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RESEARCH ARTICLE

Assessment of the Impact of COVID-19 on the physical and physiological fitness of LGBTQ individuals and sex workers in an urban Indian setting

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ABSTRACT

The COVID-19 pandemic has had far-reaching consequences on public health, particularly for marginalized communities. This study aims to assess the impact of the pandemic on the physical and physiological fitness of LGBTQ individuals and sex workers in an urban Indian setting—two populations often sidelined in healthcare discourse. Using a cross-sectional design, we gathered data through structured questionnaires and physical health assessments. Key parameters measured included Body Mass Index (BMI), blood pressure, pulse rate, and hematological and biochemical markers to evaluate overall health status.

Our findings underscore a significant decline in physical and physiological health among the study participants during the pandemic. Both LGBTQ individuals and sex workers reported increased psychological distress and reduced access to healthcare services, compounded by socioeconomic challenges. Notably, the study observed marked deviations in physical health indicators: many participants exhibited lower body mass index (BMI) values, abnormal blood pressure, and irregularities in blood and biochemical profiles. These findings reflect heightened vulnerability to chronic diseases and overall health deterioration.

Economic instability played a central role in amplifying these health disparities. The lockdowns and social distancing measures led to substantial income losses and job insecurity, severely impacting the livelihoods of sex workers and members of the LGBTQ community. Furthermore, systemic stigma and limited support mechanisms worsened access to essential health services during this critical period.

In conclusion, the study highlights the urgent need for inclusive public health policies and targeted interventions that address the unique vulnerabilities of LGBTQ individuals and sex workers, especially during public health emergencies like the COVID-19 pandemic.

Keywords: COVID-19, LGBTQ community, Sex workers, Physical fitness, Physiological parameters, Urban setting

Abbreviations:

- COVID-19 – CornoaVirus Disease of 2019
- LGBTQ – Lesbian Gay Bisexual Transgender Queer individuals

Introduction

The COVID-19 pandemic has precipitated profound socio-economic disturbances across the globe, with nations endeavoring to counteract the deleterious repercussions that the pandemic has inflicted upon the societal fabric. The pandemic has affected all segments of the population, but has been particularly, and disproportionately detrimental to members of the social groups in the most vulnerable situations. Among the communities worst affected are sex workers constituting 20 million, and transgenders constituting nearly 5 million of India's population. Most of these communities, including the LGBTQ in India, are subject to stigma, social exclusion and discrimination even under normal conditions; the COVID-19 pandemic has exaggerated their difficulties. Individuals engaged in sex work and those identifying with diverse gender identities routinely encounter systemic invalidation and bias within societal structures. Stigma associated with gender identity or occupation, alongside discrimination, significantly heightens susceptibility to health-related challenges, culminating in disparities across various aspects of life. These disparities manifest as elevated incidences of victimization and restricted access to public services, housing and health care.

An observational study in 2020 by Kai Liu et al.[1] in Complementary Therapies in Clinical Practice examined the effects of a 6-week respiratory rehabilitation program on 72 elderly COVID-19 patients. Participants who underwent rehabilitation showed significant improvements in pulmonary function, physical endurance (6-minute walk test), quality of life, and reduced anxiety levels. However, there was minimal improvement in depression scores. The study emphasized the importance of addressing both respiratory and mental health in post-COVID-19 recovery, particularly in the geriatric population.

Systematic review by Jorge Medina-Martínez et al.[2] in 2021, highlighted significant health disparities among LGBT individuals, including higher rates of mental health issues, substance abuse, and discrimination in healthcare settings. It emphasized the critical role of nurses in addressing these inequities and the need for inclusive, culturally competent care.

A review by Sue Westwood et al.[3] in 2020, highlighted health disparities among the LGBT+ population in the UK, attributing them to social inequalities, discrimination, and inadequate provider understanding. It called for more research to support policy efforts and underscored the lack of similar studies on LGBTQ health in India.

A study by Suraj Pal et al.[4] in 2023 published in BMC Public Health examined the health and HIV/STI awareness of MSM in Indian metro cities, revealing high rates of physical and mental health issues, including disordered eating and suicidal thoughts. It also found low awareness of HIV/STI prevention and emphasized the urgent need for targeted healthcare interventions and further research to address the disparities faced by LGBTQ individuals in India.

Letícia Penna Braga in Medicine (Baltimore)[5] conducted a study in 2016 which highlighted significant health vulnerabilities among female sex workers (FSWs) in Brazil, including high rates of depression and low HIV testing due to stigma and fear. These findings underscore the urgent need to address similar issues in India, prompting the inclusion of sex workers in the current assessment.

A review article by Victoria J. McGowan et al.[6] 2016 circulated in BMJ Open found no published studies on COVID-19's impact on LGBT+ health but included 11 grey literature reports showing worse outcomes in mental health, safety, and healthcare access. The study highlighted the urgent need for systematic data collection to address health inequities among sexual and gender minorities during the pandemic.

A cross-sectional study by Avelar Oliveira Macedo Neto et al.[7] in 2022 published in Cadernos de Saúde Pública, analyzed COVID-19 vulnerability among Brazilian sexual and gender minorities. It found higher vulnerability among cisgender men, older adults, and those with less common sexual orientations, highlighting the effectiveness of cross-sectional methods for such research.

A study by Nupur Mahajan et al.[8] in 2023, published in the Indian Journal of Community Medicine used media scanning to analyze challenges faced by commercial sex workers (CSWs) during COVID-19. It highlighted economic, social, psychological, and health-related issues, emphasizing the urgent need for further research and policy action to support CSWs in India.

A project by John P. Salerno and Bradley O. Boekeloo[9] in LGBT Health found that increased LGBTQ identity-related victimization during COVID-19 significantly raised psychological distress among sexual and gender minority college students. The study highlighted the urgent need for targeted mental health interventions and utilized online surveys for data collection, an approach incorporated in this research.

Although the government has released schemes for the communities to benefit from, an extremely large proportion of LGBTQ and sex workers are deprived from its benefits by lack of awareness. A major factor behind this is the paucity of reliable and productive data shedding light on the requirements of these communities. A more detailed analysis of the effect of COVID19 on the health of these communities is urgently needed as very few of such articles have been found published in prominent health journals in India. Moreover, such studies would address the most ignored and impoverished sections of society, as urban populations have been worse affected by COVID-19.

Conducting such an analysis on LGBTQ people and Sex workers requires a hybrid approach, utilizing both the conventional offline approach alongside conducting online data questionnaires via the internet. Online questionnaires are very useful in assessing the social and mental impact on these communities, while general health checkups are needed to assess physical health. All the data received needs to be analyzed by inductive reasoning to reach a conclusion regarding the effects.

Aims and Objectives

a) PRIMARY OBJECTIVES

- Assessing the physical and physiological fitness of LGBTQ
- Assessing the physical and physiological fitness of sex workers
- Assessing the physical and physiological fitness of a control group

b) SECONDARY OBJECTIVES

- Comparing the results obtained from the studies conducted on LGBTQ and Sex workers
- Comparing the results obtained from the studies conducted on LGBTQ and control group
- Comparing the results obtained from the studies conducted on Sex workers and Control group

Research Hypothesis

HYPOTHESIS [H1]:
The COVID-19 pandemic has disproportionately impacted the physical and physiological fitness of LGBTQ individuals and sex workers in urban India, intensifying their socio-economic and health-related challenges compared to the general population.

Materials and Methods

1) STUDY SETTING

- The present study was carried out on the LGBTQ Individuals affiliated with various Social Institutes in Hyderabad city, with emphasis on transgenders, and Sex workers part of the various associations/NGOs in Hyderabad city, from 1st October 2023 to 1st December 2023.

- The online questionnaire was sent through the internet, via WhatsApp messaging to the LGBTQ and Sex workers included in the study.
- The questionnaires were sent in both English and Telugu, the local language and the participants were asked to revert back for any difficulties or doubts in understanding and filling the questionnaires

2) SAMPLE SIZE

- A sample size of 384 was calculated, assuming the effect of COVID-19 on LGBTQ and CSW (Commercial Sex Workers) to be 50%, using power of 80% and confidence level of 95% and an absolute precision of 5%.
- Sample size is calculated using Fisher's formula, $n=Z^2PQ/D^2$, where n is the estimated sample size, Z^2 is the score of confidence interval at 95% and is 1.962. P is the prevalence in this case at 50% and Q is (1 – P). D is the degree of error which is 5% Therefore n =384 subjects.

3) STUDY DESIGN

- The study was a cross-sectional observational study, involving quantitative analysis among LGBTQ individuals and Sex workers affiliated with various NGOs/social institutions in Hyderabad.
- The quantitative part had:
  - i A Cross-sectional checklist-based assessment
  - ii A cross-sectional survey, assessing the general wellbeing of the entire sample size.

4) STUDY PERIOD

- The proposal was carried out in 2 months following its commencement.
- The first 15 days were required for enrollment of the subjects required to fit the sample size.
- The next fifteen days were spent in data collection, utilizing both offline checkups and online questionnaires.

TIMELINE	1st 15 Days	Last 15 Days of 1st Month	2nd Month
1) Enrollment of participants			
2) Data Collection at various centers			
3) Compilation and analysis of data			

- The following one month was required for data analysis and forming a conclusive result. Moreover 5% Attrition rate was considered in the study.

5) STUDY AREA

- The Study was conducted in various social institutions/NGOs housing LGBTQ individuals and Sex workers in Hyderabad City.

6) STUDY TECHNIQUE

1. The sampling method mentioned above was used to select a sample size in each group i.e. LGBTQ individuals, Sex workers and age-matched controls.
2. Line listing was done according to the ages of the subjects, with older subjects examined first.
3. All the subjects who were enlisted underwent a general health checkup and related tests to analyze physical and physiological wellbeing.
4. After completion of these tests, an online questionnaire was sent to the subjects, which analyzed their social and mental health which enabled the subjects to maintain their privacy and confidentiality while assisting the study, as instead of using their names a study number was allotted to the subjects.

INCLUSION CRITERIA

1. LGBTQ individuals and sex workers between the age of 18 to 50.
2. Subjects who are willing to give an informed consent that they are willing to be a part of the research project.
3. LGBTQ individuals and sex workers associated with an NGO or social institutions.

EXCLUSION CRITERIA

1. Subject who may be needing emergency treatment making it difficult for them to participate
2. Subjects having chronic mental illnesses
3. Subjects not associated with any NGO or social institution.
4. Subjects having a criminal record.

7) QUANTITATIVE ASSESSMENT

- The main outcome of the study was the assessment of physical and physiological well-being of the subjects. This was done in person, by assessing the subjects in following parameters:
- Blood Pressure and Pulse measurement
- Height, Weight measurement
- BMI calculation
- Kidney Function Test (KFT)
- Liver Function Test (LFT)
- Complete Hemogram
- Blood sugar levels measurement

The subjects were assessed to ascertain the number of individuals with abnormal levels of the above mentioned parameters, which were then compared to the number and range of abnormal levels detected in the control group.

8) STUDY TOOLS

In quantitative assessment firstly the comparison of the normal levels of physiological and physical health parameters with the data obtained from the examined individual's i.e. normal blood sugar and BMI levels was done alongside other previously mentioned parameters.

9) DATA ANALYSIS

- The completed questionnaire was checked for completeness and consistency.
- Collected data was entered in the MS Excel spreadsheet, coded
- Appropriately and later cleaned for any possible errors in a SPSS (Statistical Package for Social Studies) for Windows, and Analysis was carried out using SPSS.
- During data cleaning, more variables were created so as to facilitate association of variables. Clear values for various outcomes will be determined before running frequency tests
- Categorical data was presented as percentage (%).
- Kruskal-Wallis-H Test was applied (non-parametric) and significant values were adjusted by the Bonferroni correction for multiple tests.

Results

The study was conducted on a total sample size of 384 which included 128 LGBTQ individuals, 128 Sex Workers and 128 controls. The pairwise age, height, weight, BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse comparisons among the LGBTQ, control, and sex worker groups revealed significant differences in various parameters. The following values were observed when Kruskal-Wallis-H Test was applied (non-parametric):

Given below are the pairwise comparisons of the various parameters among the different study groups, with each row testing the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050. Moreover, significant values have been adjusted by the Bonferroni correction for multiple tests.

Variables	z-value	Asymp. Sig.
Age	71.814	0.00
Height	45.011	0.00
Weight	29.656	0.00
BMI	7.905	0.02
SBP	17.051	0.00
DBP	27.178	0.00
Pulse	79.665	0.00
Hemoglobin	16.586	0.00
PCV	65.094	0.00
RBC count	11.465	0.00
MCV	59.366	0.00
MCH	19.498	0.00
MHCH	13.747	0.00
TLC	30.199	0.00
Creatinine	87.081	0.00
BUN	230.386	0.00
AST	161.878	0.00
ALT	244.794	0.00
RBS	41.474	0.00

1) Height (Ht)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
SEX WORKERS-LGBTQ	62.724	13.852	4.528	.000	.000
SEX WORKERS-CONTROLS	-90.426	13.825	-6.541	.000	.000
LGBTQ-CONTROL	-27.702	13.852	-2.000	.046	.137

The table presents pairwise comparisons between Sex Workers, LGBTQ individuals, and Control groups, revealing statistically significant differences in outcomes for most comparisons ($p < 0.05$), except for the LGBTQ-Control group, which loses significance after adjustment (Adj. Sig. = 0.137). The strongest contrast is observed between Sex Workers and Control (Test Statistic = -90.426, p = .000).

2) Body Mass Index (BMI)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
SEX WORKERS-LGBTQ	4.439	13.865	.320	.749	1.000
SEX WORKERS-CONTROL	-35.207	13.837	-2.544	.011	.033
LGBTQ-CONTROL	-30.768	13.865	-2.219	.026	.079

The table indicates a significant difference between Sex Workers and Control groups (Adj. Sig. = .033), while comparisons between LGBTQ–Control and Sex Workers–LGBTQ are not statistically significant after adjustment (Adj. Sig. = .079 and 1.000, respectively).

3) Systolic BP(SBP), Diastolic BP (DBP) and Pulse

a) SBP

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-SEX WORKERS	-41.152	13.860	-2.969	.003	.009
LGBTQ-CONTROL	-54.339	13.860	-3.921	.000	.000
SEX WORKERS-CONTROL	-13.187	13.832	-.953	.340	1.000

The table reveals significant differences between LGBTQ individuals and both Sex Workers (Adj. Sig. = .009) and Control groups (Adj. Sig. = .000), whereas the difference between Sex Workers and Control is not statistically significant (Adj. Sig. = 1.000).

b) DBP

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-SEX WORKERS	-52.997	13.852	-3.826	.000	.000
LGBTQ-CONTROL	-68.422	13.852	-4.939	.000	.000
SEX WORKERS-CONTROL	-15.426	13.825	-1.116	.265	.794

The table shows highly significant differences between LGBTQ individuals and both Sex Workers and Control groups (Adj. Sig. = .000), while the difference between Sex Workers and Control is not statistically significant (Adj. Sig. = .794). -4.939, -1.116

c) Pulse

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
CONTROL-LGBTQ	78.247	13.841	5.653	.000	.000
CONTROL-SEX WORKERS	121.566	13.814	8.800	.000	.000
LGBTQ-SEX WORKERS	-43.319	13.841	-3.130	.002	.005

The table shows statistically significant differences across all group comparisons, with the Control group scoring significantly higher than both LGBTQ (Adj. Sig. = .000) and Sex Workers (Adj. Sig. = .000), and LGBTQ individuals differing significantly from Sex Workers as well (Adj. Sig. = .005).

4) Hematological Parameters

a) Hemoglobin concentration (Hb)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
SEX WORKERS-CONTROL	-43.559	13.833	-3.149	.002	.005
SEX WORKERS-LGBTQ	54.157	13.860	3.907	.000	.000
CONTROL-LGBTQ	10.599	13.860	.765	.444	1.000

The table shows significant differences between Sex Workers and both Control (Adj. Sig. = .005) and LGBTQ groups (Adj. Sig. = .000), while no significant difference is observed between Control and LGBTQ groups (Adj. Sig. = 1.000).

b) Packed cell volume (PCV)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
SEX WORKERS-LGBTQ	32.841	13.863	2.369	.018	.054
SEX WORKERS-CONTROL	-108.598	13.835	-7.849	.000	.000
LGBTQ-CONTROL	-75.757	13.863	-5.465	.000	.000

The table indicates highly significant differences between Sex Workers–Control and LGBTQ–Control groups (Adj. Sig. = .000), while the difference between Sex Workers and LGBTQ is marginally non-significant after adjustment (Adj. Sig. = .054).

c) RBC COUNT

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
SEX WORKERS-CONTROL	-31.430	13.806	-2.276	.023	.068
SEX WORKERS-LGBTQ	46.497	13.834	3.361	.001	.002
CONTROL-LGBTQ	15.067	13.834	1.089	.276	.828

The table shows a significant difference between Sex Workers and LGBTQ groups (Adj. Sig. = .002), while differences between Sex Workers–Control (Adj. Sig. = .068) and Control–LGBTQ (Adj. Sig. = .828) are not statistically significant after adjustment.

d) Mean corpuscular volume (MCV)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-CONTROL	-61.353	13.862	-4.426	.000	.000
LGBTQ-SEX WORKERS	-105.373	13.862	-7.602	.000	.000
CONTROL-SEX WORKERS	44.020	13.835	3.182	.001	.004

The table shows statistically significant differences across all group comparisons, with LGBTQ individuals differing significantly from both Control and Sex Workers (Adj. Sig. = .000), and a notable difference also observed between Control and Sex Workers (Adj. Sig. = .004).

e) Mean corpuscular hemoglobin (MCH)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-SEX WORKERS	-43.627	13.837	-3.153	.002	.005
LGBTQ-CONTROL	-57.291	13.837	-4.140	.000	.000
SEX WORKERS-CONTROL	-13.664	13.755	-.993	.321	.962

The table shows significant differences between LGBTQ individuals and both Sex Workers (Adj. Sig. = .005) and Control groups (Adj. Sig. = .000), while the difference between Sex Workers and Control is not statistically significant (Adj. Sig. = .962).

f) Mean corpuscular hemoglobin concentration (MCHC)

Sample1-Sample2	Test Statistic	Std.Error	Std. Statistic	Sig.	Adj.Sig. [a]
CONTROL-SEX WORKERS	3.648	13.751	.265	.791	1.000
CONTROL-LGBTQ	46.485	13.834	3.360	.001	.002
SEX WORKERS-LGBTQ	42.836	13.834	3.096	.002	.006

The table indicates significant differences between the Control group and LGBTQ individuals (Adj. Sig. = .002), and between Sex Workers and LGBTQ individuals (Adj. Sig. = .006), while no significant difference is found between Control and Sex Workers (Adj. Sig. = 1.000).

g) Total leucocyte count (TLC)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
SEX WORKERS-LGBTQ	39.389	13.844	2.845	.004	.013
SEX WORKERS-CONTROL	-75.457	13.761	-5.483	.000	.000
LGBTQ-CONTROL	-36.068	13.844	-2.605	.009	.028

The table reveals statistically significant differences across all group comparisons, with the strongest difference between Sex Workers and Control (Adj. Sig. = .000), followed by LGBTQ–Control (Adj. Sig. = .028) and Sex Workers–LGBTQ (Adj. Sig. = .013).

5) Biochemical Parameters

- Creatinine

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-SEX WORKERS	-81.513	13.524	-6.027	.000	.000
LGBTQ-CONTROL	-124.572	13.524	-9.211	.000	.000
SEX WORKERS-CONTROL	-43.059	13.444	-3.203	.001	.004

The table indicates highly significant differences across all group comparisons, with the largest difference observed between LGBTQ and Control (Adj. Sig. = .000), followed by LGBTQ–Sex Workers and Sex Workers–Control, all showing strong statistical significance.

- Blood urea nitrogen (BUN)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-SEX WORKERS	-59.413	13.819	-4.299	.000	.000
LGBTQ-CONTROL	-203.334	13.819	-14.714	.000	.000
SEX WORKERS-CONTROL	-143.922	13.737	-10.477	.000	.000

The table shows highly significant differences across all group comparisons (Adj. Sig. = .000), with the greatest difference observed between LGBTQ and Control groups, followed by Sex Workers–Control and LGBTQ–Sex Workers.

- Aspartate transaminase (AST)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-CONTROL	-79.126	13.836	-5.719	.000	.000
LGBTQ-SEX WORKERS	-175.025	13.836	-12.650	.000	.000
CONTROL-SEX WORKERS	95.898	13.754	6.972	.000	.000

The table demonstrates highly significant differences across all comparisons (Adj. Sig. = .000), with the largest gap between LGBTQ and Sex Workers, followed by LGBTQ–Control and Control–Sex Workers.

- Alanine transaminase (ALT)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-SEX WORKERS	-108.894	13.840	-7.868	.000	.000
LGBTQ-CONTROL	-216.027	13.840	-15.609	.000	.000
SEX WORKERS-CONTROL	-107.133	13.757	-7.787	.000	.000

The table shows highly significant differences between all group comparisons (Adj. Sig. = .000), with the largest difference between LGBTQ and Control groups, followed closely by LGBTQ–Sex Workers and Sex Workers–Control.

- Random Blood Sugar (RBS)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Statistic	Sig.	Adj. Sig.[a]
LGBTQ-SEX WORKERS	-59.389	13.842	-4.290	.000	.000
LGBTQ-CONTROL	-89.760	13.842	-6.485	.000	.000
SEX WORKERS-CONTROL	-30.371	13.760	-2.207	.027	.082

The table reveals significant differences between LGBTQ individuals and both Sex Workers and Control groups (Adj. Sig. = .000), while the difference between Sex Workers and Control is not statistically significant after adjustment (Adj. Sig. = .082).

Discussion

CURRENT INDIAN SCENARIO

In 2020, the COVID-19 pandemic emerged as a crisis of unprecedented scale. It spread across the globe with tremendous speed and severity, transcending borders, and disrupting the daily lives of billions. The impact extended far beyond the usual immediate health crisis, causing significant economic turmoil. Countries grappled with lockdown measures that slowed commerce to a crawl and threw industries into disarray. Moreover, the COVID-19 pandemic also unleashed a myriad of challenges, significantly affecting both physical and mental health across various populations throughout the globe. The relentless spread of the virus resulted in a staggering toll of illness and death, overwhelming healthcare systems and exposing critical shortcomings in public health infrastructure. The mental health impact was equally severe, with widespread reports of anxiety, depression, and stress due to isolation, fear of infection, and the profound uncertainties of the future. The economic downturn exacerbated these health issues, hitting the most vulnerable populations the hardest. Job losses and financial insecurity became rampant, disproportionately affecting those already at a disadvantage due to pre-existing inequalities. Discrimination and stigma, particularly in healthcare settings, intensified, further marginalizing groups and individuals, and complicating efforts to seek and provide treatment. Thus, the pandemic's effects varied widely among different strata of society. This period underscored the grim reality that while the virus itself did not discriminate, the stratification of society and the healthcare systems in which we live amplify pre-existing disparities, deepening the scars left by the pandemic.

LGBTQ individuals and sex workers in India represent some of the most marginalized segments of the population, grappling with systemic inequalities and social stigmatization that long predate the COVID-19 pandemic[10,11]. Historically, these groups have faced significant socio-economic challenges, often rooted in deeply entrenched societal norms and discriminatory practices. Although precise numbers are challenging to ascertain due to underreporting and lack of comprehensive data, estimates suggest that there are millions of LGBTQ individuals and hundreds of thousands of sex workers in India. These communities are among the poorest, with many members living in precarious economic conditions and lacking access to formal employment, social security, and healthcare.

The onset of the COVID-19 pandemic exacerbated the vulnerabilities of LGBTQ individuals and sex workers in India, striking them with disproportionate severity[11]. The lockdowns and social distancing measures, while necessary for public health, had devastating economic impacts on those who rely on informal or daily-wage labor for their livelihoods, a common scenario for many within these groups. For sex workers, the pandemic meant an abrupt halt to their primary source of income, without access to alternative means of financial support. Similarly, many LGBTQ individuals, especially those estranged from their families, found them without a safety net, facing heightened risks of homelessness and food insecurity.

The pandemic also intensified social isolation and mental health challenges among these populations. Discrimination in healthcare access became even more pronounced, with individuals often facing stigma and bias when seeking COVID-19-related care and support. Furthermore, the pandemic disrupted the work of many non-governmental organizations and community support systems that play a crucial role in providing aid and advocacy for LGBTQ individuals and sex workers. Efforts to mitigate the pandemic's impact on these communities were hampered by their invisibility in mainstream relief programs and the lack of targeted support measures, in sum underscoring and intensifying the socio-economic disparities and health inequities faced by LGBTQ individuals and sex workers in India.

The present study was carried out on the LGBTQ individuals affiliated with the STAR Foundation, Mobbera Foundation, Mitr Clinic and QT Centre in

Hyderabad and the Sex Workers affiliated with the Sex Worker's Organization, Yadadrigutta wherein all the organizations being situated in Hyderabad Metropolitan Region (HMR).

ANALYSIS OF VARIOUS PARAMETERS

1) BMI

- In this study the observed data indicated no significant difference in Body Mass Index (BMI) between LGBTQ individuals and sex workers, while both groups individually had significantly lower BMI in comparison to the control group.
- This unveiled a critical narrative about the nutritional and health disparities faced by these marginalized communities. BMI, a fundamental measure for assessing both under-nutrition and obesity, serves as a window into an individual's general health status, influencing their risk for various diseases, including metabolic syndrome, cardiovascular diseases, and diabetes[12].
- A lower BMI, especially when significantly diverging from the norm, may signal under-nutrition or other health complications that could impair immune function and overall well-being.
- The relevance of these findings becomes increasingly significant when considering the broader context of the COVID-19 pandemic. For marginalized communities, such as LGBTQ individuals and sex workers, the compounded effects of social stigma, economic vulnerability, and limited access to healthcare have heightened their risk during the pandemic.
- The causal link between the lower BMI observed in these groups and the impact of COVID-19 can be understood through the lens of nutritional status and its direct influence on immune system efficacy. Adequate nutrition is paramount for maintaining a robust immune response, which is critical for warding off infections, including viral ones like SARS-CoV-2. Studies have demonstrated that undernourished individuals are at a higher risk of developing severe complications if infected by the virus, due to a compromised immune system that cannot effectively combat the pathogen[13].
- Furthermore, the pandemic exacerbated the challenges faced by these populations in maintaining a healthy BMI and, by extension, their overall health. Lockdowns and economic downturns had restricted access to nutritious food and healthcare services, while increasing psychological stress, all of which contributed to adverse health outcomes. The interplay of these factors underscores the importance of addressing the nutritional needs of LGBTQ individuals and sex workers.
- In conclusion, the significant finding of lower BMI among LGBTQ individuals and sex workers relative to the control group serves as a critical indicator of the broader health vulnerabilities faced by these communities.

2) Blood Pressure

- The study also found that LGBTQ individuals have significantly lower systolic and diastolic blood pressure (SBP and DBP) as compared to both sex workers and the control group, highlights the complex interplay of physiological and psychological stressors influenced by socioeconomic factors and the COVID-19 pandemic[14].
- LGBTQ individuals disproportionately face mental health challenges, including anxiety, depression, and stress-related conditions, often stemming from societal stigma, discrimination, and internalized homophobia. The chronic stress associated with these experiences plays a crucial role in regulating blood pressure, potentially leading to abnormal readings.
- The stress-induced alterations in blood pressure are further compounded during crises like the COVID-19 pandemic, where isolation and limited access to support networks intensify mental health struggles.

In societies with strong traditional norms, LGBTQ individuals frequently encounter ostracization from family and community, heightening their experience of social isolation. This isolation, particularly acute in countries like India, can exacerbate stress and adversely affect blood pressure. Discrimination in healthcare settings further impedes access to quality health services, leaving many health issues, including those affecting blood pressure, unmanaged and unaddressed. Moreover, economic instability is a significant stressor for many LGBTQ individuals, arising from employment discrimination and job insecurity.

- This vulnerability restricts access to nutritious food and healthcare, essential for maintaining healthy blood pressure levels. The economic downturns associated with the COVID-19 pandemic likely exacerbated these challenges, highlighting the intersection between economic stability and health. Finally, despite legal advancements, societal acceptance and legal protections for LGBTQ individuals in many regions, including India, remain limited. Incorporating these insights, it's evident that the observed blood pressure disparities among LGBTQ individuals relative to other groups are the result of a multifaceted interplay of mental health issues, social isolation, discrimination, economic vulnerability, and the broader legal and societal context. The COVID-19 pandemic has amplified these challenges, underscoring the urgent need for targeted interventions.

3) PULSE

The study also showed that both LGBTQ individuals and sex workers had notably lower pulse rates than the control group. Among them, LGBTQ individuals had a slightly lower pulse rate compared to sex workers, although the difference is minimal. These observations offer valuable insights into the cardiovascular health and stress levels of these marginalized populations, especially in the context of the COVID-19 pandemic, as pulse rate is an essential parameter for assessing cardiovascular health. It can signal various conditions, from physical fitness and emotional states to more severe health issues like cardiovascular disease or infection. Typically, a lower resting pulse rate is associated with better cardiovascular fitness, but abnormally low rates could indicate underlying health problems[15]. The observed differences in pulse rates among LGBTQ individuals and sex workers compared to the control group can be partially attributed to the heightened stress, anxiety, and socioeconomic challenges exacerbated by the COVID-19 pandemic. Marginalized communities often face increased stress due to discrimination, social isolation, and economic instability, all of which can affect heart rate. The pandemic likely intensified these stressors, with lockdowns and social distancing measures increasing isolation, while economic hardships and health concerns may have further contributed to the physiological stress response, manifesting in lower pulse rates. For LGBTQ individuals, the slightly lower pulse rate compared to sex workers, albeit marginal, might reflect the increased severity of compounded effects of social stigma and discrimination, which could be more pronounced in certain contexts. This slight difference underscores the nuanced impacts of social determinants on health, even within marginalized groups.

4) Hematological Parameters

The examination of hematological parameters during the study also revealed distinct disparities among sex workers, LGBTQ individuals, and a control group, specifically in Red Blood Cell (RBC) count, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC), with Total Leukocyte Count (TLC) showing no significant variance across these cohorts. The findings noted were:

A. Increased RBC Count in Sex Workers:

The elevated RBC count observed among sex workers could be attributed to chronic hypoxia, potentially stemming from environmental pollutants or behaviors such as smoking, which

are prevalently higher in marginalized groups. COVID-19 exacerbates this condition through its pathophysiological effects on the respiratory system, leading to hypoxemia and subsequent compensatory erythrocytosis as a physiological adaptation to enhance oxygen delivery to tissues.

B. Reduced MCV, MCH, and MCHC:

The observed reductions in MCV, MCH, and MCHC across sex workers and LGBTQ individuals signify a trend towards microcytic anemia, possibly indicative of iron deficiency, chronic inflammation, or hematopoietic disruptions. These conditions can be exacerbated by nutritional deficiencies, which are more common in populations experiencing socio-economic marginalization. The systemic inflammation induced by COVID-19, coupled with its gastrointestinal manifestations that may impair nutrient absorption[16] presents a plausible aggravating factor, leading to worsened hematological profiles.

C. Stable TLC Across Groups:

The absence of significant disparities in TLC suggests a homogenous leukocyte response among the studied populations. This uniformity could indicate that the direct immunological impact of COVID-19 on leukocyte counts is comparable across these groups. However, it underscores the need to explore chronic, rather than acute, factors contributing to the observed disparities in other hematological parameters.

Moreover, some other factors which could have resulted in such a pattern in the findings are:

i. Chronic Inflammation and Immune Modulation: Chronic exposure to stress, discrimination, and socio-economic adversity can induce systemic inflammation, affecting hematological parameters. COVID-19's inflammatory response further compounds this effect, potentially altering hematopoiesis and exacerbating anemia.

ii. Environmental and Behavioral Factors: Exposure to environmental toxins and lifestyle choices (e.g., smoking, substance use) prevalent in these populations can contribute to altered RBC dynamics. The pandemic may amplify these exposures by limiting access to safer environments and health-promoting resources.

In conclusion, the scientific examination of hematological disparities among sex workers, LGBTQ individuals, and a control group reveals complex interactions between socio-economic, nutritional, environmental, and physiological factors. COVID-19 adds another layer of complexity, potentially exacerbating pre-existing disparities through its direct and indirect impacts on health.

5. Biochemical Parameters

The investigation of biochemical parameters reveals significant disparities in Creatinine, Blood Urea Nitrogen (BUN), Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), and Random Blood Sugar (RBS) levels between sex workers, LGBTQ individuals, and a control group, with the former 2 groups showing lower values. This points to potential disparities in renal and liver function, as well as glucose metabolism, which could incorporate major issues with:

- **Creatinine and BUN:** These renal function markers suggest variations in glomerular filtration rate (GFR) and nitrogenous waste clearance. Lower values could indicate reduced muscle mass or altered dietary protein intake, critical in assessing kidney health.
- **AST and ALT:** Liver enzymes such as AST and ALT are pivotal in diagnosing liver injury or disease. Lower levels may reflect a range of health statuses but are generally associated with lesser hepatic stress or damage.
- **RBS:** As a measure of glucose concentration in the blood at a random time, RBS levels are instrumental in monitoring glucose metabolism, with implications for diabetes management and diagnosis.

Some causes which could've led to a significant disparity in these parameters are:

a. Nutritional and Socioeconomic Impact:
The pandemic has exacerbated economic hardships, leading to increased food insecurity and nutritional deficiencies. These factors can influence muscle mass (affecting creatinine levels) and dietary protein intake (impacting BUN), especially in marginalized groups.

b. Healthcare Access and Chronic Disease Management:
COVID-19 strained healthcare systems, hindering regular monitoring and management of chronic conditions. This strain may have affected the diagnosis and treatment of liver conditions (reflected in AST and ALT levels) and diabetes (influencing RBS levels).

c. Psychosocial Stress:
The pandemic-induced stress can lead to changes in health behavior and physiological stress responses, potentially altering liver enzyme levels and glucose metabolism. Chronic stress is known to affect glycemic control, which could explain variations in RBS.

d. Immune Response and Inflammation:
For those affected by or which may have been exposed to; COVID-19's systemic inflammatory response may indirectly affect renal and liver function, as well as glucose metabolism,[17] though the exact mechanisms and long-term impacts require further investigation.

Conclusion

In assessing the profound impact of COVID-19 on LGBTQ individuals and sex workers in an urban Indian context, our study evaluated various parameters to paint a comprehensive picture (Figure. No.1) of its effects on these marginalized communities.

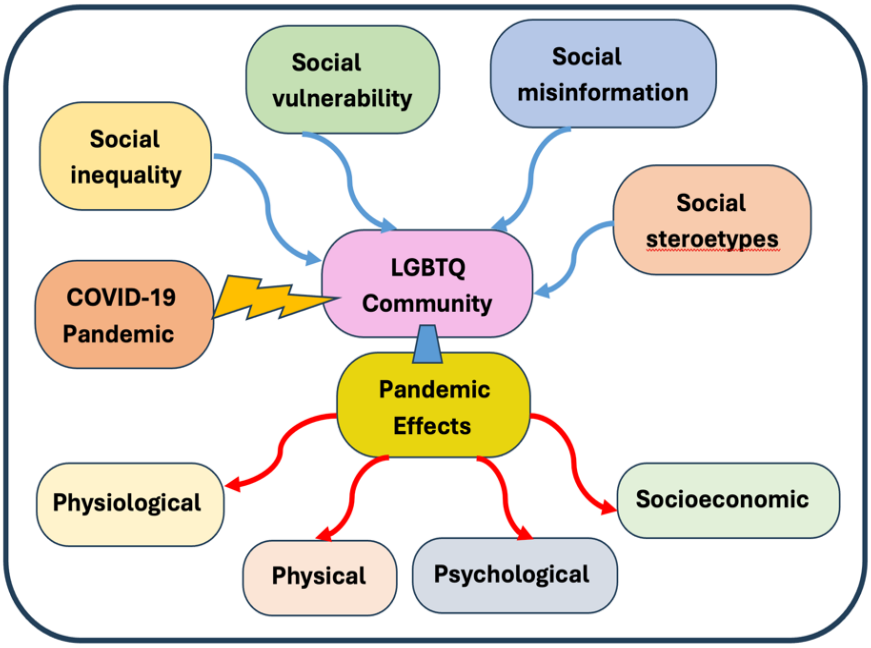

Figure. No. 1: Impact of COVID-19

Through the analysis of responses and an array of physical health indicators including BMI, blood pressure, pulse rate and hematological, and biochemical parameters, the results unveiled the stark disparities and challenges exacerbated by the pandemic. The findings reveal that LGBTQ individuals and sex workers have been disproportionately impacted by the COVID-19 pandemic, experiencing significant deteriorations in physical well-being. The economic precarity, compounded by the loss of income and employment instability, particularly affected these groups more severely than the general population. Additionally, the study highlighted exacerbated health disparities, with lower BMI,

abnormal blood pressure levels, and deviations in hematological and biochemical markers indicating broader health vulnerabilities within these populations.

SIGNIFICANCE OF FINDINGS

The findings of this study underscore the urgent need for targeted, inclusive public health interventions and policies that address the unique challenges faced by LGBTQ individuals and sex workers, especially in India, a developing country where such minorities face formidable challenges. Research has demonstrated that health care disparities for this group have a detrimental impact on LGBTQ people's health outcomes[18]. It calls attention to the necessity of integrating these communities into the broader socioeconomic and healthcare framework, ensuring equitable access to support services, healthcare, and financial assistance. Importantly, the study illuminates the resilience mechanisms within these communities, suggesting potential pathways for supportive interventions that leverage existing community networks and coping strategies.

RECOMMENDATIONS FOR FURTHER RESEARCH

- Qualitative Explorations: In-depth qualitative research is needed to better understand the lived experiences, coping mechanisms, and resilience strategies of LGBTQ individuals and sex workers during the pandemic. Such studies can provide nuanced insights that inform culturally sensitive and community-specific support systems.
- Policy Analysis: Studies assessing the impact of existing policies and relief measures on LGBTQ individuals and sex workers can provide valuable feedback for policymakers, highlighting gaps and opportunities for more inclusive and effective policy frameworks. In sum, the study presents a clarion call to acknowledge and address the compounded vulnerabilities of LGBTQ individuals and sex workers amidst the COVID-19 pandemic. It emphasizes the imperative for dedicated research and policy action to safeguard the health, wellbeing, and rights of these marginalized communities, ensuring they are not left behind in our collective response to current and future public health crises.

Summary

This research explored the disproportionate effects of COVID-19 on the physical and physiological well-being of LGBTQ and sex workers in Indian city of Hyderabad. Data from NGOs in Hyderabad through a mixed-method analysis showed wide health differences such as low BMI, changed blood parameters, and evidence of increased stress and anxiety. Participants also indicated challenges in accessing medical care, economic instability and enhanced stigma. These results vindicated the hypothesis of the study, revealing deep socioeconomic and health problems in such populations. The study is advocating for specific public health interventions and inclusive policy. Further research can investigate long-term effects and resilience process.

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