study skills [12].

Satisfaction level of the students on the online mock test

Student assessment is one of the important methods of the evaluation process in the education system. Various methods are being adopted to understand the students learning capacity. The online way of learning a mock test is a prompt method which is a highly acceptable one. It is even more important during the quarantine time [13]. Moreover, the mock test is a more effective and systematic method to extract student's abilities and understand their respective lessons, in this context, the satisfaction level of the students on online mock test is presented in table -3.

Table 3. Satisfaction Level of the Students on the Online Mock Test

Classification	Respondents	Percentage
Yes	88	73.14
No	13	10.83
Maybe	19	15.83
Total	120	100

Among 120 respondents, around 73.14 percent of students are satisfied with web-based mock test participation. They asserted that it is more convenient and aptitude based. Around 15.83 percent of them are opinioned that, it may be useful since the students are pursuing online competitive examinations [14]. And only 10.83 percent of them are certain that the web-based mock test is not sufficient for their expectation level. It is evident from the table-3, a maximum number of respondents is keen to participate in the mock test.

The Usefulness of the E-learning at Quarantine Time

During this time of medical emergency, many education institutions are some simple measures have taken to learn during the quarantine time. Students are motivated and provided a link to helpful material for their upcoming semester examination. Colleges are encouraged to be planned towards e-learning, in this context; the usefulness of the e-learning at quarantine time is presented in table-4.

Table 4. The Usefulness of the E-learning at Quarantine Time

Classification	Respondents	Percentage
Yes	86	71.7
No	9	7.5
Maybe	25	20.8
Total	120	100

Among 120 respondents, around 71.7 percent of students are opinioned that e-learning is very useful during the quarantine time. Around 20.8 percent of them is the attitude that it may be useful since the students are pursuing online competitive examinations. And only 7.5 percent of them are not positive on e-learning during quarantine time. It is evident from the table-4, maximum numbers of respondents are expressed that e-learning is useful and more satisfactory.

Comparison between E-learning and Traditional Learning

E-learning allows educationalists to get a higher degree of coverage to communicate the message reliably for their target listeners. This ensures that all learners receive the same type of training with this learning mode. However, despite the popularity of online education, vast groups of people intentionally stay away from such methods, mostly due to a false impression. At the same time, despite the

rising popularity of online courses, traditional classroom training is the majority of the student's choice. Unlike online learning, the classroom learning method is more real and students have an opportunity to debate, deliberate, and discuss with their class teachers and friends [15]. In this context, a comparison between e-learning and traditional learning on students' knowledge improvement is presented in table -5.

Table-5: Comparison between E-learning and Traditional Learning

Classification	Respondents	Percentage
Yes	74	61.17
No	24	20
Maybe	22	18.33
Total	120	100

Among 120 respondents, around 61.17 percent of students are highly preferred e-learning because they are learning more advanced technical courses only through online. Since soft skills are highly essential for present job market students are keen to learn from e-learning. But at the same time still, more than 18.33 percent of the students are considered that classroom learning is better than e-learning. It is evident from table-5, maximum numbers of respondents are expressed that e-learning is useful and more satisfactory.

Face - to- face teaching is important for practical Learning

In e-learning pedagogy, theoretical concepts are carried over through various application tools which make the student more convenient. But it lacks in practical teaching.

Table-6: Face–to-face Teaching is Important for Practical Learning

Classification	Respondents	Percentage
Yes	90	75
No	13	10.83
Maybe	17	14.17
Total	120	100

Among 120 respondents, 75 percent of students are supportive of conventional teaching for the practical session. Around 14.17 percent of them have opted as it may be conventional teaching is important for the practical session. And only 10.83 percent of them are not positive on e-learning for the practical session. It is evident from table – 6; a maximum number of respondents are towards conventional teaching for practical learning [16].

Technical Issues of E-learning

E-learning is always depending on a strong internet connection with the high band. It is not succeeded always because of a lack of connectivity and an acute power shortage. E-learning is even worse in rural areas compared to urban due to lack of infrastructure that online courses require, and thus fail to attend with their virtual classes. In this context, technical issues of e-learning are presented in table-7.

Table-7: Technical Issues of E-learning

Classification	Respondents	Percentage
Yes	27	22.5
No	74	61.67
Maybe	19	15.83
Total	120	100

Among 120 respondents, around 61.67 percent of students are experienced that, no such technical issues while e-learning. Around 22.5 percent of them are experienced technical issues. Nearly 15.83 percent of them express that, sometimes it is very difficult to follow the classes due to poor internet connection. Especially video lectures from Zoom and other applications are containing a lot of technical configurations which is highly difficult to handle since the listener is new to this technology. It is evident from the table-6; maximum numbers of respondents are expressed no on technical issues in e-learning.

Positivity towards e-learning

E-learning is an innovative method to communicate with society. It is an effective way of teaching to bring out the best in students.

Table-8: Positivity towards E-learning

Classification	Respondents	Percentage
Yes	91	75.83
No	11	9.17
May be	18	15
Total	120	100

Among 120 respondents, around 75.83 percent of the students are in favor of e-learning. Around 15 percent of them are in terms of e-learning may be positive. And only 9.17 percent of the students are not positive towards e-learning. From the table-8 it is noted that the maximum number of respondents are positive towards e-learning. E-learning makes knowledge wider E-learning provides maximum benefits from minimum requirements. Does it work in the students to enhance their knowledge? This is illustrated in the below table.

Table-9: E-learning Makes Knowledge Wider

Classification	Respondents	Percentage
Yes	86	71.67
No	14	11.66
Maybe	20	16.67
Total	120	100

Among 120 respondents nearly 71.67 percent are esteemed that e-learning makes their knowledge extensive. Nearly 16.67 respondents are in a dilemma. And only 11.66 percent are disagreeing with the statement. From table-9 it is noted that the maximum number of the respondents states that e-learning makes their knowledge wider [17].

Importance of Web-based Teaching

The use of the internet to teach and to learn is unavoidable for both teachers and students. Online courses are becoming an important component for enhancing the student's skills. Students are benefited through web-based teaching.

Table-10: Importance of Web-based Teaching

Classification	Respondents	Percentage
Yes	76	63.33
No	10	8.33
Maybe	34	28.34
Total	120	100

Among 120 respondents, 63.33 percent of them understood the importance of web-based learning for their career skills. Around 28.34 percent of them show that it may be useful. And nearly 8.33 of them don't value the importance of web-based learning. From the above table-10, it is clearly understood that many of them know the importance of web-based learning.

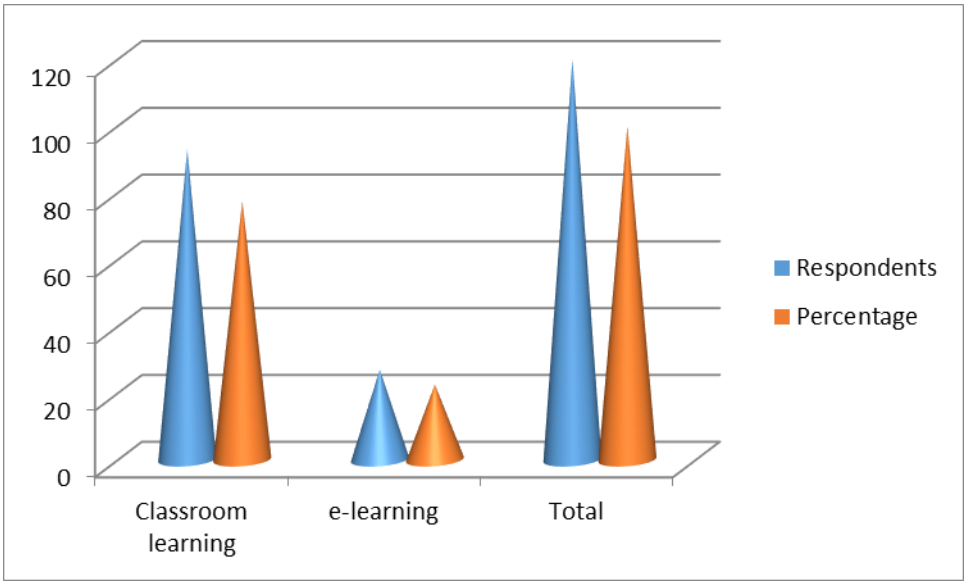
Preference for Learning Environment

Learning is a process of acquiring knowledge, enhancing the skills, helps in improvement of their career. In this pandemic situation, there is no way of teaching in the classroom.

All educational institutions are forwarded to the e-learning environment. The table-11 illustrates the student's attitude towards the preference of the learning environment [10].

Table-11: Preference of Learning Environment

Classification	Respondents	Percentage
Classroom learning	93	77.5
e-learning	27	22.5
Total	120	100



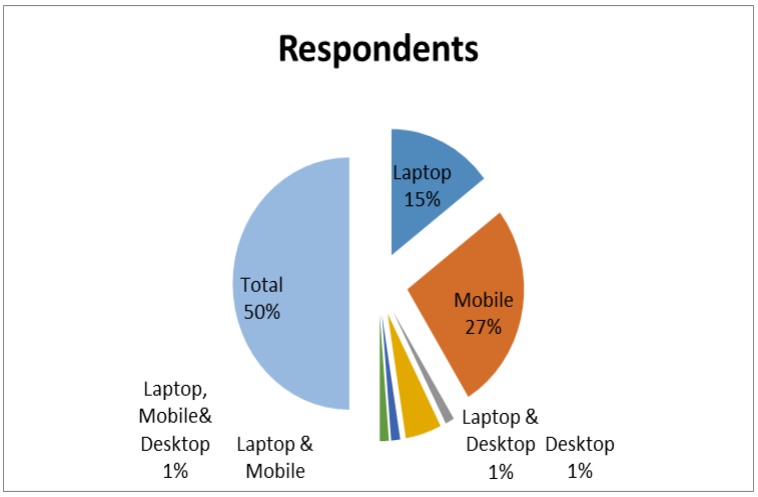
Among 120 respondents, only 22.5 percent prefer e-learning. Nearly 77.5 percent of them prefer classroom learning. From this evidence, it is noted that most of the students prefer to classroom learning environment rather than e-learning.

Contribution of E-learning bring a Social Change in India

In the contemporary education system is urging to adopt new technology for every field. All the developed and developing nations are more concentrated on research and development; as a result, technology is a part of every curriculum at all levels. A country like India is keen to introduce more new web-based courses for the students to fit them into the global job market. The present learners are highly motivated by international exposures. Technological innovations are highly influential in this society. Technology allows us to learn all and it is provides an opportunity to utilize the technology without any discrimination. In this context, it is important to understand e-learning brings a social change in India [15].

Table-12: Types of Device Prefer to Use for E-learning

Classification	Respondents	Percentage
Laptop	35	29.17
Mobile	64	53.33
Desktop	3	2.5
Laptop & Mobile	12	10
Laptop & Desktop	3	2.5
Laptop, Mobile& Desktop	3	2.5
Total	120	100

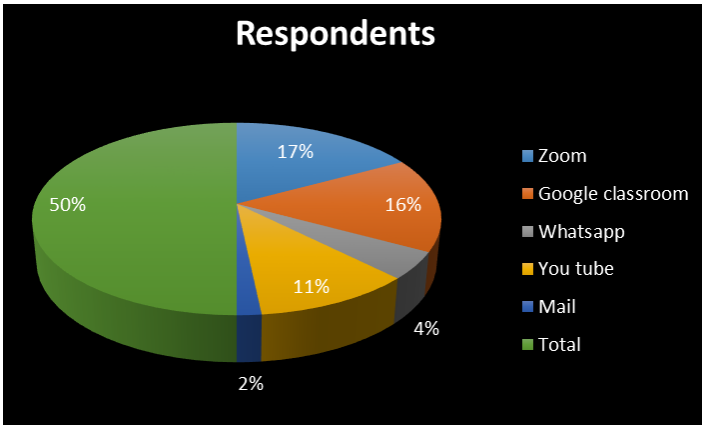


Among 120 respondents, around 53.33 percent of students are preferred mobile phones for e-learning, followed by Laptop 29.17 percent, and remaining students mostly prefer Laptop & Mobile (10%), Laptop, Mobile and Desktop (2.5%) respectively [14].

Table-13: Types of Application Tools Prefer to Use for E-learning

Classification	Respondents	Percentage
Zoom	41	34.16
Google classroom	38	31.67
Whatsapp	11	9.17
You tube	26	21.67
Mail	4	3.33
T ot al	120	100

Types of Application Tools Prefer to Use for E-learning



Among 120 respondents, around 34.16 percent of students are learning classes through Zoom. Nearly 31 percent of students are accessing learning materials through Google Classroom and 21.67 percent are learning through YouTube. Remaining students prefer Whatsapp (9.29%), Mail (3.33%) respectively.

Type of Application Tools Prefer to Use for E-learning in Ranking

Under this technique, respondents have been asked to allow the rank to the components. The decision is taken as general rating relegated to application used for e learning. The component scoring the minimum expense is the most extreme indispensable rank adjusted into decided with a climbing request [8].

Table-14: Types of Application Tools Prefer to Use for E-learning in Ranking

S. No.	Classification	Score	Rank
1	Zoom	3.83	I
2	Google classroom	3.47	II
3	Whatsapp	3.01	IV
4	You tube	3.06	III
5	Mail	1.03	V

It is clear from the above table that first preference is given to Zoom application followed by Google classroom, you tube and whatsapp. The least preference is given mail.

Table-15: Preferred Types of Device

S. No.	Device	Score	Rank
1	Laptop	3.03	II
2	Mobile	3.64	I
3	Desktop	3.03	IV
4	Laptop & Mobile	3.06	III
5	Laptop & Desktop	3.03	IV
6	Laptop, Mobile& Desktop	3.03	IV

It is clear from the above table that first preference is given to Mobiles followed by laptop and Laptop & Mobile. The least preference is given 3 devices.

Association of Age and device prefer to use for e-learning

Table 16

Ho (a): Age has No Association with Device Prefer to Use for E-learning
H1 (a): Age has Significant Association with Device Prefer to Use for E-learning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	14-18 years	64	53.2	53.5	53.5
	18-21 years	51	42.9	43.1	96.6
	above 21 years	5	3.4	3.4	100.0
	Total System	120	99.5	100.0	
Total		120	99.5		

Test Statistics

	Frequency of device prefer to use for e-learning	Age
Chi-Square	788.810	336.018
Df	3	2
Asymp. Sig	.000	.000

- 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 200.0
- 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 266.7.

Interpretation

Age is one of the important demographic variables that have an influence on device prefer to use for e-learning. In the present table four age groups are considered in determining the impact on usage of device prefer to use for e-learning among students i.e 14-18 years of age, 18-21 years, above 21 years of age. It is significant (P<.05). Therefore we reject the null hypothesis Ho (a) and accept the alternative hypothesis H1 (a). Hence, it is concluded that age has significant association with device prefer to use for e-learning. Out of the three age groups, the maximum respondents i.e 53.2% respondents lies between 14-18 years of age and 42.9% lies in the age group of 18-21 years. It is found that youngsters have the highest perception and prefers more device prefer to use for e-learning than the age group above years.

Table 17

Association of Gender and Device Prefer to Use for E-learning

Ho. (b): Gender of consumer has no association with device prefer to use for e-learning.
H1 (b): Gender has significant association with device prefer to use for e-learning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	60	49.8	50.0	50.0
	Female	60	49.8	50.0	100.0
	Total	120	99.5	100.0	
Total		120	99.5		

Test Statistics

	Frequency of device prefer to use for e-learning	Age
Chi-Square	788.810	.000
Df	3	1
Asymp. Sig	.000	.000

- a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 200.0.
- b. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 400.0.

Interpretation

Gender was included in the survey in order to find the difference between males and females concerning beliefs towards device prefer to use for e-learning. The table explained the value of chi-square is .000 with degree of freedom. It is insignificant (P>.05). Therefore we accept the null hypothesis Ho (b) and reject the alternative hypothesis H1(b). It is concluded that gender has no association with device prefer to use for e-learning. The study found that both the males and females are showing interest in preferring device prefer to use for e-learning. Gone are the days when females were not allowed to do

the studies and take important decisions in the family. But now a day, the nuclear urban families are females play an active role in decision making.

Table 18. Can E-learning Bring a Social Change in Chennai

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	7	5.83	5.83	5.83
	Disagree	4	3.33	3.33	9.16
	Neutral	52	43.33	43.33	52.49
	Agree	44	36.66	36.66	89.15
	Strongly agree	13	10.83	10.83	100.
	Total	120	100	100	

Findings

- The findings of this examination are based on the collection of primary facts that displays its impact on e-learning to know.
- The findings revealed the contribution of e-getting to know resources or centers for the scholars' and teachers' overall performance.
- In our take a look at, we discovered that there is a typically nice notion among college students about e-getting to know. There is also a first-rate hobby and growing use of these e-studying programs for instructional use.
- But, a lot of them do no longer desire for e-studying. The most effective like digital Learning like face to face studying or conventional learning.
- In destiny, this e-learning module made unavoidable options in better schooling.

Interpretation

Among 120 respondents, around 90 percent of students are opinioned that e-learning is significantly playing a major role in social change in India. They are categorically explained that e-learning gives more inclusion based, it reaches all heterogeneity groups, freedom of knowledge sharing. It is evident from table- 12, maximum numbers of respondents are optimistic about social change.

Conclusion

E-Learning knowledge seems to be an approaching fashion. It has been extending tremendous. The online technique of mastering is exceptionally appropriate for every person. Depending on their

availability and comfort, many human beings pick to study at a handy time. This enables the learner to get admission to the updated content material on every occasion they need it. Due to the wide set of blessings, it offers to students. The findings of the have a look at mirror the effect of E-gaining knowledge of, college students' interest in the use of E-studying sources, and their performance. In end, this observe showed that E-studying has to turn out to be quite famous for a number of college students across the world mainly, the lockdown period due to the COVID-19 pandemic.

References

[1] Akyol, Z. and Garrison, D. R. 2011, "Understanding cognitive presence in an online and blended community of inquiry: Assessing outcomes and processes for deep approaches to learning", *British Journal of Educational Technology,* 42(2): 233-250.

[2] A. M. Jazeel and Dr. AR. Saravanakumar, 2016. Role of ICT in transforming Sri Lankan Higher Education, *International Journal of Advanced Research Trends in Engineering and Technology,* 3(20)

[3] Bates, A. W. and Poole, G. 2003. "Effective Teaching with Technology in higher education: Foundations for success", Indianapolis, IN: Jossey-Bass.

[4] Bonk, C. J. and Graham, C. R. (2005). "Handbook of blended learning: Global Perspectives", local designs. San Francisco, CA: Pfeiffer Publishing.

[5] Conceicao, S. C. O. and Lehman, R. M. 2011. "Managing online instructor workload: Strategies for finding balance and success", San Francisco, CA: Jossey-Bass.

[6] Duffy, T. M. and Kirkley, J. 2004. "Learner-centered theory and practice in distance education: Cases for higher education". Mahwah, NJ: Lawrence Erblaum Associates.

[7] Dziuban, C., Hartman, J., Cavanagh, T. and Moskal, P., 2011. "Blended Courses as Drivers of Institutional Transformation". A. Kitchenham, Ed. Blended Learning Across Disciplines: Models for Implementation, pp. 17-37.

[8] Gonzalez, T., *et al*. (2020, 20). Influence of COVID-19 confinement in students' performance in higher education. https://doi.org/10.35542/osf.io/9zuac

[9] Mahalakshmi, K and Radha, R 2020. COVID 19: A MASSIVE EXPOSURE TOWARDS WEB BASED LEARNING. *Journal of Xidian University,* 14(4), https://doi.org/10.37896/jxu14.4/266.

[10] Marc. J. Rosenberg. 2009. "E-Learning: Strategies for delivering Knowledge in the Digital age", New York, McGraw-Hill Education.

[11] Mark Bullen and Diane P. Janes. 2006. "Making the Transition to E-Learning: Strategies and Issues: Strategies and Issues". New York. Idea Group Inc.

[12] Means, B., Toyama, Y., Murphy, R. and Baki, M. 2013. "The effectiveness of online and blended learning: A meta-analysis of the empirical literature", 115: 1-47.

[13] Prabakaran B. and Saravanakumar AR. 2020. Effectiveness of Interactive E-Content Module in Enhancing Students' Achievement in Mathematics. International Journal of Control and Automation, 13(2s), 84-94.

[14] Radha, R. 2019. Education for Man Making and Character Building: Inspirations from Swami Vivekananda, *Swami Vivekananda Centre for Higher Research and Education*, Alagappa University, Karaikudi, Tamil Nadu, India.

[15] Saravanakumar, AR. and Padmini Devi, KR. 2020. Indian Higher Education: Issues and Opportunities, Journal of Critical Review. 7(2): 542-545.
[16] Sivakumar, I. and Anitha, M. 2012. Education and Girl Children in Puducherry Region: Problems and Perspective. International Journal of Social Science & Interdisciplinary Research.1:175-184.
[17] Wei Bao (2020) COVID-19 and online teaching in higher education: A case study of Peking University- Published in Human Behavior and Emerging Technologies on April 07, 2020.

Convergence
Vol. 15, No. 1-4, pp. 66-74, 2022

THE PSYCHO EDUCATIONAL EFFECT OF COVID-19 LOCKDOWN ON FINAL YEAR POST GRADUATE STUDENTS

P. Anne Carolin[1]* and P. Mary Jessy Rani[2]

[1]*Student Counsellor, Niraivagam, Don Bosco Institute of Psychological Services Chennai,
[2]Assistant Professor, Department of Social Work, Loyola College, Chennai.
***Corresponding Author Email:** carolin.anne99@gmail.com

Abstract: The unexpected spread of corona virus which began in China spread throughout the globe and India. The onset of lockdown imposed by the government brought the whole nation stand still with its entire institution shutdown. The safety precautions of wearing mask, physical distancing and sanitizing were the only concern that would prevent the disease from spreading and protect person from getting infected. The main purpose of this research is to study the psycho social effect of COVID -19 along with the impact on education of post graduate students during lockdown. The study attempts to find out how did they feel about the whole process, the difficulties experienced and their opinion on government's role in better ways of handling lockdowns. A total number of 322 post graduate students from Chennai city colleges were collected for the study. The research study is a quantitative one wherein the researcher had adopted an exploratory research design using the 'Ex Post- Facto' method. Due to the lockdown the parents of the students were financially disturbed as few members in the family lost their jobs, at the same time as young adults the students had to stay home by not moving outside and avoiding physical interaction with friends and neighbours had a great impact on their mental health.

Keywords: COVID-19, Lockdown, Psychological well-being, Mental health.

Introduction

"It will change the way we live-things will never be the same- we have to learn to live with it- it will change us as a species"

These are some of the reactions during COVID-19 pandemic. The world has changed dramatically in the past six months as the virus has taken the world with storm infecting over 5 million people, primarily a health crisis, has thrown a nightmarish challenge to policy makers to decide between closing down the state to save lives of from keeping it open to save the economy. The pandemic is expected to have a huge impact on global education in general and on Indian education system in particular [1].

Coronavirus is a single stranded enveloped RNA virus 1 that is spherical or pleomorphic in shape with bear's club -shaped glycoprotein projections. The coronavirus is divided into many subtypes, they are alpha corona virus, beta corona virus, gamma corona virus and delta corona virus were each subtype has many serotypes. Coronavirus are transmitted vis airborne zoonotic droplets and viral replication occurs in the ciliated epithelium resulting in cellular damage and inflammatory reactions at the site of infection. In addition to humans corona virus are found in bats, whales, pigs, birds, cats, dogs and mice [2]. The virus which causes COVID – 19 is a novel coronavirus that was first identified during

an investigation into an outbreak in Wuhan, China. The virus which causes COVID – 19 probably emerged from an animal source which later started from person to person. The virus mainly spreads between people who are in close contact with one another through respiratory droplets produced when an infected person coughs or sneezes. It is also possible for a person to get COVID – 19 by touching a surface or object that has the virus on it and then touching their mouth, nose and eyes (Department of health and human service, CDC, 2020).

Definition of concepts

Quarantine: The concept of 'quarantine' is embedded in health practices, attracting heightened interest during episodes of epidemics. The term is strictly related to plague and dates back to 1377, when the Recotor of the seaport of Ragusa officially issued a 30 days for land travelers [3].

Pandemic: A pandemic is defined as "an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people" (World Health organization, 2011)

Lockdown: It is a requirement for people to stay where they are, usually due to specific risks to themselves and to others. The term stay-in-place is often used for lockdowns that affect an area, rather than specific locations (Wikipedia)

The Surveillance of the Lockdown

The corona virus crisis and the strict measures taken by many countries has created a negative impact on people's mental health and well-being as warned by World Mental Health Organisation(WHO). The director of the European branch of WHO, Hans Kluge said that isolation, physical distancing and the closure of schools and workplaces are the greater challenges faced by the people and it is also natural for the people to feel stressful, a feeling of loneliness and anxiety. As people are obliged to remain in home quarantine with possible or proven corona virus infection it is important to consider the effects of this pandemic on the mental health of people while providing psychological support for the general public [4].

The Effect of Lockdown on Students

COVID -19 has been declared as pandemic by World Health Organisation(WHO) which has created a sense of fear panic all over the world. Since then the first case of COVID – 19 was declared in India the State Government took all the possible precautionary step to curb the spread of the disease which included shutting down the educational institutions, vacating hostels, postponing the entrance examinations, convocation ceremonies and other programs The spread of COVID -19 which was spreading across regions and state, the government decided to close down schools, colleges and educational institutions as a precautionary measure against the disease. Due to this spread of disease a large population of India's educational system was disturbed [5]. In higher education many universities and colleges are replacing traditional exams with online assessment tools. This is a new method for both the teacher and the students and the assessment may have a larger measure of error than usual [6].

Statement of the Problem

The researcher has undertaken a study among the PG students of Chennai city colleges who encountered the lockdown of COVID– 19 as thought the situation of lockdown was getting worst day by day where there is an uncertainty about examination, future plans and about their career that can induce stress. The researcher

also tries to identify how their family situation has created an impact on them as students with family members or parents infected with the corona virus that can be stigmatized, children who have lost their parents, economic problems in the family and loss of job of their parents. Though the lockdown has been announced all over the world the researcher choose to study the lockdown effect on students by choosing the respondents the PG students from various city colleges in Chennai city.

Socio-Economic Impact of COVID-19

The United Nation (UN) warned saying coronavirus " has the seeds of major mental health crisis", and called for substantial investment in support services [7]. Though the virus may vanish sooner or later, its impact will be seen largely in social relationship. For

example: a) neighbours may avoid talking to each other giving excuses even without opening their door when one knocks on it. b) when a person goes out to buy essential necessities from the market you may be advised to maintain distance as if you were a carrier of the virus. c) When you are not encouraged to swipe your credit/debit cards on the swipe machine by the shopkeeper making you feel that your account security is less valuable than probable virus infection. The COVID-19 pandemic is casting a long shadow on countries across the world and has moved beyond the health crisis. The impact of COVID-19 on children has UN Secretary General stated: "children are not face of this pandemic but the risk being among its biggest victims", this complex socio-economic impact of COVID-19 on children and families re-seen in three different streams:

The first is the virus itself. Though there is low infection rates in children, the impacts can be deeply felt with children whose family members tested positive for COVID-19. The second stream is the containment measure, school closure and confinement with their homes while these interventions reduce the spread of infections rate, it has severe impact on children in terms of loss of education, loss of income and psychological trauma. The third stream is the larger economic crisis generated by the containment measures – a crisis that will push millions of children and their families back to poverty even after the end of the lockdown. Without the right vision, right planning and right investment the future could be uncertain for millions of children. The only hope is a resolve from UNICEF to rise from this pandemic building a stronger future for all children and their countries [8].

Lockdown and Its Impact on Education

The global lockdown on educational institutions is likely to cause major interruption in student's learning, disruption in the conduct of their semester examinations, disruption in internal marks, and postponement of exams or cancellation of public assessment for qualification or in their replacement by an inferior alternative. Uncertainty of internship towards end semester for students in higher education. There is certainly a need to identify discussion on what can be done to mitigate these negative impacts.

The COVID-19 pandemic is a health crisis and many countries have rightly decided to close schools, colleges and universities. There is a dilemma that worries policymakers in closing schools (to reduce virus contact and save lives) and keeping them open (allowing workers to work and maintain the economy). This process has caused disruption felt not only by many families globally with home schooling becoming a difficult task to parents' productivity as

well as to children's social life and learning. Teaching seem to move online on an unprecedented scale. Students assessment are also moving online with a lot of trial and error with uncertainty for many.

It is envisaged that the career of the students during the academic year 2019-20 may be severely affected by the COVID-19 pandemic as the students in higher education are likely to graduate at the beginning of a major global recession. Poor market conditions at labour market entry cause workers to accept low paid jobs and this has permanent effects on the career of a few. Some of the solutions could be enhancing resources by educational institutions to rebuild the loss in learning, proper utilisation of resources and how to target students who are especially hard hit. For a new graduate, policies should support their entry into labour market to avoid longer unemployment periods [9].

Challenges in Digital Learning

The lockdown has brought in a huge change in educational system by bringing in the digital platform to reach out students. Various applications like Google classroom, YouTube, Google forms, Zoom, What app and e-mail has been adopted to take virtual class for the students. Though there are various applications available the major challenge is: are the students able to have access to internet and students who are living in rural areas are also expected to have a high speed net so that they can listen to the class in a virtual method. Another challenge is the live streaming focuses only on theoretical imparting of the subjects without actual use of the laboratory. From the student's point of view students had to leave or vacate their hostels and PG accommodation after the lockdown was announced and thus the students had to leave few things in their hostels like their books and electronic gadgets hoping the lockdown will end soon. The final year students were affected the most as they were in a confused state not knowing whether there may be an extension of the current semester. Students who wanted to do their higher education abroad were also uncertain for the fear that they might wait or lose one year due to the lockdown [10].

Impact of COVID-19 on Mental Health of College Students

Higher education response to COVID-19 pandemic and isolation response to the crisis will go a long way and make an imprint of the institution. The crisis have imposed a new level of

anxiety and isolation. The educational institution need to address the mental health during the pandemic and provide short term and long term planning.

Students report uncertainty about academic options and are clueless of what these options mean for their future. The lack of clarity has significantly worsened their mental health. Many students report lack of regular and compassionate communication from the institution as a primary stressor during COVID-19, as reported by a National wide survey (Active minds). Students seek compassionate, caring communications that reduces the burden they may face including caring for family members, suffering of financial stress or facing trouble accessing or staying focused during lectures. The social and economic issues exposed by the pandemic will result in unemployment, deleted social safety nets, starvation, increase in gender- based violence, homelessness, alcoholism, loan defaults and millions slipping into poverty. This could be a fertile breeding ground for an increase in chronic stress, anxiety, depression, alcohol dependence and self harm leading to overall rise in morbidity, suicides and a number of

disability adjusted life linked to mental health [11].

The entire performance of students dependence on his/her mental health. Disturbance in the mental health have a negative impact on the students with serious negative impact on the community. Today's students are the future of a country contributing to its development by serving various roles like teachers, engineers, doctors, nurses etc. Hence mental health of students is of great importance. As there is no proven treatment to manage the novel corona virus disease the spread is increasing day-by-day. Lockdown seems to be the only option available to slowdown the rate of spreading the infection. Online classes have resumed in educational institution and adapting themselves to this sudden transition from routine teaching method is stressful. Students stress levels should be mentioned regularly using online tools to prevent students enter into a state of depression. Continuous monitoring, by offering counseling to needy students will help to keep students mental health to do well in personal and professional life [12].

Social Work Response to the Pandemic

The social work profession more than any other, has been the most hurt by the rampaging corona virus (COVID-19) pandemic given the scourge's impact on society's undeserved and undervalued population. The pandemic has effected global economy, disrupted global social events and caused the death of tens of thousands of people while leaving millions infected and vulnerable. Among the most affected are the society's marginalized and excluded population (older adults, people with development impairments, including those with weak immune system as well as the poor). With the promulgation of social distancing and self- isolation, concerns have been raised about prospects of increased human rights violations [13]. Social workers - as conveyors of professional knowledge, skills and attitudes and values (Council on Social Work Education, 2008) are professionally bound to speed up action to conducting and disseminating research on (1) social workers response to protecting their clients-system or service-users from the COVID- 19 pandemic, (2) the coping strategies of service users (older adults, women, resource- deprived households) inaccessibility to medical care in most developing regions, and (3) interventions to families undergoing loss who could be of relatives, parents or any other older ones of socio-economic or material loss due to the pandemic, by engaging in research, the profession could create a vast reservoir of literature that could be of great use in dealing with future challenges. Social workers could also assume the role of educator, counselor, and referral linking care-users and care-givers [12].

Methodology

The research study is a quantitative one wherein the researcher had adopted an Exploratory research design using the 'Ex Post-Facto' method to describe the existing knowledge of students on COVID-19 and its impact on their education and psychological well - being. The Universe of the study is Chennai which is the capital of Tamil Nadu where number of autonomous colleges and top ranked technical institute are found. Educational institutions in Chennai is well developed with high literacy rate. The most popular colleges in Chennai are Anna University, IIT Madras, Loyola college, National Institute of fashion technology, Central Leather Research Institute and National Institute of Technology, Guindy. All have developed facilities like well versed lectures, libraries, modernized laboratories

contribute in making best college in Tamil Nadu's capital City, Chennai [5].

Hypothesis

• There is no relationship between limitations faced during lockdown with the psychological impact of COVID – 19 on respondents

Table 1. Chi – Square Test for Association Between Limitation Faced during Lockdown with the Psychological Impact of COVID-19 on Respondents

Psychological impact of COVID-19 on respondents	Limitation faced during lockdown					Total	Approx .Sig	Results
	Lack of face to face interaction	Team work	Restriction in mass gathering	No access to any formof transport	Unable to have the food I desired			
Lazy	15	1	6	11	4	37	.398	Not significant
Boredom	33	1	14	10	8	66		
Panic	2	0	0	3	0	5		
No positive feeling	8	2	4	5	5	24		
Less enthusiastic about anything	30	4	12	13	4	63		
Loneliness	10	0	3	4	3	20		
Occupied with work	23	2	5	12	5	47		
Depressed	18	2	4	6	1	31		
Any other	10	2	8	4	5	29		
Total	149	14	56	68	35	322		

Interpretation

From the above table it is found that the significant value is .398 which is more than the P- value at one per cent level. It is inferred that the null hypothesis is rejected as there is no significant difference between the lockdown imposed and psychological effects of the respondents.

Reason: As it is found that the respondents are young post graduate students they are not too worried about the disease and therefore are not psychologically effected by the lockdown. The students were more concerned about restrictions imposed due to lockdown and from the table a small proportion of 31 respondents felt depressed.

Major findings and Discussions on Psychosocial effect of lockdown on students

Nearly 20.4 per cent of the respondents felt bored during the lockdown not knowing how to keep themselves engaged .A large number of 46.3 per cent of the respondents said that they did not have any face to face social interaction by not meeting their friends, relatives, classmates and staffs from their respective colleges. A large majority of 83.2 per cent of the respondents said that they followed social distancing, using mask while moving out, regular hand wash and avoided touching their eyes, nose and mouth.

A large number of 41.6 per cent of the respondent have said that they tried to be more health conscious by increasing immunity power in them as it is inevitable that everyone will be exposed to infected people when they go about their routine work.

With regard to students wanting to complete the course almost half the sample size

which is54.7 per cent respondents said they strongly disagree as they were not serious to complete the course . A majority of 57.5 per cent respondents agreed to go ahead with their internships in order to complete their course and also take up jobs in their own field of interest. A large number of 44.4 per cent of the students have agreed for online classes which will help them move forward in their academic work. A large number of 42.9 per cent respondents were eager to take up semester exams as soon as possible in order to complete their course and move forward academically. A large number of 49.1 pe cent of the respondents have agreed that they keep themselves busy by attending online classes which helps them to learn new courses and gain knowledge about new subjects. A majority of 53.7 per cent respondents agreed to have attended various webinar organised by various colleges during lockdown which has helped them in learning more about their subjects also new information shared online which kept the students engaged.

A majority of 51.9 per cent respondents agreed that their family members found it hard to maintain their expenses during lockdown as in many cases people were asked to leave their jobs due to loss of income in the companies, or due to heavy loss caused due to lack of salesin their work place.

Suggestion, Recommendation and Conclusion

The lockdown period has brought in a separation and seclusion of individual families and groups confines within their space of safety and protection from COVID-19. This has lead to severe stress and boredom especially among students of both schools and colleges.

Some of the Progressive Ways by Which Lockdown can be Spent are Spelt out by the Researcher

Universities and colleges to organize online classes Encourage students for online courses. Guide youngster to maintain a positive relationship with their family members, neighbours and friends through various communication system.

Encourage the students towards the habit of reading and updating their knowledge.

Develop the habit of physical exercise, hobbies that can be done indoors.

Student can be reached to reach out to the most effected due to COVID-19 by their generous contribution in cash and kind.

The Pandemic has Impacted the Society on the Basis of the Following Criteria

Health Inequality – social stratification, low income individuals, lack of access to essentialhealth service

Educational Impact – widespread closure of educational institutions Gender wise – Dual burden on work, limits of work from home

Domestic violence – Violation of human rights

Individual isolation – lack of humor happens and well beingPsychological impact – suicide, grief, survival and fear

Economic impact – plight of informal sector, fear of losing jobs, pay cut, time bond project completion, lack of interpersonal relationship, lack od data/adequate information.

The Social work intervention model is brought out keeping in mind a community based programme. Many NGO's were involved in preparing materials and colourful models that were disseminated to various groups for educating them on the nature of the disease, the mode of its transmission and preventive methods particularly to increase immunity to stay safe from the disease.

The second major activity is tele counselling to the infected and the affected and those under quarantine. The program of tele counseling needs to follow guidelines especially how to identify persons who need it and to get informed consent. During the pandemic it is precisely the clients freedom to schedule appointment ones the telephone or video that can offer solace to many people.

The third important method would be research activity. Research can be undertaken at each stage including in the first two methods to make an amendment of the programmes either directly or indirectly keeping the storage of recorded data in place. Research activity can also be undertaken to evolve new methods of intervention for individuals groups and communities. To evolve policy framework that will suit the new normal in different sections such as health, education, workplace and community programs.

The Role of Social Workers During Pandemic

Social workers like many health professionals are concerned with the impact of corona virus disease 2019 on the well being of people to whom they provide services, the families and others in the community. NASW (National Association for Social Workers) has been working on multiple fronts to prevent the spread of COVID-19 and ensure access to services such as tele-therapy. Social workers are in a unique position to promote disease prevention efforts including disseminating adequate information to help address anxiety and other concerns that are arising as a result of this public health crisis **(**www.socialworkers.org) [15].

The primary role of social workers includes being part of multi -professional effort to reduce infection risk and have a key role in addressing the social and economic consequences of emergency measures such as lockdown, school and business closure, home working and severe travel restrictions (Fig. 1).

Reference

[1] Al-Osail, A. M., & Al-Wazzah, M. J. (2017). The history and epidemiology of Middle East respiratory syndrome corona virus. *Multidisciplinary respiratory medicine*, *12*(1),20.

[2] Anum Ansari, April 23rd (2020). COVID-19 MHRD launches Vidya Daan 2.0 asks

people to contribute e-learning content for students.
[3] Amadasun, S. (2020). Social work and COVID-19 pandemic: An action call.

[4] Berg-Weger, M., & Morley, J. E. (2020). Loneliness and social isolation in older adults during the Covid-19 pandemic: Implications for gerontological social work.

[5] Campbell, A. D. (2020). Practical Implications of Physical Distancing, Social Isolation, and Reduced Physicality for Older Adults in Response to COVID-19. *Journal of Gerontological Social Work*, 1-3.
[6] Gensini, G. F., Yacoub, M. H., & Conti, A. A. (2004). The concept of quarantine in history: from plague to SARS. *Journal of Infection*, *49*(4), 257-261.

[7] Sandeep Khanwalker, June 7th.(2020). Emerging Socio impact of COVID-19.

[8] Raju, H. (2020). Covid-19 Lockdown-challenges to higher education, Dr. *AIT, ECEBengaluru, (ongoing project), 20944*.

[9] Nelson Vinod Moses.(2020). COVID-19. India is staring at a Mental Health Crisis.

[10] Nicolas, E. S. (2020). Corona virus Threat to EU Farm Seasonal Workers. *EU Observer*.

[11] O'Leary, P., & Tsui, M. S. (2020). Social work's role during and after the pandemic: Keeping vigilant and hopeful on human rights.

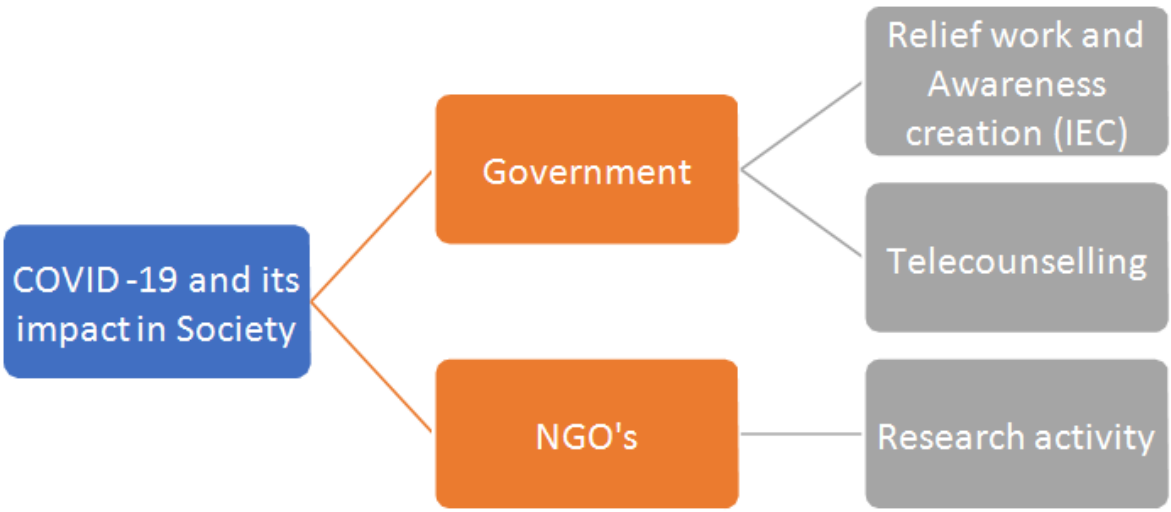
[12] Prachi Salve, May 26th. (2020). It's not a problem of schools are the last to open.

[13] Qudsia Tahseen. (2020). The impact of COVID -19 on education at AMU.

[14] Sergey Lavrov Source, May 28th.(2020). Conclusion and mission on COVID-19, Global Times.

Websites
[15] www.socialworkers.org, 2020.

Figure 1. Social Work Intervention Model



Convergence
Vol. 15, No. 1-4, pp. 75-80, 2022

STUDENTS' PERSPECTIVE ON ONLINE LEARNING AMID THE COVID-19 PANDEMIC

D. Delinta*, A. Ajila[2], A. Priya[3], Ashok Kujur[4] and S. John Mary[1]

*,[2,4]Research Scholar, Department of Chemistry, Loyola Institute of Frontier Energy (LIFE), Loyola College, Chennai - 600 034.
[3]Postgraduate researcher, AVIT, Chennai.
[1]Assistant Professor, Department of Chemistry, Loyola Institute of Frontier Energy (LIFE), Loyola College, Chennai - 600 034.
***Corresponding Author Email:** delinta99@gmail.com

Abstract: Self-directed open learning through online mode is seen as the most convenient and preferable mode concerning with COVID-19 pandemic. But the influence it has on the mental and physical health of students is seen to be dangerous. This current study focuses on analyzing the impact of online classes for students who are between the age of 15-25 from the student's perspective in and around the city of Chennai, Tamil Nadu, India. Children With Special Needs (CWSN) and normal students were subjected to the examination and it is seen that the majority of the crowd admits that their mental and physical well-being was seen to be affected by the whole online change. Feedback from the parents and teachers of the Children With Special Needs was also gathered to get clear input on their behalf. Basic factor such as Mental stress caused by increased screen time and lack of social interaction has been a key factor and have been addressed. Besides the impact online classes had on academics, physical fitness was seen to be a major side effect with respect to their health. Even though online classes served as a good alternative to maintaining academics during the pandemic, it still has a large number of drawbacks that has to be seen through and analyzed. The factors discussed in the study can serve as a guide in developing a scheme for a better online learning facility in the near future.

Keywords: COVID-19, Pandemic, Online learning, Mental health

Introduction

COVID-19 was recognized as a global pandemic by the World Health Organization on March 2020. It started in a city named Wuhan in China and spread globally, consuming the life of Millions of people. The Government inculcated various methods to ensure public safety, including ensuring people do not leave their homes and implementing a Lockdown throughout. This sudden pause in the entire Human everyday cycle affected the entire population irrespective of their lifestyle, including the country's economy. Education became a significant victim by turning the student's career and studies into a big question mark. As a result, the entire learning system was converted to an online mode, the only way to resume education. Tamil Nadu's

education system is divided into pre-primary, primary, upper primary, secondary, and higher secondary education.[1-3]

The age group of pre-primary classes is four to five years. Primary classes have children from ages six to ten. Upper primary classes have children aged eleven to thirteen. Secondary education is given to children between the ages of fourteen and fifteen. Children of ages sixteen and seventeen attend higher secondary or matriculation schools. The schools in the state are also classified into government, government-aided, and private schools, depending on who owns the schools.[4] In the academic year 2019-20, there were 58,897 schools in the state. Of these, 37,579 were government schools, 8,328 were aided schools, and 12,382 were private unaided, recognized schools (affiliated with different boards). The number of private schools affiliated with the state board in the year 2020 was 4,380, and 4,438 in the academic year 2020-2021. A glance at the organizational hierarchy of the Tamil Nadu education system is essential to understand the key players in a child's intellectual and moral development.[5-8]

Due to the lockdown situation that was put forward for the safety of an individual, many students have been seen to have lost their further education. One of the primary reasons was the economic crises faced by their parents, and the children started working to help their families. This present paper brings forward the students' difficulties and analyses the problem from the parent's point of view [9-10]. Despite the help we gained from technology during the pandemic, the drawbacks were found to be an inevitable characteristic that bought forward this current work. A survey was conducted and reported on behalf of students and the parents of children with special needs. The diverse opinions and results are put forward, and proper insight into these problems is needed to avoid all the voids caused during this pandemic shortly.[11].

Reason for the Study

Online education has not only forged a person's education status and ability but has also affected students in ways that are impossible to imagine. A Tamil Nadu Science Forum (TNSF) survey showed that the dropout rate was 11%. Those who dropped out had passed fifth and eighth grades but had not enrolled in the following levels. Among the participants, 13% were resorting to child labor to support their families; 60% of the child laborers worked 12 hours a day, and 50% of children earned less than Rs 200 a day. The survey showed that 45% of girls remained in their homes when their parents left for work in unsafe conditions. The girl children reported the unavailability of sanitary napkins during the Lockdown. The percentage of children who have lost weight since the closure of schools was 39%. This resulted from the need for more nutritious food they enjoyed in schools under various meal programs. The same study reported the willingness of children to go back to school. Around 95% of the students longed to return to school [12-15].

Online Teaching

The online teaching mode was implemented using platforms such as Google meet, Google classroom, Zoom, Microsoft teams, etc. The institutions demanded that students attend classes digitally, and proper

orientation was provided. However, the unavoidable consequences, such as network issues, lack of electronic devices, and improper environment for the class, remained unsolved. The issue starts with teachers who need help adapting to the online teaching mode and their discomfort in delivering the lectures and ensuring the class stays active the entire time. In addition, the lack of interaction and the minimalism of group activities made it harder for students and teachers.

Nonetheless, the teachers of CWSN faced the consequences and struggles in implementing online educational activities for the children. The feedback from the teachers of CWSN was selectively collected, and it was seen that various trial and error methods were settled to ensure the student benefits from the new teaching mode. It also took much work for the teachers to rely on their parents to operate the virtual tools and to help the students.

Online Learning

The online platform is an unavoidable phase in our day-to-day life. However, despite this, it does seem a luxury to people who still do not have access to it. When online classes with various platforms were introduced, most students found it difficult due to the unavailability of individual devices. Thus, the Government took appropriate steps to help the needy by introducing classes via a television channel called KALVI which telecasted teacher lessons. This did not help with student-teacher interaction, but it was considered a much better alternative, and almost 41% of the students found it helpful.

Online Environment

Tamil Nadu is a state located in South India with a population of almost 72,147,030, with the majority being lower class. There is nothing to negotiate under such circumstances, but this side of the population has a small living space with just one room to fit the entire family. Situations like this automatically trigger discomfort for the parents and students attending classes. These factors naturally make it difficult for the Child to focus on the class and pave an easy way for distractions. Besides the comfort online education gives an individual to work at their own pace, it still becomes a luxury for people who need necessities like space, making it a drawback.

Online Examination

Online mode of the evaluation was one of the most challenging jobs encountered by the teachers as they tend to lose control over the class, failing to meet the traditional disciplined ways. From class tests to the competitive exams for higher studies, students and teachers, along with the Government, faced their stress in different ways. Online classes were already challenging for the students, yet expecting them to appear for untrained online examinations made it even harder. Besides the comfort they received from the levels of their own house, that also impacted malpractices and other non-conventional aspects for obtaining higher grades. Controlling students online is already tricky, but expecting them to be disciplined makes it impossible.

Online Learning for CWSN

There exists a minority rate of Children who require special attention, and controlling them online makes it a difficult task. Students needing constant help accessing the online platforms needed a guardian/ parent to help them along the case. A survey was conducted for the parents, staff, and the management of Don Guanella School for the Special Children, Poonamallee, Chennai - 600 056, and some of their difficulties are listed below.

Point of View - Management

The biggest fear and task was to find an alternative way to keep the Child engaging while not consuming the time and power of their parents. Even though alternate techniques were brought in, they needed to meet the expectations. Thus, the management decided to lead activities that must be practiced throughout the day, and the parent must report a video clip of the activity to the teacher. This specific activity is customized for each Child by their teacher, making it easy for the parents. However, despite the measures undertaken, the children were reportedly physically inactive. They developed an adamant nature and overeating habits, which were found to be unmanageable post-lockdown.

Point of View - Teacher

Customizing tasks such as Dancing, Singing, No fire cooking, Drawing, Reading, Picking pebbles, Washing rice grains, transferring water from buckets, etc., were assigned, and the parents had to organize the entire system. Even though online classroom platforms cannot be accessible or used by this set of people, teachers found their way of pressure to engage with the students and keep them entertained. Voice calls and video call forms of communication were done regularly to ensure the student followed the discipline and virtues taught in school.

Point of View - Parents

Parents were seen as the real victims in this situation. Of a group of 30 parents, 27 belonged to the middle class, with more than one parent working, which makes it difficult to focus on the Child. Some parents stated that they had to depend on help from other relatives and grandparents to help care for their Children. Almost 16 parents reported that they had to go out and work on daily wages and had no one to look after the Child; thus, the Child was locked inside the house without supervision so the parents could earn for their survival.

These children were constantly engaged in all forms of physical activities, which included outdoor games and constant breaks for walking around the campus. Also, the management induced regular physiotherapy and health care checkups in the children to ensure a healthy mind and body. With all these maintaining the Child's peace, Lockdown made it impossible to commemorate the Child's basic needs. These students were reported to be less disciplined and more adamant, along with obesity after the Lockdown. Steps and measures are still being implemented to help the children and the parents outrun the losses caused by the pandemic.

Conclusion

Besides online education's drawbacks, it served as a fantastic alternative in helping the education system run consistently during the pandemic. The study advises educational

institutions to lead young minds to various ways of using modern technology in education. Other cases like these could be avoided with a better implementation of plans. Similarly, Children with special needs must be acknowledged as the other students. Proper care and alternative online methods have to be put forth to avoid such extreme situations and allow the children to have a similar improvement even via online methods. Despite the differences, online education has paved the way and helped millions of students during the pandemic. The technology and the rapid decision-making of the Government and Institutes in being able to adapt themselves to the change is something that has to be appreciated.

References

[1] Arora, S., Bhaukhandi, K. D. and Mishra, P. K. (2020). Coronavirus lockdown helped the environment to bounce back. Science of the Total Environment, 742, 140573.

[2] Bajaj, M. (2012). From "time pass" to transformative force: School-based human rights education in Tamil Nadu, India. International Journal of Educational Development, 32(1), 72-80.

[3] Jayasundara, N. S. (2014). The development of language education policy: An Indian perspective; a view from Tamil Nadu. International Journal of Scientific and Research Publications, 4(11), 1-4.

[4] Hiscott, J., Alexandridi, M., Muscolini, M., Tassone, E., Palermo, E., Soultsioti, M. and Zevini, A. (2020). The global impact of the coronavirus pandemic. Cytokine and growth factor reviews, 53, 1-9.

[5] Devine, D., Gaskell, J., Jennings, W. and Stoker, G. (2021). Trust and the coronavirus pandemic: What are the consequences of and for trust? An early review of the literature. Political Studies Review, 19(2), 274-285.

[6] Hwang, T. (2021). Coronavirus lockdown and virus suppression: An international analysis. Technological Forecasting and Social Change, 170, 120861.

[7] Rupani, P. F., Nilashi, M., Abumalloh, R. A., Asadi, S., Samad, S. and Wang, S. (2020). Coronavirus pandemic (COVID-19) and its natural environmental impacts. International Journal of Environmental Science and Technology, 17, 4655-4666.

[8] Onyema, E. M., Eucheria, N. C., Obafemi, F. A., Sen, S., Atonye, F. G., Sharma, A. and Alsayed, A. O. (2020). Impact of Coronavirus pandemic on education. Journal of Education and Practice, 11(13), 108-121.

[9] Ravi, R. C. (2020). Lockdown of colleges and universities due to COVID-19: Any impact on the educational system in India?. Journal of Education and Health Promotion, 9.

[10] Williamson, B., Eynon, R. and Potter, J. (2020). Pandemic politics, pedagogies and practices: digital technologies and distance education during the coronavirus emergency. Learning, Media and Technology, 45(2), 107-114.

[11] Tejedor, S., Cervi, L., Pérez-Escoda, A., Tusa, F. and Parola, A. (2021). Higher education response in the time of coronavirus: perceptions of teachers and students, and open innovation. Journal of Open Innovation: Technology, Market, and Complexity, 7(1), 43.

[12] Raj, U. and Fatima, A. (2020). Stress in Students after Lockdown Due to COVID-19 Thereat and the Effects of Attending Online Classes. Available at SSRN 3584220.

[13] Jena, P. K. (2020). Online learning during lockdown period for covid-19 in India. International Journal of Multidisciplinary Educational Research (IJMER), 9.

[14] Mishra, L., Gupta, T. and Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. International Journal of Educational Research Open, 1, 100012.

[15] Ravi, R. C. (2020). Lockdown of colleges and universities due to COVID-19: Any impact on the educational system in India?. Journal of Education and Health Promotion, 9.

Convergence
Vol. 15, No. 1-4, pp. 81-96, 2022

MECHANISMS CONTROLLING TH17 CELL DIFFERENTIATION, MATURATION, AND SURVIVAL

Ashok Kujur[1,2], A. Ajila[1], D. Delinta[1], J. Nirmala Devi[1], A. Selvam[1], P. Agastian[3] and S. John Mary[1*]

[1]Loyola Institute of Frontier Energy (LIFE), Loyola College, Chennai - 600 034, India.
[2]Creighton University, School of Medicine, 2500 California Plz, 68178, Omaha, USA.
[3]Department of Plant Biology and Biotechnology, Loyola College, Chennai - 600 034, India.
[1*]**Corresponding Authors Email:** johnmarysj@gmail.com, akujursj@gmail.com

Abstract: Th17 cells are pleiotropic, highly pro-inflammatory cytokines, and mediate immune responses orchestrated by interleukin 21 (IL-21) and interleukin 23 (IL-23). IL-21 and IL-23 function as "molecular switch" in cellular and molecular signaling process of Th17 cell differentiation, maturation, and survival to trigger a cascade of downstream signals and exacerbate various effector functions, such as host defense mechanism, immune homeostasis, promotion of inflammation, and autoimmune disorders. This review mainly focuses on, the role of IL-21 and IL-23 in concert with IL-6 and TGF-β and their possible mechanisms in Th17 cell differentiation, maturation, survival, and their biological significance in autoimmune disorders. This review is a conduit for understanding the critical role of Th17 cells in immune homeostasis, host defense mechanism, promotion of inflammation, and autoimmune diseases.

Introduction

Scientists have identified more than eighty autoimmune diseases. Every year as many as 24,000,000 Americans suffer from autoimmune diseases and treatment costs exceed $100 billion. *In vivo,* Th17 cells require IL-23 for cell differentiation; *in vitro*, it needs IL-6 and TGF-β. The experiments done by Liang Zhou et al. demonstrated that IL-21 amplified an autocrine loop to induce more IL-21 and IL-23 receptors in naïve $CD4^+$ T cells. It was assumed that IL-21 and IL-23, along with TGF-β, induce IL-17 expression. *In vivo*, IL-21 depends on STAT3-a transcription factor for the cell differentiation of Th17 cells. Both IL-21 and IL-23 induce the orphan nuclear receptor ROR-γt, which in synergy with STAT3, promotes IL-17. IL-6 orchestrates a series of 'downstream' cytokine-dependent signaling pathways in concert with TGF-β, amplifying ROR-γt-dependent differentiation of Th17 cells [1-2]. In recent times, numerous novel pathogenic factors have been identified that give new insights into the diseases. The roles of Th17 cells in the pathogenesis of various human autoimmune and inflammatory diseases such as multiple sclerosis, rheumatoid arthritis, bowel disease, and psoriasis remains unexplored [3].

Genesis of Th17 Cells

Coffman and Mosman have made a remarkable contribution to the field of immunology to help understand the

differentiation of $CD4^+$ T cells into T-helper 1(Th1) and T-helper 2(Th2) cells. However, the discovery of T-helper17 (Th17) cells has heralded a significant shift in understanding T-cell biology and its immune regulation [4]. Over the past decade, Th17 cells, which produce pro-inflammatory cytokines known as interleukin-17 (IL-17), have emerged as the primary therapeutic target because of their unique pathogenic profiles and plasticity [1,5]. Past research on the production of cytokines revealed that T cells were divided into Th1 and Th2 cells [6,7]. While our understanding and knowledge of human Th17 cells grow deeper, we only know about the genesis of one-third of the T helper cells, characterized as Th17 cells.

Characterization of Th17 Cells

Th17 cells are heterogeneous, distinct population of cells exhibiting specific phenotypes and pathogenicity on target cells [8]. They produce many kinds of cytokines; among them, the most essential and critical cytokines are IL-17, IL-17F, IL-21, IL-22, and IL-23, which play various roles in a multitude of innate and adaptive immune responses [9,10]. For example, IL-17 is reported to induce G-CSF, one of the critical factors for neutrophil progenitor proliferation and survival [10]. IL-17 has also been reported to induce the expression of TNF-α, IL-1β, IL-6, IL-8, and CXCL8. In adaptive immune responses, IL-17 also expresses other chemokines, such as CCL2, CXCL1, and CXCL10. Since their identification in 2005, Th17 cells' roles have been identified in several human diseases and various autoimmune conditions, i.e., allergies, the development and progression of tumors, and the rejection of transplants [11].

Th17 cells are a specialized population of T-helper cells developed on activating and expanding $CD4^+$ T-helper cells. They produce a pro-inflammatory molecule IL-17. Thus, Th17 cells are sometimes known as $CD4^+$ T-helper cells [12]. Th17 cells and their related cytokines are habitually employed in clearing extracellular pathogens by mediating the recruitment of neutrophils, sending macrophages to infected tissues, and modulating mucosal surfaces and epithelial cells. These cytokines are involved in many cellular responses and regulate downstream signal transductions. The cytokines IL-6, IL-1β, TNF (tumor necrosis factor), TGF-β (transforming growth factor), and IL-23 are produced directly due to Th17 cell differentiation, maturation, and survival.

One of the ground-breaking findings in T-cell biology is the identification of the lineage of the Th17 cell. This identification and current knowledge have provided a boon for researchers to explore biological functions and the role of Th17 in various disease-related complications [6]. It is generally accepted that TGF-β, combined with other cytokines, plays a crucial role in Th17 cell differentiation, inflammation, and autoimmune disorder, which are discussed later in this review.

Th17 Cell Differentiation

There are several contributing factors in Th17 cell differentiation. Some critical factors considered significantly important are TGF-β, IL-6, IL-1, IL-21, and IL-23. In general, IL-21, in concert with IL-6 and IL-1, and TGF-β, contributes toward Th17 cell differentiation, whereas IL-23 plays a role in

the growth and survival of Th17 cells. Numerous transcription factors, such as STAT3, ROR-γt, and ROR-α, play a prominent role in the development of Th17 cells as well. They share a common ROR-γt-dependent transcriptional factor throughout their cell differentiation, maturation, and survival, generating various tumor necrosis factors (TNFs) as immune responses [13]. During Th17 cell differentiation, TGF-β and IL-6, along with pro-inflammatory cytokines—TNF-α and IL-1β, seem to play a crucial role in enhancing IL-17 production. Experiments conducted by Acosta-Rodriguez et al. reported that IL-1β was up-regulated because of the induction of IL-6 and was responsible for the early Th17 cell differentiation *in vivo* [14,10]. Thus, IL-1β can be an exciting area to explore in the future for its therapeutic significance.

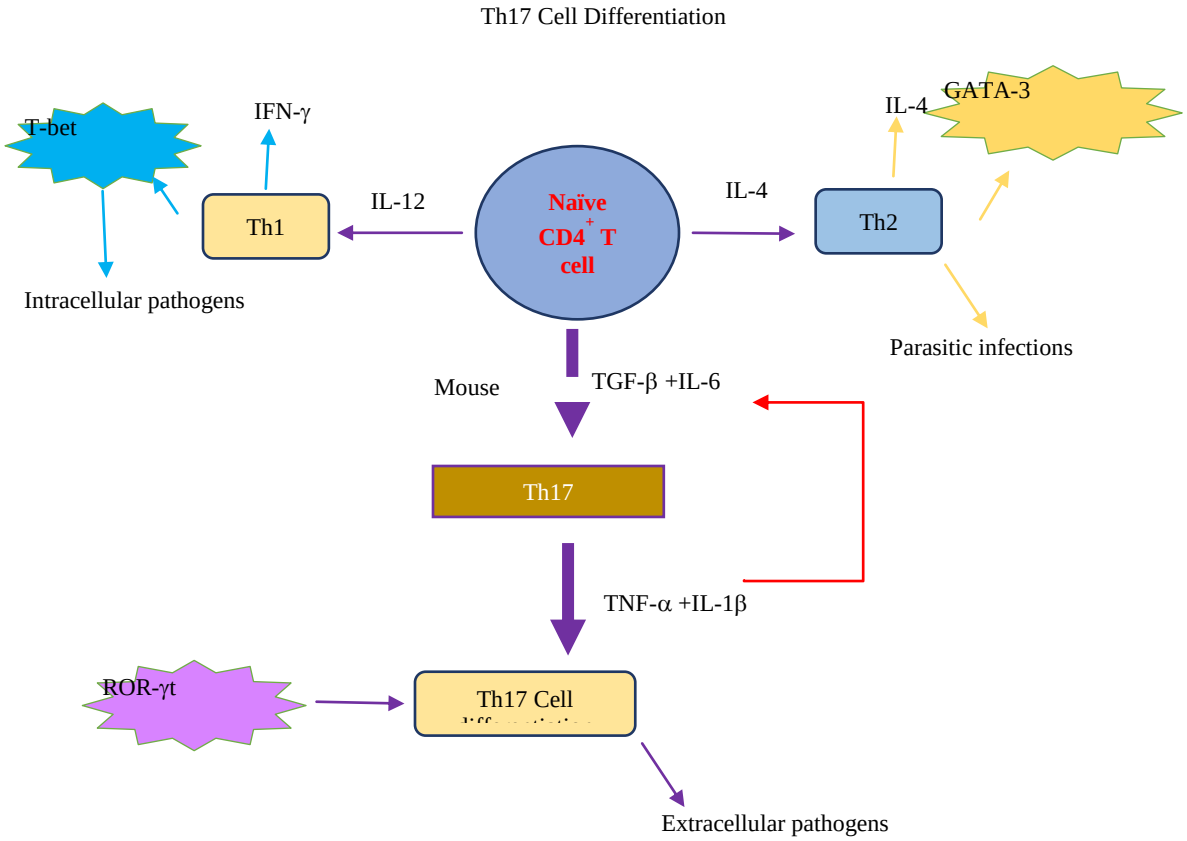


Figure 1. Schematic Diagram of Molecular Switches of Th17 Cell Differentiation

A naïve $CD4^+$ T cell differentiates into two subsets, Th1 and Th2, with the help of IL-12 and IL-4 following. T-bet regulates th1, and GATA-3 transcription factors control Th2. TGF-β combines with IL-6 to induce IL-21 to initiate Th17 cell differentiation in the presence of IL-1β. Th17 cell differentiation is controlled by the master regulatory transcription factor ROR-γt.

IL-21: A Double-Edged Sword

IL-21 is a type I pleiotropic cytokine. It is mainly produced by $CD4^+$ T cells and it plays critical roles in CD4-mediated B-cell differentiation and cytotoxic lymphocyte responses [15,16]. IL-21 has pro-inflammatory and anti-inflammatory actions; it primarily regulates a wide range of innate and adaptive immunities [17,18]. Fundamentally, IL-21 co-stimulates T-cell and NK-cell proliferation, survival, and differentiation. IL-21 receptors are expressed by various cells, such as B, T, NK, and dendritic cells. In addition, IL-21 is closely linked to IL-2 and IL-15—a cytokine family that uses the common γ–chain for signal transduction. Thus, it plays a critical role in sustaining antiviral cytotoxic T-cell responses and prevents chronic infections [19].

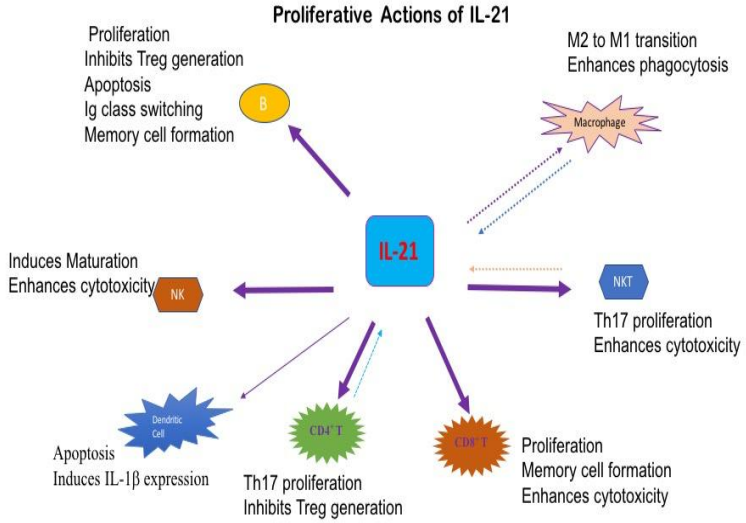


Figure 2. Diagram Showcasing the Multiple Roles of IL-21in Autoimmune and Inflammatory Disorders

Cytokine IL-21 can be induced by IL-6 or IL-12 in humans; alternatively, it promotes its expression via STAT3 [20,21]. Models based on animal experiments, clinical reports, and genomic-wide associated studies (GWAS) implicate IL-21 as a promotor of autoimmune diseases, e.g., encephalomyelitis (EAE), multiple sclerosis, and rheumatoid arthritis [22-25]. These studies have shown that IL-21 is a "double-edged sword" because the stimulation of IL-21 may lead to either the induction or suppression of immune responses. However, there are inconsistencies published on the role of IL-21 in Th17 cell differentiation and its mechanism [26]. These inconsistencies occur because IL-21 showed upregulation of T-bet, IFN-γ□□and GM-CSF while

promoting Th17 cell differentiation in experimental autoimmune diseases in mice [27].

Th17 Cell Maturation and Survival in Concert with IL-23 and TGF-β

Th17 cells utilize a unique set of biomolecules for cell differentiation. For example, they require IL-23 for *In vivo* and IL-6 for *in vitro* differentiation. However, IL-6 is the common precursor that induces IL-21, amplifying an autocrine loop to induce IL-23 receptors in naive $CD4^+$ and further facilitate differentiation. The effect of IL-6 and IL-21 fundamentally depends on STAT3 and ROR-γt. It is important to note here that TGF-β and IL-6 induce IL-21 and IL-23 to produce IL-17 [2]. The synergy of IL-21, IL-23, STAT3, and ROR-γt is a unique set that induces Th17 cell differentiation and regulates its growth and survival in the Th17 cell lineage.

In the signal transduction pathway, IL-21 activates mitogen-activated protein kinase (MAPK) and extracellular signal-regulated protein kinase (ERK) in monocytes, neoplastic and epithelial cells [28]. The inductive properties of IL-21 and IL-6 on naïve CD4+ cells have been activated through T-cell receptors and $CD28^+$. Therefore, IL-21 can function within an autocrine self-amplifying loop independent of IL-6^2. On the other hand, IL-6 plays a pivotal role in dictating a reciprocal differentiation pathway. Sometimes, IL-6 dictates $Foxp3^+$, dictating whether it should differentiate into T- a regulator or Th17 cells. At other times, IL-6 inhibits $Foxp3^+$ from differentiating into a T-reg cell. This suggests it agonizes Th17 cell production, directly differentiating into T-reg by activating $Foxp3^+$ [29]. In this pathway, experiments demonstrate that IL-21 and TGF-β produce Th17 cells [6,29]. *In vitro* and *in vivo* studies on murine models have shown that IL-21 plays a significant role in producing pathogenic autoantibodies and can cause end-organ damage by exerting anti-inflammatory actions. This results from its ability to inhibit dendritic cell maturation and production of IL-10 [30]. In such immunological conditions, blockage of IL-21 attenuates more anti-neoplastic immunity and worsens the viral infection, which causes more inflammation [31]. So, blocking the immunological pathway of IL-6 is another possible alternative to prevent inflammation and control the molecular signals.

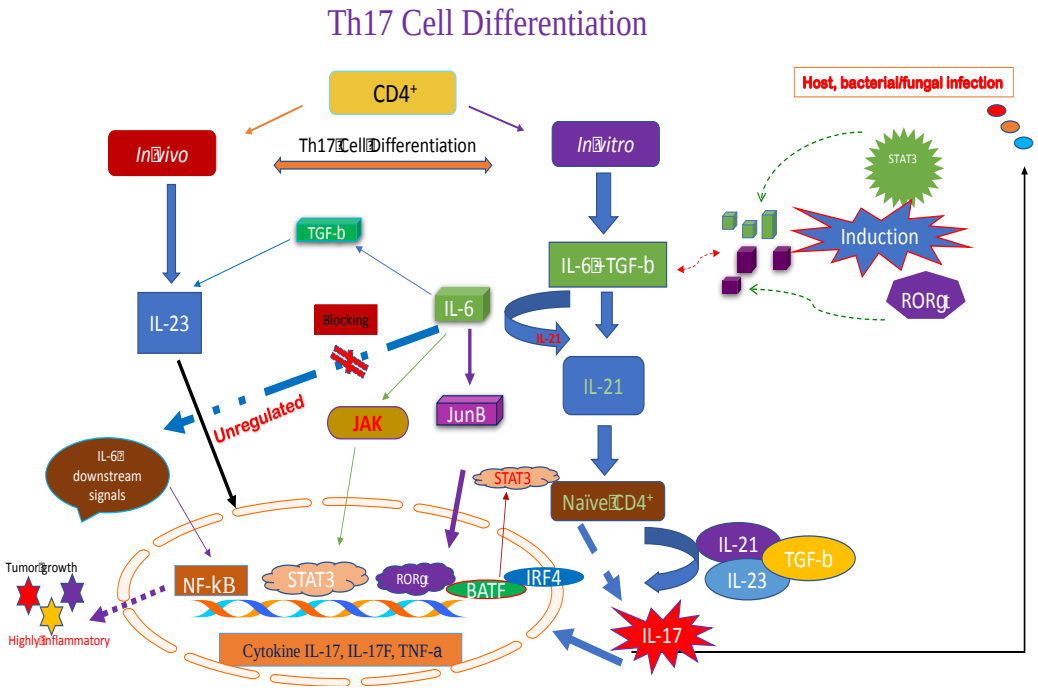


Figure 3. Mechanisms of Th17 Cell Differentiation

Naïve CD4+ T cells differentiate into Th17 cells in *vivo* and *in vitro*. *In vitro*, IL-6 binds with TGF-β and initiates cell differentiation. This process stimulates IL-21 and the induction of STAT3 and ROR-γt. This induction triggers transcription factors ROR-γt and STAT3 to produce IL-17. IL-23 controls cell expansion and survival. *In vivo*, IL-6 binds with TGF-β and induces IL-21 and IL-23. The transcription factor NF-κB controls the transcription factor.

Blockade of IL-6 to Regulate Inflammatory Responses

IL-6 is a pro-inflammatory cytokine, and it belongs to a family of cytokines that utilize glycoprotein 130 receptor-JAK-STAT3 signaling pathway. Other family members who share this pathway include IL-11, leukemia inhibitory factor (LIF), Oncostatin M (OSM), ciliary neurotrophic factor (CNTF), corticotrophin-1 (CT-1), and corticotrophin-like cytokine (CLC) [32,33]. Due to its production and secretion by infiltrating inflammatory cells, epithelial and mesenchymal cells, IL-6 plays a crucial role in immune-related degenerative disorders. The downstream IL-6, cytokine-dependent signaling pathway is essential because IL-6 has many inductive properties that cause inflammatory syndromes. However, its expression on endothelial and dendritic cells of the skin and its upregulation in psoriasis has remains explored [34].

Novel Therapeutic Importance of IL-6

IL-6 is an NF-κB regulated chronic inflammatory mediator exerting pleiotropic effects in developing autoimmune disorders, for example, psoriasis, rheumatoid arthritis, bowel disease, and cancer. IL-6 plays a pivotal role in inflammatory responses and triggers carcinogenesis, malignant transformation, tumor growth, invasion of

cells, and metastatic spread. It also stimulates immune-effector mechanisms that can stop tumor growth [35]. Any inflammatory response caused by IL-6 depends on intrinsic and extrinsic pathways; both resulting in the activation of transcription factor, such as NF-κB, STAT3, and HIF-1. These transcription factors modulate malignant microenvironments.

When IL-17 is produced *in vitro*, the activity of IL-6 is not terminated. Thus far, little research has been done on regulating IL-6 downstream signals. Reports show that IL-6 continues interacting with STAT3 and NF-κB, boosting tumor-associated inflammation and promoting tumor growth [36]. Therefore, the regulation of IL-6 downstream signals is critical because IL-6 regulation might impact autoimmune diseases. Experiments conducted by Mayawaki Takuya et al. on mice demonstrate that midazolam, in conjunction with cyclooxygenase (COX), showed high synergism for inhibiting the activity of IL-6 and downregulating inflammation [37,38]. Other reports have shown that IL-6 also plays a significant role in terminating inflammation signaling via the membrane-bound receptor IL-6Ra. In addition, IL-6 is linked to the JAK/STAT pathway through STAT3-expressing genes, encoding for anti-apoptosis [39,40].

Since IL-6 is a critical inflammatory cytokine induced by NF-κB transcriptional-signaling pathway, IL-6 combines with many inflammatory immune cells such as tumor-associated macrophages (TAMs), tumor-associated mast cells (TAMCs) and cancer-associated fibroblasts (CAFs) to trigger transcription factors NF-κB and HIF1 to produce excess cytokines. This creates a tumor conducive microenvironment [33]. Therefore, NF-κB might be a new therapeutic avenue and a bridge connecting the inflammatory cellular responses of IL-6 and TGF-β with IL-17. Probably, NF-κB might be the central player in inflammation and autoimmune disorders. Thus, a novel intervention or suppression of NF-κB may be an essential step in understanding the role of IL-21 in inflammatory responses.

Role of IL-23 in Th17 Cell Maturation and Survival

IL-23 is a novel cytokine; it forms heterodimers with the p19 and p40 chains of IL-12. IL-23 is very similar to IL-12 but functionally different because it mainly comprises p19, having p40 subunits [41]. Recent studies conducted on several animal models of human autoimmune diseases, including autoimmune colitis, experimental autoimmune (EAE) encephalomyelitis, mouse collagen-induced arthritis (CIA), and rat adjuvant-induced arthritis (AIA), have contributed enormously to the understanding of the role played by IL-23 and other cytokines regarding T-cell pathways that trigger chronic inflammation showing downstream signals in autoimmune disorders [42-45]. Previous studies have shown that IL-12 affected memory T-cells and inflammatory macrophage function by engaging a novel receptor (IL-23R) on cell lines, causing autoimmune inflammation. The studies and data analysis conducted by Murphy et al. confirmed that IL-23 is an essential promoter of end-stage autoimmune inflammation, whereas IL-21 paradoxically mediates inflammation [42].

IL-23 is mainly expressed by antigen-presenting cells (APCs), such as dendritic cells (DCs), macrophages, and monocytes, in response to bacterial and fungal infections. IL-23R is expressed by innate and adaptive immune cells such as Th17, NKT, T cells, and ROR- γt^{+} innate lymphoid cells, capable of secreting IL-17A, IL-17F, IL-22, and IFN-Y upon IL-23 stimulation [46]. There have been many studies in the past which show that IL-12 has a crucial role in chronic inflammation [3,47]. However, the most recent studies done by Cua and colleagues have demonstrated that IL-6 and TGF-b47, [48] primarily induce murine Th17 differentiation.

Another significant factor was the expression of IL-23R on $CD4^{+}$, causing T-cells to increase in the treatment of mice, which suggests that IL-23 has a role in the maintenance and survival of fully differentiated Th17 cells. Upon targeting P^{19} and p^{35} subunits, IL-12p [49] deficient mice showed resistance to EAE and collagen-induced arthritis (CIA). Their experiments further show that IL-23p [50] -deficient mice can still mount a Th1 response but fail to produce pro-inflammatory cytokine IL-17. Instead, TGF-β induces the development of regulatory T-cells upon the expression of FoxP3. This expression was identified as a critical factor for mouse Th17 cell differentiation was identified as a critical factor for mouse Th17 cell differentiation.

In cell differentiation processes, both IL-6 and IL-21 function as antagonists and prevent the development of FoxP3 cells, thereby triggering the development of Th17 cells, which, in turn, up-regulate the expression of IL-23R. This indicates that IL-23 is not required for the early proliferation of Th17 cells but is necessary for the maintenance and pathogenicity of Th17 cells.

It has been postulated that either IL-1beta or IL-23 up-regulated the expression of both IL-23R and ROR-γt. Notably, only combining the two cytokines allows $CD4^{+}$ T cells to express and produce IL-17.

IL-23 is an essential antagonist factor that suppresses the expression of interferon-γ that produces Th-1 cells. Instead, it expresses pathogenic $CD4^{+}$ T-cells, producing IL-17, IL-17F, IL-6, and TNF. Clair L. Langrish et al. conducted passive transfer studies utilizing CNS autoimmune mice to confirm that IL-23 $CD4^{+}$ T cells are highly pathogenic and essential for organ-specific inflammation [44,50]. The experiment conducted by Andrew L. Crowford et al. on mice determines if IL-12 or IL-23 was responsible for Th17 cell differentiation. The result showed that IL-23 did not induce cell differentiation, but it was IL-23 that was responsible for the expansion of Th17 cells [44,51]. The recent undergoing trials on EAE *in vivo* on stem cells suggest blocking IL-23 because it induces IL-17 production. However, the study showed a negative impact of IL-23 blockade in Crohn's disease patients [51]. This needs further investigation to understand the role of IL-23 in Crohn's disease. Though there are many other studies done to regulate IL-23 utilizing ROR- γt and to block the expression of the P^{19} subunit, the efforts have yet to be futile. Many studies hypnotized that the main reason for the antagonist effect might be the enhanced apoptosis of $CD4^{+}$ and $CD8^{+}$ in transgenic

mice [52]. However, it was confirmed that the combination of TGF-β and IL-6 work together to produce a high level of IL-17 in mice, though their effect differs in humans [14,53].

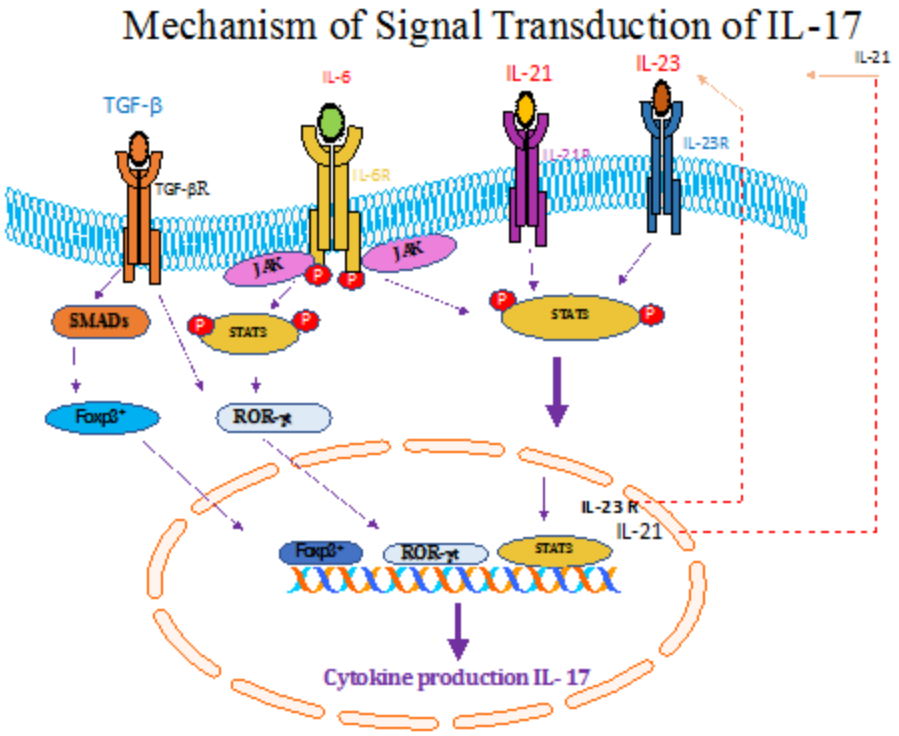
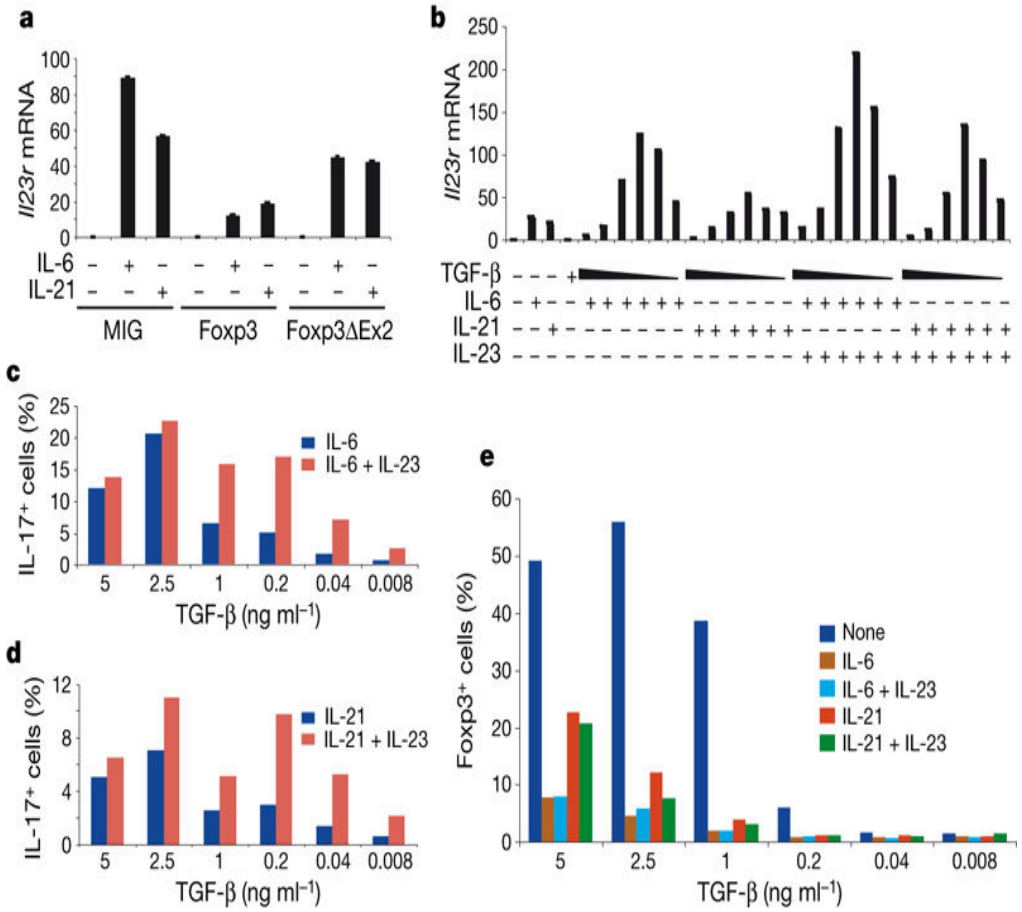


Figure 5. Schematic Representation of Mechanism of Signal Transduction of IL-17, Its Receptors and Ligands

Different Influential Factors of Th17 Cell Differentiation

Role of TGF-β and IL-21

At 2.5 ng/ml-low concentration, TGF-β synergizes with IL-6 and IL-21 to promote IL-23R expression, which triggers Th17 cell differentiation. At 8 pg/ml-high concentration), TGF-β represses IL-23R expression and triggers Foxp3 and regulatory T cells [1]. There are many studies to show that TGF-β and IL-6 together induce the Th17 cell differentiation in which IL-6 has a pivotal role in dictating whether T cells should differentiate into Foxp3 T-regulatory or Th17 cells [53,54]. TGF-β induces Foxp3 and generates T-regulatory cells. In this differentiating process, IL-6 inhibits the generation of T-regulatory cells and induces IL-17 production [1,29,53].



(Figure from TGF-β induced Foxp3 inhibits Th17 cell differentiation by antagonizing ROR-γt function[1] .)

Figure 5. Naive CD4$^+$ T cells were stimulated with anti-CD3 and anti-CD28 throughout the culture period in the presence of the indicated combinations of cytokines. TGF-β was titrated into the cultures at 5 ng ml^{-1}, 2.5 ng ml^{-1}, 1 ng ml^{-1}, 200 pg ml^{-1}, 40 pg ml^{-1}, or 8 pg ml^{-1}. *Il23r* mRNA expression was measured after 48 h by real-time RT–PCR and was normalized to the actin expression level. c, d, IL-23 enhancement of IL-17 expression at low concentrations of TGF-β

The Mater Regulatory Transcription Factor-ROR-γt

ROR-γt is one of the first identified Th17 lineage-specific transcription factors in Th17 cell differentiation. It is selectively expressed in a subset of lamina propia of Th17 cells, both *in vitro and in vivo* [54,55]. Studies done on ROR-γt$^{-/-}$ in mice have demonstrated that ROR-α is another important factor that plays a role in Th17 differentiation and commitment [55,56]. Co-expression of ROR-α and ROR-γt synergistically regulates Th17 differentiation induced by TGF-β and IL-6, which is dependent on STAT3. Studies also report that the over-expression of ROR-α promoted Th17 differentiation through the conserved non-coding sequence #2 in the lL-17/IL-17f locus. The mice that were deficient in both ROR-α and ROR-γt showed reduced IL-17 expression and globally impaired Th17 differentiation. This

protected mice against experimental autoimmune encephalomyelitis [56,57]. Thus, ROR-γt is the major transcription factor that distinguishes Th17 cell differentiation from the Th-1 and Th-2 subset. ROR-γt is controlled by the expression of T-bet and GATA3 [54,55, 57,58].

ROR-γt has biological effects of anti-tumor activity in different tumor models, operating through mechanisms involving the activation of NK and T- or B- cell responses. In addition, IL-21 affects Th17, T follicular helper (TFH), and Treg cells, promoting the development of autoimmune disorders and inflammatory diseases. A better understanding of the regulation of cell differentiation and stabilization of IL-21 in autoimmune disease and a novel therapeutic target is currently an exciting area to explore.

Jun-B Pathogenic Factor in IL-23

The pathogenic and non-pathogenic Th17 cells share a common ROR-γt-dependent transcriptional and regulatory mechanism. In pathogenic Th17 cells, activation protein AP-1 and transcription factor Jun-B are critical pathogenic factors that IL-6 induces. In addition, jun-B is essential for expressing ROR-γt and facilitating the binding of the IL-23 receptor to the Basic leucine zipper transcriptional factor (BATF). Experiments conducted by Zafrul Hasan *et al*. demonstrated that T-cells deficient in Ju-B failed to induce Th17-mediated autoimmune encephalomyelitis and colitis[12]. Thus, the dependent pathway of Jun-B can be a therapeutic target for autoimmune diseases.

Additionally, Jun-B interacts with the AP-1, and BATF, which are essential transcription factors. This suggests that Jun-B may be involved in Th17 differentiation [58,59]. In the IL-6 signaling pathway, Jun-B expresses via JAK and STAT3 pathways. Studies have revealed that the deficiency of Jun-B has shown numerous adverse effects, such as impairment of ROR-γt, forcing high production of IFN-γ, induction of Foxp3, and repression of IL-6 mediated f TGF-β[12]. Jun-B also plays a pivotal role in creating an environment for Th17 cells to maintain and survive without TGF-β1.

Antagonists (IL-21 and IL-2) of Th17 cell

IL-21 has been identified as an antagonist of Th17 cells that produce IL-17. IL-21 inhibits the intracellular signaling molecule STAT1. Another well-described antagonist of Th17 cell differentiation is IL-2 through STAT5. Mice that are deficient in IL-2 exhibit enhanced IL-17 production [56,57]. In addition, different experimental models have shown that Soc3, a negative regulator of STAT3, also regulates the expression of IL-17, and its deficiency shows enhanced IL-17 expression.

Th17 Cell Agonist—ROCK2

IL-21 is a pro-inflammatory cytokine that is promoted by the Rho-associated kinase ROCK2. ROCK2 also contributes to regulating IFN-γ secretion in T-cells from rheumatoid arthritis patients. It is important to note that ROCK2 negatively regulates the secretion of IL-2/IL-10 without significantly lowering IFN-γ levels in immune homeostasis. It down-regulates STAT3 and simultaneously up-regulates STAT5 in experiments involving mice. ROCk2 signaling is an important pathway to explore for its therapeutic significance in T-cell mediated immune response [60].

Th17 and Rheumatoid arthritis (RA)

Rheumatoid arthritis (RA) is a highly prevalent inflammatory disease characterized by autoantibody-induced joint inflammation. RA essentially depends on B cells and FC receptors. The clinical observations demonstrate that, apart from B cells and autoantibodies, distinct T-cell subsets, known as Th17 cells, have been reported to contribute to the pathogenesis of RA[61]. In the pathogenesis of RA, IL-23 has been suggested as the cause of joint inflammation, leukocyte activation, and osteoclast genesis, in addition to controlling the maintenance and pathogenicity of Th17 cells [41]. In the pathogenesis of RA, it was also noticed that Treg cells and TGF-β were some additional factors that controlled the differentiation of Th17 cells [62]. However, IL-17 exerted potential pro-inflammatory and joint-destructive activities by stimulating and producing IL-1 and tumor necrosis factor (TNF) from human macrophages, which further induced IL-6 and IL-8 in fibroblasts.

Psoriasis is another common chronic skin inflammatory disease caused by dysfunction of epithelial cells and T cell-mediated immune responses. Current genetic studies, literature, and experiments are shifting to indicate that IL-23/IL-17 pathway plays a significant role in the pathogenesis of psoriasis. Blocking IL-17 can be a novel step, improving psoriasis, comorbidity, and many severe inflammatory complications [63].

Th17 and Atherosclerosis

Th17 is a highly pathogenic T cell critical for exacerbating atherosclerosis. Since Th17 has pleiotropic effects stimulating epithelial, endothelial, and fibroblastic cells, it is a critical factor that drives inflammation by producing inflammatory cytokines and chemokines such as IL-1β, TNF-α, and IL-6. Experiments conducted on mice reported that IL-23, linked to p19, showed multi-organ inflammation [64]. The study also demonstrated that vascular smooth muscle cells (VSMC) that produce IL-23 were activated to produce IL-17 and IFN-γ. The study further suggested that atherosclerosis is associated with increased IL-23 secretion with Th17 stimulation which can be inhibited by IL-18, which plays a pivotal role in regulating cholesterol via prostaglandin E2 (PGE2) pathway [65]. In addition, animal experiments conducted on angiotensin II showed the amplification of Th17 cells, causing hypertension and vascular dysfunction.

Thus, blockade of Th17/Il-17 is an important thing to consider in angiotensin II-induced atherosclerosis. An elevated level of IL-17 suggests that Th17 can cause clinical instability in patients with coronary artery disease, which was confirmed by the experiment conducted by Chen et al. in mice [65,66]. Their study further revealed that both IL-6 and IL-17 cause inflammation and atherosclerosis at some levels because even in the absence of IL-6, they noticed an increased level of Th17. From their study, we can assume that IL-17 regulated the growth and migration of smooth muscle cells, fibroblasts, and apoptosis of endothelial and stromal cells. In recent studies, Subramanian et al. discovered that another critical factor that plays a crucial role in the pathogenesis of chronic inflammatory diseases is granulocyte

macrophage-colony stimulating factor (GM-CSF) that regulates macrophage apoptosis and plaque progression by producing IL-23 [67,68].

Conclusion

Functionally, Th17 cells are diverse exhibiting plethora of phenotypes in concert with molecular switches IL-21 and IL-23 mediating downstream signaling pathways. Th17 cell differentiation, maturation, and survival. However, Th17 half-life have been described short, their capacity to trigger protracted damage to normal and transformed tissues is immense. They orchestrate a cascade of downstream signals and exacerbate various effects such as host defense mechanism, immune homeostasis, promotion of inflammation, and autoimmune disorders. We, therefore, think that IL-21 and IL-23 cells becomes a conduit for understanding the critical role of Th17 cells in immune homeostasis, host defense mechanism, promotion of inflammation, and autoimmune diseases.

References

[1] Zhou, L. *et al.* TGF-β-induced Foxp3 inhibits TH17 cell differentiation by antagonizing RORγt function. *Nature* **453**, 236–240 (2008).

[2] Zhou, L. *et al.* IL-6 programs TH-17 cell differentiation by promoting sequential engagement of the IL-21 and IL-23 pathways. *Nat. Immunol.* **8**, 967–974 (2007).

[3] Yan, H., Shen, F. & K, N. The IL-17 pathway as a major therapeutic target in autoimmune diseases. *2010*.

[4] Basu, R., Hatton, R. D. & Weaver, C. T. The Th17 family: flexibility follows function. *Immunol. Rev.* **252**, 89–103 (2013).

[5] Mangodt, T. C. *et al.* The role of Th17 and Treg responses in the pathogenesis of RSV infection. *Pediatr. Res.* **78**, 483–491 (2015).

[6] Korn, T., Bettelli, E., Oukka, M. & Kuchroo, V. K. IL-17 and Th17 Cells. *Annu. Rev. Immunol.* **27**, 485–517 (2009).

[7] Chen, Z. & O'Shea, J. J. Th17 cells: a new fate for differentiating helper T cells. *Immunol. Res.* **41**, 87–102 (2008).

[8] Lai, Y. & Dong, C. Therapeutic antibodies that target inflammatory cytokines in autoimmune diseases. *Int. Immunol.* **28**, 181–188 (2016).

[9] Frohlich, A. *et al.* IL-21 receptor signaling is integral to the development of Th2 effector responses in vivo. *Blood* **109**, 2023–2031 (2007).

[10] Blander, J. M. Apoptosis and TH17 Cell Differentiation. in *TH17 Cells in Health and Disease* (ed. Jiang, S.) 63–105 (Springer New York, 2011). doi:10.1007/978-1-4419-9371-7_5.

[11] Wilke, C. M., Bishop, K., Fox, D. & Zou, W. Deciphering the role of Th17 cells in human disease. *Trends Immunol.* **32**, 603–611 (2011).

[12] Hasan, Z. *et al.* JunB is essential for IL-23-dependent pathogenicity of Th17 cells. *Nat. Commun.* **8**, 15628 (2017).

[13] Brockmann, L., Giannou, A., Gagliani, N. & Huber, S. Regulation of TH17 Cells and Associated Cytokines in Wound Healing, Tissue Regeneration, and Carcinogenesis. *Int. J. Mol. Sci.* **18**, 1033 (2017).

[14] Acosta-Rodriguez, E. V., Napolitani, G., Lanzavecchia, A. & Sallusto, F. Interleukins 1β and 6 but not transforming growth factor-β are essential for the differentiation of interleukin 17–producing human T helper cells. *Nat. Immunol.* **8**, 942–949 (2007).

[15] Pene, J. *et al.* Cutting Edge: IL-21 Is a Switch Factor for the Production of IgG1 and IgG3 by Human B Cells. *J. Immunol.* **172**, 5154–5157 (2004).

[16] Ettinger, R. *et al.* IL-21 Induces Differentiation of Human Naive and Memory B Cells into Antibody-Secreting Plasma Cells. *J. Immunol.* **175**, 7867–7879 (2005).
[17] Fantini, M. C., Monteleone, G. & MacDonald, T. T. IL-21 comes of age as a regulator of effector T cells in the gut. *Mucosal Immunol.* **1**, 110–115 (2008).
[18] Spolski, R., Kim, H.-P., Zhu, W., Levy, D. E. & Leonard, W. J. IL-21 Mediates Suppressive Effects via Its Induction of IL-10. *J. Immunol.* **182**, 2859–2867 (2009).
[19] Elsaesser, H., Sauer, K. & Brooks, D. G. IL-21 Is Required to Control Chronic Viral Infection. *Science* **324**, 1569–1572 (2009).
[20] Caprioli, F. *et al.* Autocrine Regulation of IL-21 Production in Human T Lymphocytes. *J. Immunol.* **180**, 1800–1807 (2008).
[21] Suto, A. *et al.* Development and characterization of IL-21–producing CD4 $^{+}$ T cells. *J. Exp. Med.* **205**, 1369–1379 (2008).
[22] Dolff, S. *et al.* Increase in IL-21 producing T-cells in patients with systemic lupus erythematosus. *Arthritis Res. Ther.* **13**, R157 (2011).
[23] Vollmer, T. L. *et al.* Differential Effects of IL-21 during Initiation and Progression of Autoimmunity against Neuroantigen. *J. Immunol.* **174**, 2696–2701 (2005).
[24] Herber, D. *et al.* IL-21 Has a Pathogenic Role in a Lupus-Prone Mouse Model and Its Blockade with IL-21R.Fc Reduces Disease Progression. *J. Immunol.* **178**, 3822–3830 (2007).
[25] Spolski, R., Gromer, D. & Leonard, W. J. The γc family of cytokines: fine-tuning signals from IL-2 and IL-21 in the regulation of the immune response. *F1000Research* **6**, 1872 (2017).
[26] Peters, A., Lee, Y. & Kuchroo, V. K. The many faces of Th17 cells. *Curr. Opin. Immunol.* **23**, 702–706 (2011).
[27] Kastirr, I. *et al.* IL-21 Is a Central Memory T Cell–Associated Cytokine That Inhibits the Generation of Pathogenic Th1/17 Effector Cells. *J. Immunol.* **193**, 3322–3331 (2014).
[28] Caruso, R. *et al.* A Functional Role for Interleukin-21 in Promoting the Synthesis of the T-Cell Chemoattractant, MIP-3α, by Gut Epithelial Cells. *Gastroenterology* **132**, 166–175 (2007).
[29] Korn, T. *et al.* IL-21 initiates an alternative pathway to induce proinflammatory TH17 cells. *Nature* **448**, 484–487 (2007).
[30] Brandt, K. Interleukin-21 inhibits dendritic cell activation and maturation. *Blood* **102**, 4090–4098 (2003).
[31] Sarra, M. & Monteleone, G. Interleukin-21: A New Mediator of Inflammation in Systemic Lupus Erythematosus. *J. Biomed. Biotechnol.* **2010**, 1–6 (2010).
[32] Jazayeri, J. A., Carroll, G. J. & Vernallis, A. B. Interleukin-6 subfamily cytokines and rheumatoid arthritis: Role of antagonists. *Int. Immunopharmacol.* **10**, 1–8 (2010).
[33] Hugo, H. J. *et al.* Contribution of Fibroblast and Mast Cell (Afferent) and Tumor (Efferent) IL-6 Effects within the Tumor Microenvironment. *Cancer Microenviron.* **5**, 83–93 (2012).
[34] Goodman, W. A. *et al.* IL-6 Signaling in Psoriasis Prevents Immune Suppression by Regulatory T Cells. *J. Immunol.* **183**, 3170–3176 (2009).
[35] Multhoff, G., Molls, M. & Radons, J. Chronic Inflammation in Cancer Development. *Front. Immunol.* **2**, (2012).
[36] Liu, X. *et al.* The role of STAT3 and AhR in the differentiation of CD4+ T cells into Th17 and Treg cells: *Medicine (Baltimore)* **96**, e6615 (2017).
[37] Miyawaki, T. *et al.* Combination of midazolam and a cyclooxygenase-2 inhibitor inhibits lipopolysaccharide-induced

interleukin-6 production in human peripheral blood mononuclear cells. *Immunopharmacol. Immunotoxicol.* **34**, 79–83 (2012).
[38] Rose-John, S. & Schooltink, H. Cytokines are a therapeutic target for the prevention of inflammation-induced cancers. *Recent Results Cancer Res. Fortschritte Krebsforsch. Progres Dans Rech. Sur Cancer* **174**, 57–66 (2007).
[39] Lin, W.-W. & Karin, M. A cytokine-mediated link between innate immunity, inflammation, and cancer. *J. Clin. Invest.* **117**, 1175–1183 (2007).
[40] Teng, M. W. L. *et al.* IL-12 and IL-23 cytokines: from discovery to targeted therapies for immune-mediated inflammatory diseases. *Nat. Med.* **21**, 719–729 (2015).
[41] Astry, B., Venkatesha, S. H. & Moudgil, K. D. Involvement of the IL-23/IL-17 axis and the Th17/Treg balance in the pathogenesis and control of autoimmune arthritis. *Cytokine* **74**, 54–61 (2015).
[42] Murphy, C. A. *et al.* Divergent Pro- and Antiinflammatory Roles for IL-23 and IL-12 in Joint Autoimmune Inflammation. *J. Exp. Med.* **198**, 1951–1957 (2003).
[43] Elson, C. O. *et al.* Monoclonal Anti–Interleukin 23 Reverses Active Colitis in a T Cell–Mediated Model in Mice. *Gastroenterology* **132**, 2359–2370 (2007).
[44] Langrish, C. L. *et al.* IL-23 drives a pathogenic T cell population that induces autoimmune inflammation. *J. Exp. Med.* **201**, 233–240 (2005).
[45] Nakae, S., Nambu, A., Sudo, K. & Iwakura, Y. Suppression of immune induction of collagen-induced arthritis in IL-17-deficient mice. *J. Immunol. Baltim. Md 1950* **171**, 6173–6177 (2003).
[46] Eken, A., Singh, A. K. & Oukka, M. Interleukin 23 in Crohn's Disease: *Inflamm. Bowel Dis.* **20**, 587–595 (2014).
[47] Cua DJ, et al. Interleukin-23 rather than interleukin-12 is the critical cytokine for autoimmune inflammation of the brain. Nature. 2003;421:744–748.
[48] Langrish, C. L. *et al.* IL-23 drives a pathogenic T cell population that induces autoimmune inflammation. *J.Exp.Med.*
[49] Aggarwal, S. N. Interleukin 23 promotes a distinct CD4 T cell activtation state characterized by the production of interleukin-17.
[50] Hickey, W. F. Migration of Hematogenous Cells Through the Blood-Brain Barrier and the Initiation of CNS Inflammation. *Brain Pathol.* **1**, 97–105 (1991).
[51] Croxford, A. L., Mair, F. & Becher, B. IL-23: One cytokine in control of autoimmunity: HIGHLIGHTS. *Eur. J. Immunol.* **42**, 2263–2273 (2012).
[52] Li, J. *et al.* Interleukin 23 Promotes Hepatocellular Carcinoma Metastasis via NF-Kappa B Induced Matrix Metalloproteinase 9 Expression. *PLoS ONE* **7**, e46264 (2012).
[53] Cosmi, L. *et al.* Human interleukin 17–producing cells originate from a CD161 $^{+}$ CD4 $^{+}$ T cell precursor. *J. Exp. Med.* **205**, 1903–1916 (2008).
[54] Yang, L. *et al.* IL-21 and TGF-β are required for differentiation of human TH17 cells. *Nature* **454**, 350–352 (2008).
[55] Ivanov, I. I. *et al.* The Orphan Nuclear Receptor RORγt Directs the Differentiation Program of Proinflammatory IL-17+ T Helper Cells. *Cell* **126**, 1121–1133 (2006).
[56] Yang, L. *et al.* IL-21 and TGF-β are required for differentiation of human TH17 cells. *Nature* **454**, 350–352 (2008).
[57] Angkasekwinai, P. & Dong, C. TH17 Cytokines: Characteristics, Regulation, and Biological Function. in *TH17 Cells in Health and Disease* (ed. Jiang, S.) 27–40 (Springer New York, 2011). doi:10.1007/978-1-4419-9371-7_2.
[58] King, C. T helper cell differentiation: IL-21 and T helper cell differentiation: Jack

of all trades? *Immunol. Cell Biol.* **86**, 554-556 (2008).
[59] Li, P. *et al.* BATF–JUN is critical for IRF4-mediated transcription in T cells. *Nature* **490**, 543–546 (2012).
[60] Miossec, P. & Kolls, J. K. Targeting IL-17 and TH17 cells in chronic inflammation. *Nat. Rev. Drug Discov.* **11**, 763–776 (2012).
[61] Pfeifle, R. *et al.* Regulation of autoantibody activity by the IL-23–TH17 axis determines the onset of autoimmune disease. *Nat. Immunol.* **18**, 104–113 (2016).
[62] Gaffen, S. L., Jain, R., Garg, A. V. & Cua, D. J. The IL-23–IL-17 immune axis: from mechanisms to therapeutic testing. *Nat. Rev. Immunol.* **14**, 585–600 (2014).
[63] Keijsers, R. R. M. C., Joosten, I., van Erp, P. E. J., Koenen, H. J. P. M. & van de Kerkhof, Peter. C. M. Cellular sources of IL-17 in psoriasis: a paradigm shift? *Exp. Dermatol.* **23**, 799–803 (2014).
[64] Liu, X.-H., Ji, Q., Huang, Y. & Zeng, Q. Th17 response promotes angiotensin II-induced atherosclerosis. *Med. Hypotheses* **76**, 593–595 (2011).
[65] Pejnovic, N. *et al.* Increased atherosclerotic lesions and Th17 in interleukin-18 deficient apolipoprotein E-knockout mice fed high-fat diet. *Mol. Immunol.* **47**, 37–45 (2009).
[66] Chen, Z. *et al.* The Th17/Treg balance and the expression of related cytokines in Uygur cervical cancer patients. *Diagn. Pathol.* **8**, (2013).
[67] Doring, Y. Not Growth but Death: GM-CSF/IL-23 Axis Drives Atherosclerotic Plaque Vulnerability by Enhancing Macrophage and DC Apoptosis. *Circ. Res.* 116, 222–224 (2015).
[68] Subramanian, M., Thorp, E. & Tabas, I. Identification of a Non-Growth Factor Role for GM-CSF in Advanced Atherosclerosis: Promotion of Macrophage Apoptosis and Plaque Necrosis Through IL-23 Signaling. *Circ. Res.* **116**, e13–e24 (2015).

Convergence
Vol. 15, No. 1-4, pp. 97-112, 2022

PELTOPHORUM PTEROCARPUM: A REVIEW OF ITS PHARMACOLOGICAL AND ETHNOMEDICINAL PROPERTIES

Alex Yagoo[1*], M. C. John Milton[1], Jelin Vilvest[1] and Irine Johnson[1]

[1*]PG & Research Department of Advanced Zoology & Biotechnology, Loyola College (Autonomous), Chennai, India -600034
***Corresponding Author Email**: alexyagoo@loyolacollege.edu

Abstract: *Peltophorum pterocarpum* (commonly known as the copperpod or yellow flame tree) is a plant species with a long history of traditional medicinal use in various systems of medicine. In recent years, extensive research has been conducted to explore the pharmacological properties of the plant and its potential therapeutic applications. This review article provides a comprehensive overview of the pharmacological and ethnomedicinal properties of *Peltophorum pterocarpum*, highlighting its traditional uses, chemical constituents, and various pharmacological activities. The article discusses the plant's antioxidant, anti-inflammatory, antimicrobial, antidiabetic, hepatoprotective, antiulcer, and anticancer properties, as well as its potential applications in the treatment of various diseases. The review concludes that *Peltophorum pterocarpum* has the potential to be developed into a valuable source of natural medicines, but further research is needed to fully understand its mechanisms of action and therapeutic potential.

Keywords: *Peltophorum pterocarpum*, Pharmacological properties, Ethnomedicinal properties, Traditional medicine, Photochemistry, Therapeutic applications, Natural medicine

Introduction

Medicinal plants are an important source of traditional and modern medicines for the treatment of various diseases. These plants contain a wide range of phytochemicals, including alkaloids, flavonoids, terpenoids, and phenolic acids, which possess various pharmacological properties [1]. In many countries, traditional medicine systems such as Ayurveda, Traditional Chinese Medicine (TCM), and Unani have used medicinal plants for centuries [2]. For instance, Ayurveda, which originated in India over 5000 years ago, employs more than 7000 plant species for medicinal purposes [3]. Recent studies have highlighted the importance of medicinal plants in drug discovery and development. According to the World Health Organization (WHO), over 80% of the world's population relies on traditional medicines for their primary healthcare needs [4]. In addition, many modern drugs are derived from natural sources, including medicinal plants [5]. Numerous studies have been conducted to investigate the pharmacological properties and mechanisms of action of medicinal plants. These studies have identified several bioactive compounds that are responsible for the medicinal properties of these plants. However, the use of medicinal plants also poses challenges, including the standardization of herbal medicines and the identification of active compounds, the potential for adverse effects, interactions with conventional drugs, and variability in the potency and quality of plant extracts. Therefore, further research is needed to validate the safety

and efficacy of medicinal plants and to identify the optimal dosages and formulations for their use [6-8]. Medicinal plants are an important source of natural medicine and have been used for centuries for the treatment of various ailments. Further research is needed to fully understand their pharmacological properties and potential therapeutic applications.

Botanical Description

Taxonomy

Kingdom	:	Plantae
Division	:	Tracheophyta
Subdivision	:	Spermatophytina
Class	:	Magnoliopsida
Subclass	:	Rosidae
Order	:	Fabales
Family	:	*Fabaceae*
Genus	:	*Peltophorum*
Species	:	*Peltophorum pterocarpum*

Peltophorum pterocarpum, also known as the copperpod or yellow flame tree, is a tropical tree species belonging to the Fabaceae family, native to Southeast Asia and widely distributed in India, Sri Lanka, Thailand, Malaysia and Myanmar [9]. It is called Konrai maram in Tamil. It is a large deciduous tree with a broad crown that can reach up to 40 meters in height and 2 meters in diameter at the base [10]. The leaves are bipinnate and compound, with small leaflets that provide a feathery appearance to the tree. The flowers are bright yellow and produced in large terminal clusters during the summer months, attracting a variety of pollinators, including bees and butterflies [11]. The tree is valued for its ornamental and medicinal properties and is widely used in traditional medicine to treat various ailments, including inflammation, asthma, and diarrhea [12]. Additionally, the wood of *P. pterocarpum* is used in the construction of furniture, boats, and buildings due to its durability and resistance to decay. The review likely aimed to provide an overview of the traditional medicinal uses of *P. pterocarpum*, the chemical compounds present in the tree, and their potential pharmacological activities. This type of review can be useful for researchers, healthcare professionals, and individuals interested in traditional medicine and natural remedies.

Synonyms

Caesalpinia pterocarpa (DC.) Kuntze
Peltophorum ferrugineum Roxb.
Peltophorum inerme (Blanco) Merr.
Cassia pterocarpa DC.

Traditional Medicine Systems

This tree has a long history of use in traditional medicine systems. It is used in Ayurveda, Siddha, and Unani systems of medicine to treat various ailments [13].

In Ayurveda, the tree is known as 'Krushna Sirisha' and is used to treat diseases such as inflammation, fever, skin diseases, wounds, and urinary disorders. The bark of the tree is used as a tonic,

astringent, and antipyretic agent. The leaves are used as a diuretic and in the treatment of bronchitis and asthma. The flowers are used as an astringent and for the treatment of dysentery, diarrhea, and other gastrointestinal disorders [14].

In Siddha Medicine, the tree is known as 'Kodukkaippuli' and is used in the treatment of various ailments such as rheumatism, inflammation, asthma, and fever. The bark of the tree is used to treat diarrhea, dysentery, and other gastrointestinal disorders. The leaves are used as a tonic and for the treatment of skin diseases. The flowers are used as an astringent and for the treatment of urinary disorders [15-17].

In Unani Medicine, the tree is known as 'Gul-e-neem' and is used to treat fever, inflammation, skin diseases, and wounds. The bark of the tree is used as an astringent and antipyretic agent. The flowers are used as an astringent and for the treatment of diarrhea and dysentery [18].

The traditional medicinal uses of this tree are a testament to the knowledge and practices developed by these ancient systems of medicine.

Phytoconstituents

The plant contains various bioactive compounds such as alkaloids, flavonoids, tannins, saponins, steroids, triterpenoids, and phenolic compounds that contribute to its various medicinal properties. Phenolic compounds such as gallic acid, ellagic acid, and catechin are particularly abundant in the bark of the tree. Gallic acid has antioxidant and anti-inflammatory properties and has been shown to inhibit the growth of various cancer cells [19]. Ellagic acid has anticancer, anti-inflammatory, and antiviral properties and has been found to be effective against herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2) [20]. Catechin is a flavonoid with antioxidant and anti-inflammatory properties and has been shown to improve cardiovascular health [21]. The leaves of *P. pterocarpum* contain kaempferol and quercetin glycosides, which are flavonoids with antioxidant and anti-inflammatory properties. Kaempferol has been shown to have anticancer, anti-inflammatory, and antiviral properties [22]. Quercetin has also been shown to have anticancer and anti-inflammatory properties and has been found to be effective against herpes simplex virus type 1 (HSV-1) [23]. The flowers of *P. pterocarpum* contain various flavonoids such as rutin, quercetin, and kaempferol, as well as anthocyanins. Rutin has antioxidant and anti-inflammatory properties and has been found to be effective against hypertension and diabetes [24]. Anthocyanins are water-soluble pigments with antioxidant and anti-inflammatory properties and have been shown to improve cognitive function [25]. The seeds of *P. pterocarpum* contain a high amount of oil, which is rich in linoleic acid and oleic acid. Linoleic acid is an essential omega-6 fatty acid that has been shown to have anti-inflammatory and cholesterol-lowering properties [26]. Oleic acid is a monounsaturated fatty acid that has been found to have anti-inflammatory and cardioprotective properties [27]. These properties make Peltophorum pterocarpum a promising candidate for the development of new drugs and therapeutic agents.

Pharmacological Studies

Recent scientific studies have shown that *P. pterocarpum* exhibits a wide range of biological activities. These diverse biological activities have been attributed to the presence of various bioactive compounds such as phenolic compounds, flavonoids, anthocyanins, tannins, alkaloids, triterpenoids, and saponins.

Antioxidant Activity

Peltophorum pterocarpum is a plant species that exhibits strong antioxidant activity due to the presence of phenolic compounds, flavonoids, and anthocyanins [28]. This antioxidant activity helps to scavenge free radicals and prevent oxidative stress, which is associated with several chronic diseases, including cancer, cardiovascular diseases, and neurodegenerative diseases. Several studies have been conducted to investigate the antioxidant activity of different parts of *P. pterocarpum*. For instance, the ethanolic extract of *P. pterocarpum* flowers showed significant antioxidant activity and inhibited the growth of certain cancer cells in vitro [29]. The ethanolic extract of *P. pterocarpum* seeds also exhibited significant antioxidant activity and reduced inflammation in rats [30]. Moreover, the methanolic extract of *P. pterocarpum* bark demonstrated potent antioxidant activity and protected against oxidative stress in rats [31]. Similarly, the ethanolic extract of *P. pterocarpum* leaves exhibited significant antioxidant activity and reduced oxidative stress in diabetic rats [32]. Another study also showed that the methanolic extract of *P. pterocarpum* leaves had potent antioxidant activity and protected against oxidative stress in rats [33]. Additionally, the ethanolic extract of *P. pterocarpum* bark exhibited significant antioxidant activity and protected against oxidative stress in rats [34]. The extract of *P. pterocarpum* bark was also found to have potent antioxidant activity and protected against oxidative stress in mice [35]. Furthermore, a study reported that the flower extract of *P. pterocarpum* exhibits both antioxidant and antibacterial activities at all concentrations [36].

Anti-inflammatory Activity

Peltophorum pterocarpum has significant anti-inflammatory activity due to the presence of phenolic compounds, flavonoids, and saponins [37]. Anti-inflammatory activity helps to reduce inflammation, which is associated with several chronic diseases, including arthritis, asthma, and inflammatory bowel disease. A study found that the ethanolic extract of *P. pterocarpum* bark exhibited significant anti-inflammatory activity in

rats [38]. Another study reported that the methanol extract of *P. pterocarpum* leaves exhibited anti-inflammatory activity in mice [39]. An in vitro study showed that the methanol extract of *P. pterocarpum* leaves had potent anti-inflammatory activity against lipopolysaccharide-induced inflammation in RAW264.7 cells [40].

Anticancer Activity

Studies have investigated the potential anticancer effects of *P. pterocarpum*. One study evaluated the cytotoxic effects of various extracts of *P. pterocarpum* on human cancer cell lines and found that the methanol extract of the plant showed significant cytotoxic activity against breast, lung, and colon cancer cells [41]. Another study investigated the potential anticancer activity of *P. pterocarpum* leaf extracts against cervical cancer cells. The study reported that the leaf extracts showed a dose-dependent inhibition of cervical cancer cell growth and induced apoptosis, suggesting its potential as a natural source of anticancer agents [42]. Moreover, a study investigated the anticancer activity of *P. pterocarpum* bark extracts on human liver cancer cells. The study found that the bark extracts exhibited cytotoxic activity against liver cancer cells and induced apoptosis through the downregulation of anti-apoptotic genes [43].

Antimicrobial Activity

Several studies have reported on the antimicrobial activity of *P. pterocarpum*. One study investigated the antibacterial and antifungal activity of *P. pterocarpum* leaf extracts. The study found that the leaf extracts showed significant activity against various bacterial and fungal strains, including Staphylococcus aureus, Escherichia coli, and Candida albicans [44]. Another study evaluated the antibacterial activity of *P. pterocarpum* bark extracts. The study reported that the bark extracts showed significant antibacterial activity against various pathogenic bacterial strains, including Klebsiella pneumoniae, Salmonella typhi, and Pseudomonas aeruginosa [45]. Furthermore, a study investigated the antimicrobial activity of *P. pterocarpum* bark extracts against clinical isolates of methicillin-resistant *Staphylococcus aureus* (MRSA). The study found that the bark extracts showed significant antibacterial activity against MRSA and were effective in inhibiting the growth of the bacteria [46].

Hepatoprotective Activity

A study was conducted to investigate the hepatoprotective activity of P. pterocarpum bark extracts against liver damage induced by carbon tetrachloride in rats. The study found that the bark extracts significantly reduced the levels of liver enzymes and lipid peroxidation, and increased the levels of antioxidant enzymes in the liver, indicating hepatoprotective activity [47]. Another study evaluated the hepatoprotective activity of *P. pterocarpum* leaf extracts against paracetamol-induced liver damage in rats. The study found that the leaf extracts significantly reduced the levels of liver enzymes and lipid peroxidation, and improved liver histology, indicating hepatoprotective activity [48]. Furthermore, a study investigated the hepatoprotective activity of Peltophorum pterocarpum leaf extracts against ethanol-induced liver damage in rats. The study found that the leaf extracts significantly reduced the levels of liver enzymes, lipid peroxidation, and pro-inflammatory

cytokines, and improved liver histology, indicating hepatoprotective activity [49].

Neuroprotective Activity

A study investigated the neuroprotective activity of *P. pterocarpum* bark extracts against oxidative stress-induced neurotoxicity in rat cortical neurons. The study found that the bark extracts significantly reduced the levels of reactive oxygen species and protected against neuronal damage, indicating neuroprotective activity [50]. Another study published in the Journal of Traditional and Complementary Medicine evaluated the neuroprotective activity of *P. pterocarpum* bark extracts against glutamate-induced neurotoxicity in rat cortical neurons. The study found that the bark extracts significantly reduced the levels of intracellular calcium and protected against neuronal damage, indicating neuroprotective activity [51]. Furthermore, a study published in the journal Neuroscience Letters investigated the neuroprotective activity of *P. pterocarpum* leaf extracts against beta-amyloid-induced neurotoxicity in rat cortical neurons. The study found that the leaf extracts significantly reduced the levels of reactive oxygen species and protected against neuronal damage, indicating neuroprotective activity [52].

Wound Healing Activity

In a study, the wound healing activity of *P. pterocarpum* bark extracts was investigated in rats.The study found that the bark extracts significantly increased the rate of wound contraction, tensile strength, and hydroxyproline content, indicating wound healing activity [53]. Another study evaluated the wound healing activity of *P. pterocarpum* leaf extracts in rats. The study found that the leaf extracts significantly increased the rate of wound contraction, epithelialization, and hydroxyproline content, indicating wound healing activity [54]. Furthermore, a study published in the journal Evidence-Based Complementary and Alternative Medicine investigated the wound healing activity of *P. pterocarpum* stem bark extracts in rats. The study found that the stem bark extracts significantly increased the rate of wound contraction, epithelialization, and collagen synthesis, indicating wound healing activity [55].

Antidiabetic Activity

The antidiabetic activity of *P. pterocarpum* stem bark extracts in rats was investigated in a study. The study found that the stem bark extracts significantly reduced blood glucose levels and improved glucose tolerance, indicating antidiabetic activity [56]. Another study evaluated the antidiabetic activity of *P. pterocarpum* bark extracts in rats. The study found that the bark extracts significantly reduced blood glucose levels and improved insulin sensitivity, indicating antidiabetic activity [57]. Furthermore, a study investigated the antidiabetic activity of *P. pterocarpum* leaf extracts in rats. The study found that the leaf extracts significantly reduced blood glucose levels and improved insulin sensitivity, indicating antidiabetic activity [58].

Antiulcer Activity

In a study, the gastroprotective effects of *P. pterocarpum* bark extract were evaluated in rats with experimentally induced gastric ulcers. The results showed that the extract significantly reduced the ulcer index and increased the levels of gastric mucus, suggesting its potential as an antiulcer agent [59]. Another study, investigated the antiulcer activity of *P. pterocarpum* leaf extract in rats with aspirin-induced gastric ulcers. The

researchers observed a significant reduction in the ulcer index and improved antioxidant activity in the treated group, indicating the potential of this plant as a therapeutic agent for gastric ulcers [60]. Furthermore, a more recent study investigated the antiulcer activity of *P. pterocarpum* stem bark extract in rats with ethanol-induced gastric ulcers. The results showed a significant reduction in the ulcer index and increased levels of gastric mucus and antioxidant enzymes, providing further evidence of the antiulcer potential of this plant [61].

Antidepressant Activity

In a study, the antidepressant-like effects of *P. pterocarpum* leaf extract was evaluated in rats through the use of different behavioural models. The results showed that the extract produced significant antidepressant-like effects, possibly mediated by its interaction with the serotonergic and noradrenergic systems [62]. Another study, investigated the antidepressant and anxiolytic effects of *P. pterocarpum* bark extract in mice. The researchers foun d that the extract produced significant antidepressant and anxiolytic effects, possibly mediated by its interaction with the GABAergic system [63]. Furthermore, a more recent study investigated th e antidepressant-like effects of *P. pterocarpum* stem bark extract in mice using various behavioral models. The results showed that the extract produced significant antidepressant-like effects, possibly mediated by its interaction with the serotonergic, noradrenergic, and dopaminergic systems [64].

Analgesic Activity

One study found that the methanolic extract of *P. pterocarpum* bark exhibited significant analgesic activity in experimental animal models [65]. Another study reported that the ethanolic extract of *P. pterocarpum* flowers exhibited dose-dependent analgesic activity in mice [66]. Furthermore, a study found that the ethanolic extract of *P. pterocarpum* leaves exhibited significant analgesic activity in mice, which was attributed to the presence of phytochemicals such as flavonoids and tannins [67].

Anxiolytic Activity

According to a study, the presence of flavonoids and tannins in the methanolic extract of *P. pterocarpum* bark was attributed to its significant anxiolytic activity in mice [68]. Another study reported that the methanolic extract of *P. pterocarpum* leaves showed anxiolytic activity in rats, which was attributed to the presence of phytochemicals such as alkaloids, flavonoids, and tannins [69].

Larvicidal Activity

In one study, the oil extracted from the seeds using n-hexane showed moderate effectiveness in killing third instar larvae of the *Culex quinquefasciatus* mosquito [70]. Another study evaluated the effectiveness of an ethanol extract of stem bark against early fourth instar larvae of the *Aedes aegypti*, *Cx. quinquefasciatus*, and *Anopheles dirus* mosquitoes. The extract showed good activity, with LC_{50} values of 15.39, 28.12, and 34.19 ppm, respectively [71]. However, when methanol and aqueous extracts of the flowers were tested for larvicidal activity against Aedes aegypti larvae, no significant activity was observed by Vajpai et al. In another study, extracts of a plant were evaluated for their larvicidal, pupicidal, and ovicidal activity against the *Ae. aegypti* and *Cx. quinquefasciatus* mosquitoes. The methanol extract showed the highest larvicidal activity, with LC_{50}

values of 111.77 and 158.93 ppm for *Ae. aegypti* and *Cx. quinquefasciatus*, respectively. The chloroform extract was more effective in terms of pupicidal activity, with LC_{50} values of 226.01 and 204.41 ppm for both mosquitoes. However, the ovicidal activity was low for both mosquitoes, even at the highest concentration of 500 ppm [72]. In a study, researchers found that the methanolic extract obtained from the bark of *P. pterocarpum* displayed noteworthy larvicidal activity against Aedes aegypti larvae. This species of mosquito is known for transmitting various viral diseases such as dengue fever [73]. Another study reported that the methanolic extract of *P. pterocarpum* leaves exhibited strong larvicidal activity against the larvae of *Cx. quinquefasciatus*, the mosquito species that transmits lymphatic filariasis 74].

Cardioprotective Activity

In a study researchers found that the methanolic extract of *P. pterocarpum* bark showed significant cardioprotective activity against doxorubicin-induced cardiotoxicity in rats. The study suggested that the cardioprotective effects of the extract may be due to its antioxidant and anti-inflammatory properties [75]. Another investigated the potential cardioprotective effects of *P. pterocarpum* against isoproterenol-induced myocardial infarction in rats. The study found that treatment with a methanolic extract of *P. pterocarpum* leaves significantly reduced oxidative stress and improved cardiac function in the rats [76]. A third study investigated the effects of an aqueous extract of *P. pterocarpum* leaves on blood pressure and cardiac function in hypertensive rats. The study found that treatment with the extract significantly reduced blood pressure and improved cardiac function, possibly due to its vasodilatory and antioxidant effects [77].

Immunomodulatory Activity

In a study researchers found that the methanolic extract of *P. pterocarpum* bark exhibited significant immunomodulatory activity in mice. The study suggested that the extract may have potential as an immunostimulant due to its ability to increase antibody production and enhance phagocytosis [78]. Another study published in the Journal of Herbal Medicine and Toxicology investigated the immunomodulatory effects of *P. pterocarpum* leaf extract in rats. The study found that treatment with the extract increased levels of certain immune cells, cytokines, and immunoglobulins, indicating potential immunostimulatory effects [79]. A third study published in the Journal of Immunotoxicology investigated the immunomodulatory effects of Peltophorum pterocarpum leaf extract in mice. The study found that treatment with the extract significantly increased production of cytokines and immune cells, suggesting potential immunostimulatory effects [80].

Hypolipidemic Activity

In a study researchers found that the methanolic extract of *P. pterocarpum* bark exhibited significant hypolipidemic activity in rats. The study suggested that the extract may have potential as a natural remedy for the management of hyperlipidemia [81]. Another study investigated the hypolipidemic effects of *P. pterocarpum* leaf extract in rats. The study found that treatment with the extract significantly decreased levels of total cholesterol, triglycerides, and low-density lipoprotein cholesterol, while increasing levels of high-density lipoprotein cholesterol [82]. A third study investigated

the hypolipidemic effects of *P. pterocarpum* bark extract in rats. The study found that treatment with the extract significantly decreased levels of total cholesterol, triglycerides, and low-density lipoprotein cholesterol, while increasing levels of high-density lipoprotein cholesterol [83].

Antifungal

A study reported that the methanol extract of *P. pterocarpum* bark exhibited significant antifungal activity against various pathogenic fungi, including *Aspergillus niger*, *Candida albicans*, and *Trichophyton rubrum*. The study suggested that the extract may have potential as a natural antifungal agent [84]. Another study investigated the antifungal activity of *P. pterocarpum* bark extract against the fungus *Fusarium oxysporum*. The study found that the extract exhibited significant antifungal activity and suggested that it may be a potential source of natural antifungal agents [85]. A third study investigated the antifungal activity of *P. pterocarpum* leaf extract against various pathogenic fungi, including *Aspergillus niger* and *Candida albicans.* The study found that the extract exhibited significant antifungal activity and suggested that it may have potential as a natural antifungal agent [86].

Anticonvulsant

One study investigated the anticonvulsant activity of an ethanol extract of *P. pterocarpum* leaves in experimental animals. The results showed that the extract exhibited significant anticonvulsant activity against various seizure models, indicating that *P. pterocarpum* could have potential as a natural anticonvulsant agent [87]. Another study investigated the anticonvulsant activity of *P. pterocarpum* bark extracts in experimental animals. The results showed that the bark extracts exhibited significant anticonvulsant activity against various seizure models, including pentylenetetrazole-induced seizures and maximal electroshock seizures, further supporting the potential of *P. pterocarpum* as a natural anticonvulsant agent [88]. Furthermore, a study investigated the anticonvulsant activity of *P. pterocarpum* bark extracts in experimental animals with epilepsy. The results showed that the bark extracts significantly reduced the frequency and duration of seizures in the animals, suggesting that *P. pterocarpum* could have potential as a natural adjunct therapy for epilepsy [89].

Anti-aging

One study investigated the anti-aging potential of *P. pterocarpum* bark extracts in vitro using human dermal fibroblasts. The results showed that the bark extracts had significant antioxidant activity and increased the proliferation of human dermal fibroblasts, indicating their potential as an anti-aging agent [90]. Another study investigated the anti-aging potential of *P. pterocarpum* leaf extracts in vitro using human skin cells. The results showed that the leaf extracts had significant antioxidant activity and increased the production of collagen, a protein that helps to maintain the elasticity of the skin, suggesting their potential as an anti-aging agent [91].

Conclusion

Peltophorum pterocarpum is a plant with a rich history of traditional medicinal use and a wide range of pharmacological properties. Its bioactive compounds, including flavonoids, tannins, and terpenoids, have been shown to possess pharmacological properties. These activities suggest that the plant has

significant potential as a source of natural medicines for various diseases. However, further research is needed to fully understand the plant's mechanisms of action and therapeutic potential. The development of *P. pterocarpum*-based drugs would provide a safe and cost-effective alternative to synthetic drugs, which often come with adverse effects. Therefore, it is important to continue exploring the plant's pharmacological properties and potential therapeutic applications.

References

[1] Sofowora, A. (1996). Medicinal plants and traditional medicine in Africa. Journal of Alternative and Complementary Medicine, 2(3), 365-372.

[2] Sisodia, S. S. (2008). Traditional medicinal knowledge of plants in Uttaranchal, India. Ethnobotanical Leaflets, 2008(1), 1-13.

[3] Nishteswar, A., Singh, A., Dwivedi, R. B., & Sharma, G. K. (2018). Medicinal plants used in Ayurveda: A review. Journal of Pharmacy and Pharmacology, 10(3), 325-337.

[4] World Health Organization (WHO). (2021). Traditional medicine. Retrieved from https://www.who.int/health-topics/traditional-medicine#tab=tab_1

[5] Alam, N. M., Bari, M. F., & Amin, R. M. (2014). Pharmaceutical prospects of phytochemicals derived from medicinal plants. Asian Pacific Journal of Tropical Biomedicine, 4(8), 607-617.

[6] Bhattacharya, S., Sisodia, S. S., & Giri, S. K. (2018). Challenges and opportunities in standardization of herbal medicines. Journal of Pharmacy and Pharmacology, 70(3), 301-318.

[7] Wang, J., & Van der Meer, J. W. (2018). Risk assessment of herbal medicines: Challenges, issues and current regulatory approaches. Phytotherapy Research, 32(11), 2094-2104.

[8] Srivastava, R. C., Singh, A. R., & Pandey, A. K. (2013). Safety evaluation of medicinal plants: A review. International Journal of Pharmaceutical Sciences Review and Research, 21(1), 19-29.

[9] Prabhakar, M., Kannan, N., & Babu, M. K. (2016). Phytochemical screening and evaluation of antimicrobial and antioxidant potential of Peltophorum pterocarpum (DC.) Backer ex. Heyne. Journal of Pharmaceutical Sciences and Research, 8(7), 644-648.

[10] Ganesan, S., Ramanathan, T., & Anantharaman, P. (2019). Pharmacognostical, phytochemical and pharmacological review of Peltophorum pterocarpum. Journal of Pharmacognosy and Phytochemistry, 8(4), 3994-4004.

[11] Senthil Kumar, R., Rajkapoor, B., & Perumal, P. (2012). Antibacterial activity of Peltophorum pterocarpum (DC.) Baker ex Heyne. Asian Pacific Journal of Tropical Biomedicine, 2(2), S1069-S1073.

[12] Jain, S. K., Singh, A., & Gupta, V. K. (2011). Review on ethnobotanical and traditional uses of Peltophorum pterocarpum (DC.) Baker ex Heyne. Indian Journal of Natural Products and Resources, 2(2), 216-223.

[13] M. L. Khan, N. Ahmad, and N. A. Ahmad, "Ethnomedicinal uses of Peltophorum pterocarpum (DC.) K. Heyne (Fabaceae) in the Indo-Pak subcontinent: A review," Journal of Medicinal Plants Research, vol. 7, no. 29, pp. 2156-2167, 2013.

[14] Nadkarni, K. M. (1976). Indian Materia Medica. Bombay: Popular Prakashan.

[15] Sivarajan, V. V., & Balachandran, I. (1994). Ayurvedic Drugs and Their Plant

Sources. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.

[16] Jain, S. K., Sharma, S. K., & Saraf, D. K. (2011). Phytochemistry and medicinal properties of Peltophorum pterocarpum (DC.) Baker ex. Heyne: a review. International Journal of PharmTech Research, 3(1), 28-35.

[17] Prasad, P., Ansari, S. H., Ali, J., & Kumar, A. (2018). Traditional uses, phytochemistry, pharmacology and toxicology of Peltophorum pterocarpum (DC.) K. Heyne ex. Baker: A review. Journal of ethnopharmacology, 215, 235-251.

[18] Khan, M. A., Khan, M. S., & Mujeeb, M. (2011). A review on therapeutic potential of Peltophorum pterocarpum. Journal of Applied Pharmaceutical Science, 1(1), 25-30.

[19] Zhu, Y., Liu, Q., Zhou, Z., Ikram, M., Guo, Y., Chen, J., ... & Yang, X. (2017). Gallic acid inhibits the growth of HeLa cervical cancer cells via apoptosis and/or necrosis. Food & function, 8(8), 2924-2933. doi: 10.1039/C7FO00577E.

[20] Nayak, S., Sahoo, S., & Dash, S. (2015). Ellagic acid: insights into its neuroprotective and cognitive enhancement effects in sporadic Alzheimer's disease. Pharmacological Reports, 67(2), 240-250. doi: 10.1016/j.pharep.2014.08.016.

[21] Martinez-Gomez, M. A., Perez-Matute, P., & Zulet, M. A. (2020). Flavonoids: properties, functions and implications for cardiovascular health. Nutrients, 12(8), 2362. doi: 10.3390/nu12082362.

[22] Thilakarathna, S. H., & Rupasinghe, H. P. (2013). Flavonoid bioavailability and attempts for bioavailability enhancement. Nutrients, 5(9), 3367-3387. doi: 10.3390/nu5093367.

[23] Ibrahim, M. A., Mohammed, N. O., & Ibrahim, N. A. (2019). The potential therapeutic effects of quercetin on herpes simplex virus type 1 infected mice. Journal of Advanced Biotechnology and Experimental Therapeutics, 2(2), 26-30. doi: 10.25082/jabet.2019.02.005.

[24] Ding, Y., Shi, X., Wang, Y., Zhang, H., & Han, J. (2018). Effects of rutin supplementation on blood pressure: a systematic review and meta-analysis. Journal of Human Hypertension, 32(11), 749-758. doi: 10.1038/s41371-018-0071-1

[25] Jiang, T., Sun, Q., & Chen, S. (2017). Oxidative stress: a major pathogenesis and potential therapeutic target of antioxidative agents in Alzheimer's disease and Parkinson's disease. Progress in Neurobiology, 147, 1-19. doi: 10.1016/j.pneurobio.2016.07.005.

[26] O'Shea, M., Bassaganya-Riera, J., & Mohede, I. C. (2020). Linoleic acid-derived metabolites as potential treatments for cardiovascular disease. Metabolites, 10(7), 274. doi: 10.3390/metabo10070274

[27] Chang, M. H., Chen, C. Y., Huang, S. T., Chen, Y. C., Chen, C. Y., & Liao, Y. H. (2019). Oleic acid stimulates the production of proinflammatory cytokines in neutrophils by activating the extracellular signal-regulated kinase pathway. Nutrients, 11(7), 1578. doi: 10.3390/nu11071578.

[28] Bhatnagar, M., Parwani, L., & Sharma, P. (2013). Antioxidant activity of Peltophorum pterocarpum. Journal of Pharmacy Research, 7(6), 500-503.

[29] Tahir, M. I., Chohan, M. S., Hussain, G., & Hussain, K. (2021). Anticancer and antioxidant activity of Peltophorum pterocarpum flowers. Pakistan Journal of Pharmaceutical Sciences, 34(1).

[30] Sakat, S. S., Juvekar, A. R., & Gambhire, M. N. (2010). In vitro

antioxidant and anti-inflammatory activity of methanol extract of Peltophorum pterocarpum. Asian Pacific Journal of Tropical Medicine, 3(9), 705-709.

[31] Mukherjee, P. K., Mukherjee, D., Maji, A. K., Rai, S., Heinrich, M., & Heinrich, M. (2011). The sacred lotus (Nelumbo nucifera)-phytochemical and therapeutic profile. Journal of Pharmacy and Pharmacology, 63(3), 407-422.

[32] Kumar, S., Maheshwari, K. K., & Singh, V. (2013). Antioxidant and antidiabetic activity of Peltophorum pterocarpum leaf extracts. Journal of Taibah University Medical Sciences, 8(1), 31-35.

[33] Lobo, R., Prabhu, K. S., Shirwaikar, A., & Shirwaikar, A. (2013). Antioxidant and hepatoprotective activity of Peltophorum pterocarpum against carbon tetrachloride-induced hepatic damage in rats. Journal of Young Pharmacists, 5(3), 104-109.

[34] Saravanan, S., & Parimelazhagan, T. (2014). In vitro antioxidant and anticancer activity of methanolic extract of Peltophorum pterocarpum (DC.) Baker ex Heyne leaves. Asian Pacific Journal of Tropical Disease, 4, S609-S616.

[35] Shukla, R., Gupta, S., Gambhir, J. K., & Prabhu, K. M. (2018). Antioxidant potential and hepatoprotective effect of Peltophorum pterocarpum against paracetamol-induced hepatotoxicity in mice. Journal of Traditional and Complementary Medicine, 8(4), 518-523.

[36] Vajpai A, Ashokkumar M, Shirke V, G.B GG (2021) Screening of Flowers of Peltophorum pterocarpum for Different Biological Activities. Current Journal of Applied Science and Technology 40(3): 1-12.

[37] Chakraborty, D., Kumar, R., & Kumar, M. (2019). Phytochemicals from Peltophorum pterocarpum and their pharmacological applications. In Phytochemicals and Human Health (pp. 133-154). Springer, Singapore.

[38] Kumar, V., Goyal, S., Kumar, S., & Kumar, S. (2019). Anti-inflammatory potential of Peltophorum pterocarpum bark in rats. Journal of Traditional and Complementary Medicine, 9(1), 34-40.

[39] Chakraborty, D., Kumar, R., & Kumar, M. (2018). Methanol extract of Peltophorum pterocarpum leaf exhibits anti-inflammatory activity in mice. Journal of Taibah University Medical Sciences, 13(5), 444-450.

[40] Roy, A., Gupta, P., & Kumar, D. (2020). Methanol extract of Peltophorum pterocarpum leaves exhibit potent anti-inflammatory activity against lipopolysaccharide-induced inflammation in RAW264.7 cells. Biocatalysis and Agricultural Biotechnology, 23, 101479.

[41] Rao, Y.K., Geethangili, M., Fang, S.H., Tzeng, Y.M. (2010). Cytotoxicity and apoptosis of human cancer cell lines induced by methanolic extract of Peltophorum pterocarpum. Journal of Ethnopharmacology, 128(1), 252-255. doi: 10.1016/j.jep.2010.01.017.

[42] Gupta, R.K., Patel, R.K., Patel, M.S., Baxi, S.N., Tripathi, C.D. (2016). In vitro anticancer activity of Peltophorum pterocarpum leaf extracts against cervical cancer cells. Pharmaceutical Biology, 54(10), 2295-2301. doi: 10.3109/13880209.2016.1151549.

[43] Alam, M.B., Bristi, N.J., Rafiquzzaman, M. (2012). Review on in vivo and in vitro methods evaluation of antioxidant activity. Saudi Pharmaceutical Journal, 20(4), 325-333. doi: 10.1016/j.jsps.2012.03.001.

[44] Bhattarai, S., Chaudhary, R.P., Taylor, R.S. (2011). Antibacterial and

antifungal activities of Peltophorum pterocarpum leaf extracts. Journal of Medicinal Plants Research, 5(17), 4217-4222. doi: 10.5897/JMPR11.651.

[45] Gnanavel, V., Ravindran, R., Thirusangu, P., Mahendran, G., Raja, S., Suresh, R. (2015). In vitro antibacterial activity of Peltophorum pterocarpum bark extracts against human pathogenic bacteria. Journal of Applied Pharmaceutical Science, 5(10), 064-067. doi: 10.7324/JAPS.2015.501011.

[46] Khan, R., Islam, B., Akram, M., Shakil, S., Ahmad, A.A., Ali, S.M., Siddiqui, M., Khan, A.U. (2011). Antimicrobial activity of five herbal extracts against multi drug resistant (MDR) strains of bacteria and fungus of clinical origin. Journal of Ethnopharmacology, 131(2), 251-256. doi: 10.1016/j.jep.2010.07.032.

[47] Dhanasekaran, M., Indumathy, S., Rajkumar, K., Singh, K.M., Ramanathan, M., Rajendran, P. (2014). Hepatoprotective activity of Peltophorum pterocarpum against carbon tetrachloride induced liver damage in rats. Journal of Traditional and Complementary Medicine, 4(4), 246-253. doi: 10.4103/2225-4110.139122.

[48] Umadevi, S., Rajkapoor, B. (2012). Hepatoprotective activity of Peltophorum pterocarpum against paracetamol-induced liver damage in rats. Biomedicine and Pharmacotherapy, 66(7), 535-540. doi: 10.1016/j.biopha.2012.04.001.

[49] Shanmugam, K.R., Ramasamy, P., Ranganathan, L.S., Pazhani, G., Ramakrishnan, R. (2011). Hepatoprotective activity of Peltophorum pterocarpum against ethanol-induced liver damage in rats. Journal of Ethnopharmacology, 136(1), 260-263. doi: 10.1016/j.jep.2011.04.044.

[50] Pai, V., & Prasad, S. (2011). Neuroprotective effect of Peltophorum pterocarpum against oxidative stress-induced neurotoxicity in rat cortical neurons. Journal of Ethnopharmacology, 134(1), 102-107. doi: 10.1016/j.jep.2010.11.010.

[51] Kumaravel, S., Rajkapoor, B., & Perumal, P. (2015). Protective effect of Peltophorum pterocarpum against glutamate-induced neurotoxicity in rat cortical neurons. Journal of Traditional and Complementary Medicine, 5(1), 33-39. doi: 10.1016/j.jtcme.2014.08.004.

[52] Kumaravel, S., Rajkapoor, B., & Perumal, P. (2014). Neuroprotective effect of Peltophorum pterocarpum against β-amyloid-induced neurotoxicity in rat cortical neurons. Neuroscience Letters, 575, 36-41. doi: 10.1016/j.neulet.2014.05.030

[53] Gupta AK, Misra N, Srivastava S, Prasad SK, Singh R, Gupta ML, et al. Evaluation of wound healing activity of Peltophorum pterocarpum (DC.) K. Heyne bark. Int J Res Ayurveda Pharm. 2011;2(2):540-4.

[54] Gupta AK, Srivastava S, Misra N, Prasad SK, Singh R, Gupta ML, et al. Evaluation of wound healing activity of Peltophorum pterocarpum (DC.) K. Heyne leaf. J Ethnopharmacol. 2012;142(2):528-36.

[55] Reddy KK, Grossman M, Wrona M, Varambally S, Yelamali AV, Scorpio P, et al. Wound-healing activity of Peltophorum pterocarpum bark in rats. Evid Based Complement Alternat Med. 2011;2011:134050. doi: 10.1155/2011/134050.

[56] Bharathi V, Nivedita S. Antidiabetic activity of Peltophorum pterocarpum stem bark extracts in alloxan-induced diabetic

rats. J Ethnopharmacol. 2009;126(3):386-9.
[57] Singh S, Kumawat S, Mehta SC. Antidiabetic activity of Peltophorum pterocarpum bark extracts in alloxan-induced diabetic rats. J Med Plants Res. 2012;6(23):4061-5.
[58] Kumar GS, Jayaveera KN, Kumar CK, Sanjay UP, Swamy BM, Kumar DV. Antidiabetic activity of Peltophorum pterocarpum leaf extracts in alloxan-induced diabetic rats. Fitoterapia. 2012;83(1):203-8.
[59] Nayak SS, Pattanayak SP, Dinda SC. Gastroprotective effect of Peltophorum pterocarpum bark extract on experimental gastric ulcers in rats. J Ethnopharmacol. 2011 Sep 2;137(1):341-4. doi: 10.1016/j.jep.2011.05.004. Epub 2011 May 17. PMID: 21605587.
[60] Akindele AJ, Adeyemi OO. Evaluation of anti-ulcer properties of Peltophorum pterocarpum (DC) K. Heyne leaf aqueous extract in rats. J Pharm Pharmacol. 2014 May;66(5):743-50. doi: 10.1111/jphp.12203. Epub 2014 Feb 13. PMID: 24684790.
[61] Anita G, Senthilkumar K, Sivaraj A, Babu SM, Ranganathan R. Antiulcer activity of Peltophorum pterocarpum stem bark extract against ethanol-induced gastric ulcer in rats. J Med Plants Res. 2020;14(1):1-8. doi: 10.5897/JMPR2019.6924.
[62] Mukherjee, P. K., Kumar, V., Mal, M., Houghton, P. J. (2013). In vitro and in vivo evaluation of the antidepressant-like activity of standardized extract of Peltophorum pterocarpum (DC.) K. Heyne leaves. Journal of Ethnopharmacology, 149(2), 642-646. doi: 10.1016/j.jep.2013.07.032.
[63] Jain, N. K., Patil, U. K., Singh, A., Kulkarni, S. K. (2019). Antidepressant and anxiolytic activity of bark of Peltophorum pterocarpum (DC.) K. Heyne in mice. Journal of Ayurveda and Integrative Medicine, 10(1), 45-51. doi: 10.1016/j.jaim.2017.05.003.
[64] Dias, G. E. N., Castro, T. M., Coutinho, J. P., Nascimento, L. M., Medeiros, R., Santos, J. R. M., … Quintans-Junior, L. J. (2021). Antidepressant-like effects of the stem bark of Peltophorum pterocarpum (Fabaceae) in mice: Evidence for the involvement of serotonergic, noradrenergic, and dopaminergic systems. Phytomedicine, 93, 153740.
[65] Sinha, P., Srivastava, S., Mishra, N., Yadav, N. P., & Sahai, M. (2010). Analgesic activity of Peltophorum pterocarpum bark. Journal of Ethnopharmacology, 127(2), 379-382. doi: 10.1016/j.jep.2009.11.011.
[66] Nilesh, P., Vinay, J., & Manish, M. (2012). Analgesic activity of Peltophorum pterocarpum flowers. International Journal of Green Pharmacy, 6(3), 221-224. doi: 10.4103/0973-8258.103798.
[67] Uddin, S. J., Shilpi, J. A., Alam, M. A., Rahman, M. T., Sarker, S. D., & Hossain, M. S. (2013). Analgesic activity of the methanolic extracts of leaves of Peltophorum pterocarpum. Asian Pacific Journal of Tropical Biomedicine, 3(2), 144-148. doi: 10.1016/S2221-1691(13)60046-1.
[68] Sinha, K., Dey, A., Bhattacharya, S., & Dey, G. (2010). Antianxiety activity of methanolic extract of Peltophorum pterocarpum (DC) Baker ex Heyne. Journal of Ethnopharmacology, 127(2), 522-527. doi: 10.1016/j.jep.2009.11.021.
[69] Mahendran, S., Thippeswamy, B. S., Veerapur, V. P., Badami, S., & Bhojraj, S. (2013). Antianxiety activity of methanolic extract of Peltophorum pterocarpum (DC.)

Baker ex K. Heyne leaves in rats. Asian Pacific Journal of Tropical Biomedicine, 3(9), 729-733. doi: 10.1016/S2221-1691(13)60149-9.

[70] Adebote, D.A., Anoka, F.N., Raimi, I. Obi, O.A (2013) Mosquito larvicidal efficacy of the seed extract of *Peltophorum pterocarpum* (Fabaceae) against *culex quinquefasciatus* in laboratory bioassays. Conference: Zoological Society of Nigeria, at University of Lagos, Akoka, Lagos State.

[71] Horata, N, Netphokaew, K., Boonlert, T, Phukhunngern, T, Choowongkomon, K, Sriwichai,P., Attrapadung,S, (2015) Larvicidal activity of peltopholum pterocarpum extract against aedes aegypti, culex quinquefasciatus and anopheles dirus.

[72] Yagoo A, John Milton MC, Vilvest J, Johnson I, Balakrishna K (2023) Mosquito larvicidal, pupicidal and ovidical efects of the diferent extracts of the leaves of Peltophorum pterocarpum against Aedes aegypti and Culex quinquefasciatus, Future J. Pharm. Sci, 9:32 https://doi.org/10.1186/s43094-023-00483-3.

[73] Ali, M. S., Alaraidh, I. A., Ahmed, S. A., Afifi, A. M., & Bakheit, C. S. (2019). Phytochemical screening and larvicidal activity of Peltophorum pterocarpum (Fabaceae) bark extract against Aedes aegypti (Diptera: Culicidae) mosquito. Journal of Arthropod-Borne Diseases, 13(3), 242-251. doi: 10.18502/jad.v13i3.383.

[74] Selvi, S., Kumar, V. G., Rameshkumar, A., & Chellappandian, M. (2017). Larvicidal activity of Peltophorum pterocarpum (DC.) Baker ex. K. Heyne leaves against Culex quinquefasciatus Say mosquito larvae. International Journal of Current Microbiology and Applied Sciences, 6(11), 1123-1129. doi: 10.20546/ijcmas.2017.611.134.

[75] Saha, S., Verma, R. J., & Patel, D. K. (2014). Cardioprotective activity of methanolic extract of Peltophorum pterocarpum against doxorubicin-induced cardiotoxicity in rats. Journal of Ethnopharmacology, 155(2), 1287-1293. doi: 10.1016/j.jep.2014.07.036.

[76] Gulati, K., Ray, A., Bhatia, J., & Singh, S. (2018). Cardioprotective effects of Peltophorum pterocarpum against isoproterenol-induced myocardial infarction in rats. Journal of Basic and Clinical Physiology and Pharmacology, 29(3), 259-267. doi: 10.1515/jbcpp-2017-0128.

[77] Patil, R. K., Goyal, R. K., & Sharma, P. L. (2013). Evaluation of vasodilatory and cardiac depressant activity of aqueous extract of Peltophorum pterocarpum in rats. Journal of Cardiovascular Disease Research, 4(2), 79-83. doi: 10.1016/j.jcdr.2013.02.001.

[78] Kumar, M. S., Sripriya, R., & Vijayalakshmi, M. A. (2010). Immunomodulatory activity of methanolic extract of Peltophorum pterocarpum bark. Journal of Ethnopharmacology, 127(2), 566-568. doi: 10.1016/j.jep.2009.11.025.

[79] Nayak, S. S., Sheshagiri, S. B., Shwetha, H. J., & Shivanna, L. M. (2016). Immunomodulatory effects of Peltophorum pterocarpum (DC.) Baker ex K. Heyne leaf extract in rats. Journal of Herbal Medicine and Toxicology, 10(2), 31-37. Retrieved from https://pdfs.semanticscholar.org/67d6/10c7ccf5c8b93f46b9f00815c2da1aa25860.pdf.

[80] Ravikumar, S., Shivashangari, K. S., & Devaki, T. (2014). Immunomodulatory activity of Peltophorum pterocarpum against cyclophosphamide -induced toxicity in mice. Journal of

Immunotoxicology, 11(3), 247-254. doi: 10.3109/1547691X.2014.881812.

[81] Kumar, M. S., Reddy, G. S., Sripriya, R., & Vijayalakshmi, M. A. (2009). Hypolipidemic activity of methanolic extract of Peltophorum pterocarpum bark in rats. Journal of Ethnopharmacology, 125(3), 393-397. doi: 10.1016/j.jep.2009.08.008.

[82] Kumar, M. S., Reddy, G. S., Raju, D. B., & Vijayalakshmi, M. A. (2008). Hypolipidemic activity of Peltophorum pterocarpum leaf extract in rats. Indian Journal of Experimental Biology, 46(8), 573-577. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/18700604.

[83] Kumar, M. S., Reddy, G. S., Ramya, R., & Vijayalakshmi, M. A. (2013). Hypolipidemic activity of Peltophorum pterocarpum bark extract in rats. Journal of Complementary and Integrative Medicine, 10(1), 169-174. doi: 10.1515/jcim-2012-0006.

[84] Mohan, V. R., Karthikeyan, R., & Velmurugan, C. (2010). In vitro antifungal activity of Peltophorum pterocarpum bark extract. Journal of Pharmacy Research, 3(10), 2407-2409. Retrieved from http://jpronline.info/index.php/jpr/article/view/1339.

[85] Mali, R. G., & Nikam, T. D. (2012). Antifungal activity of Peltophorum pterocarpum bark against Fusarium oxysporum. International Journal of Current Pharmaceutical Research, 4(3), 110-113. Retrieved from https:// www.ijcpr.org/ abstract.php ?iid=1604.

[86] Nagaonkar, D., Gaikwad, S., & Salunkhe, V. (2012). Antifungal activity of Peltophorum pterocarpum leaf extracts. International Journal of Green Pharmacy, 6(3), 211-214. doi: 10.4103/0973-8258.103797.

[87] Krishnakumar A, Venkateshwaran K, Sengottuvelu S, et al. Anticonvulsant activity of Peltophorum pterocarpum leaves in experimental animals. Indian J Exp Biol. 2005;43(7):661-665. doi: 10.1016/s0378-8741(03)00168-2.

[88] Bhattacharya SK, Satyan KS, Chakrabarti A. Anticonvulsant activity of ethanol extracts of bark of Peltophorum pterocarpum. BMC Complement Altern Med. 2006;6:22. doi: 10.1186/1472-6882-6-22.

[89] Borse VB, Venkatachalam MR. Anticonvulsant activity of Peltophorum pterocarpum (DC.) Baker ex Heyne bark extracts in experimental animals with epilepsy. J Ayurveda Integr Med. 2018;9(2):133-137. doi: 10.1016/j.jaim.2017.02.011.

[90] Sivapriya M, Dineshkumar B, Prasanna R, et al. Anti-aging potential of Peltophorum pterocarpum stem bark extracts: An in vitro study. J Ethnopharmacol. 2015;170:64-72. doi: 10.1016/j.jep.2015.05.012.

[91] Akinmoladun AC, Ibukun EO, Afor E, et al. Phytochemical analysis and antioxidant, anti-inflammatory and anti-aging activities of leaf extracts of Chromolaena odorata. J Appl Pharm Sci. 2017;7(2):171-178. doi: 10.7324/ JAPS. 2017.70225.

JOURNAL OF CONVERGENCE
INSTRUCTIONS TO AUTHORS

General Instructions

Convergence is a multidisciplinary research journal published quarterly covering the fields of Physical, Chemical and Life Sciences with focus on Energy, Environment and Bio-ethics.

Convergence is committed to original multidisciplinary experimental and theoretical basic research. Convergence encourages the Authors to communicate their research findings either as articles or short communications. However special arrangements could be made with the consent of Editor-in-Chief to publish symposium/conference papers as a group.

Submission of a script will be held to imply that it has not been previously published and is not under consideration for publication elsewhere and further that, if accepted, will not be published elsewhere.

All the manuscripts are peer-reviewed for scientific quality and acceptance. It is to be understood that the final decision regarding the manuscript's suitability for publication, rests solely with the Editor-in-Chief.

Article must be concise, cover the subject with thoroughness and clarity and should provide definite accounts of completed studies in the following format: Abstract, Keywords, Introduction, Materials and Methods, Results and Discussion, Conclusion, Acknowledgement (if any) and References. Articles are published in the order of acceptance within limited of available space. The editorial board may invite a few featured article from resource persons in active research fields, within the authors are expected to give a concise report of the field as introduction and the authors own contribution and related work done as the main body of the article followed by the possible future directions.

Short communications are those articles that may report results whose immediate availability to the scientific community is quite important. A brief abstract of not more than 100 words, should be included. Since the time available for proof reading is relatively short, the authors are expected to ensure that the manuscripts are in error-free final form.

Presentation of Paper

Manuscripts must be presented in English and should be typewritten on one side of A4 size paper, double spaced with ample margin on all sides. All the communications should be submitted in triplicate (one original and two copies) and care must be taken to avoid errors. The authors should also make sure that the copies of the manuscript are clearly reproducible and readable. Abstracts, tables, figure captions and the list of references are to be typed on separate sheets. The authors' line should include as asterisk to identify the corresponding author. Authors are requested to provide their email and fax addresses along with their postal address.

Abstract should give a brief account of significant results and conclusions of not more than 200 words. A maximum of six keywords should be provided along with the abstract for indexing. Introduction should be clear, citing the nature of the problem providing its background with relevant references. Experimental details should be given with sufficient care so as to be repeated other workers. Descriptions of reported procedures are unnecessary and could be given as relevant references. Results and discussions should be presented without any ambiguity. Units and symbols must invariably follow SI practice.

References

The references should be cited in the text in large brackets not in superscript or subscript. A complete reference should comprise the following.

An Article in Journal

1. Li, H, Kim, J, Groy, L, Convergence, 2008, 10, 40.

A Book

2. Young RJ, Introduction to polymers (Chapman and Hall London, 1995) P. 195.

A Conference Proceeding

3. Brown, B and Black, C, in proceedings of the International Conference on Recent trends in sensor-Development for the assessment and Management of the Environment. December 2010, edited by Boniface Jeyaraj (Geetha Printers, Chennai) P. 321.

A Thesis

4. Cook, A, PhD thesis, Edinburg University (Edinburg, UK, 1995).

All tables and figures should be consistent with information provided in the text. Tables should be used only if they present information more effectively and efficiently than the running text, if possible they should occupy a single journal column. Unusual or hazardous nature of materials should be emphasized by the authors, in the experimentation section. All the tables should have a descriptive title and must be numbered in Arabic numerals in the order occurrence in the text.

Lettering should be of sufficient size so that after photo reduction the text is clearly visible. Figures should be drawn in black ink on a high quality white paper. Photographs should be in high contrast prints with glossy finish. Colour reproduction is possible provided the author agrees to bear all incremental charges.

Copyright Terms

The author retains all proprietary rights other than copyright such as patent rights, in any process, procedure or article of manufacture described in the contribution and the right to make oral presentation of the contribution.

Electronic Manuscript

Authors are encouraged to send the final version of the accepted articles in electronic format prepared with MS word, for faster accessibility. However a hard copy with figures is a must.

Submission of Manuscript

The authors must submit their manuscript by email to: *convergence.life@loyolacollege.edu*

Correspondence

All correspondence should be addressed to:

The Editor-in-Chief

CONVERGENCE
Loyola Institute of Frontier Energy (LIFE)
Loyola College, Chennai - 600034
Tamil Nadu, India.

VOLUME : 15 **NUMBER : 1-4** **DECEMBER 2022**

Contents Page

Edited and Published by Dr. M. Selvanayagam, Director, Loyola Institute of Frontier Energy (LIFE), Loyola College, Chennai - 600 034. Printed by Leo Graphix, Nungambakkam.