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Factors affecting the recovery of COVID-19 patients in Pakistan, with a focus on smoking: A comprehensive analysis

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Abstract

This research paper delves into the various factors influencing the recovery of COVID-19 patients in Pakistan, with a specific emphasis on the impact of tobacco smoking. To unravel these connections, we conducted a data collection campaign employing a custom-designed questionnaire, gathering responses from 170 individuals who had successfully recovered from the coronavirus. Subsequently, we employed the Ordinary Least Squares (OLS) method to examine the influence of socio-economic factors on the recovery process. Our findings revealed that patients within the age range of 36 to 46 years exhibited an extended recovery period, requiring an additional three days for recuperation compared to their younger counterparts aged 17 to 25 years. Furthermore, patients aged above 46 years experienced a more prolonged recovery period, with a delay of up to seven days. Residence played a pivotal role in recovery times, as urban-dwelling patients showed a noteworthy advantage, recuperating 1.5 days sooner than their rural counterparts. A conspicuous relationship emerged regarding smoking habits, as patients who smoked tobacco required an additional two days for recovery when compared to non-smokers. Similarly, patients classified as obese experienced 2.6 more days to regain their health compared to individuals with a normal Body Mass Index (BMI). Remarkably, our analysis revealed that factors such as income, gender, and education were insignificant in terms of the number of the days required for recovery. These results provide a comprehensive understanding of the dynamics at play in the recovery process of COVID-19 patients in Pakistan, offering valuable insights for healthcare professionals and policymakers.

Keywords: Age, COVID-19, Income, Obesity, Smoking.

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1. Introduction

In December 2019, in Wuhan City, Hubei Province, China, a total of 41 cases of pneumonia of unknown etiology were confirmed. Later on, a scientific team of the Chinese Academy of Engineering announced that the unknown virus was a new type of coronavirus, and World Health Organization (WHO) tentatively named the virus as a 2019-new/novel coronavirus (2019-nCoV) [1]. On 11th February 2020, WHO announced the official name of the virus as "Corona Virus Disease 2019" (COVID-19). The virus spreads through discharge from the nose, droplets of saliva when an infected person sneezes or coughs. The patients may have upper and lower respiratory tract, respiratory stress syndrome, hypoxemia, acute kidney injury, arrhythmia, and acute cardiac injury, which may lead to multiple organ failure and finally cause death [2]. By examining the spread and severity of the virus on 30th January 2020, the International Health Regulations WHO declared the COVID-19 a Public Health Emergency of International Concern [3].

COVID-19 has affected almost every country. As of October 25, 2023, the total world-wide cases of COVID-19 have reached 696.8 million, out of which 668.7 million people have been recovered and 6.9 million have died[1]. Every country has a different infection, recovery, and fatality rates caused by COVID-19. For instance, San Marino has the highest deaths per million (1,237), followed by Belgium, Peru, Andorra, Spain, United Kingdom, Italy, Sweden, Chile, and the USA. Conversely, Qatar has the highest per million recoveries (4,142), followed by French Guiana, Bahrain, San Marino, Chile, Kuwait, Oman, Vatican City, Panama, and Brazil[2]. Each country has implemented a variety of health policies to combat the negative effects of COVID-19. In addition, some socioeconomic factors, genetics, disease history, level of immunity, and habits can affect the recovery of the COVID-19 patients.

We use Pakistan as a case study to explore the factors that are associated with the expedited recovery from the COVID-19. Secondly, the impact of COVID-19 varies among countries because of their heterogeneous characteristics, such as government strategies, health facilities, epidemiological, clinical, and socioeconomic factors [4]. As of October 25, 2023, Pakistan[3] has 1.58 million total cases of COVID-19, total recoveries of 1.53 million, and deaths of 30,666. The government has taken various steps to control the spread of COVID-19, such as shutting down and limiting the flight operations [5], complete lockdown, regional lockdown (smart lockdown), compulsory wearing of masks, social distancing, and increasing the awareness among people about the virus. Moreover, almost free medical treatment has been given to the patients, new field hospitals were built, and tests for the COVID-19 have been subsidized in public hospitals. The government's actions led to a positive impact on the recovery rate, and the smart lockdown has reduced the spread of the COVID-19 in Pakistan.

Besides the government's efforts, socio-economic factors of patients such as the area of living, race, obesity, gender, age, habits (exercising and smoking), marital status, and educational and economic background can also play a vital role in recovering from the COVID-19. Therefore, it is immensely important for policymakers to understand the impact of these factors so that appropriate measures can be taken to increase the recovery rate or reduce the fatality rate associated with COVID-19. A few studies, such as Chen, et al. [6]; Chen, et al. [7] and Huang, et al. [8] have found clinical and epidemiological features of the deceased and recovered COVID-19 patients in China. However, socioeconomic and habitual factors associated with the recovery are unexplored in Pakistan. To our knowledge, this is the first study focusing on Pakistan and exploring the relationship between Corona recovery and socio-economic and habitual factors. We collected the data from 170 Corona recovered patients through social media during the time of lockdown and applied multiple linear regression for the statistical analysis. The paper is organized as follows: section 2 reviews the earlier studies; section 3 discusses data, variables, and statistical methods, section 4 explains the results, and 5 concludes the paper.

2. Literature Review

The scarcity of the literature on the determinants of COVID-19 is primarily due to recent emergence of the novel. However, few studies have attempted to explore the relationship between socioeconomic factors and COVID-19. For instance, in China, Jin, et al. [9] using a publicly available data set of COVID-19 found that deceased patients were significantly older (65 years and above) than survivors (35-57 years). In addition, they found that almost 65% of deceased patients had one of the serious illnesses such as chronic obstructive pulmonary disease (COPD), diabetes, cardiovascular disease, and hypertension. However, that study used the simple statistics (mean, median, and standard deviation) and did not establish the significant association between the socio-economic/clinical factors and COVID-19 survivors, as we have done in our study.

In another study in China, Chen, et al. [7] found that clinical factors were mainly responsible for patients' deaths due to COVID-19. However, they also explored the social factors that can affect the fatality rate, e.g., male patients aged older than 60 were noted to be higher risk of dying of COVID-19. The researchers used the data from 113 deceased patients and applied simple statistics such as mean, median, standard deviation, t, and χ^2 tests to report the results. Similarly, Chen, et al. [6] in China stated the epidemiological and clinical characteristics of COVID-19 deceased patients. Using data from 99 deceased patients, they found that co-infection, old age, hypertension, and smoking history were the serious risk factors. Regarding smoking as a risk factor, a few review articles, such as Alqahtani, et al. [10]; Farsalinos, et al. [11] and Farsalinos, et al. [12] have summarized that there was a positive association between smoking and fatality rate, implying that people who smoke are at greater risk of dying of COVID-19. However, Berlin, et al. [13] placed emphasis on investigating the role of smoking in the COVID-19 pandemic.

[1] https://www.worldometers.info/coronavirus/
[2] Authors' calculations using data from https://www.worldometers.info/coronavirus/
[3] https://www.worldometers.info/coronavirus/country/pakistan/

Likewise, Cai, et al. [14] in China explored the relationship between obesity and the severity of COVID-19 disease. They collected data from 383 patients with COVID-19 and applied multivariable logistic regression to examine the factors associated with the severity of COVID-19. The authors discovered that patients who were overweight had a 1.84 times higher probability of developing severe COVID-19, while those who were obese had a 3.4 times higher probability. Similarly, Stefan, et al. [15] found that older age (above 65), pre-existing diseases (cardiovascular disease, hypertension, diabetes, hypertension, and cancer), and obesity may be associated with the severity of the COVID-19. However, they used a small sample of 24 patients only and implemented simple statistics to explore the factors associated with the severity of the COVID-19, which may lead to weak estimates.

Using relatively large data of little over 2 million individuals from the United Kingdom and the United States, Lo, et al. [16] explored that ethnicity, race, and community-level social and economic factors (deprivation, disparity, and inequalities) play a vital role in the infection and deaths due to COVID-19. Applying logistic regression, they found that the risk for a positive COVID-19 test increases for non-Hispanic Black in the United States, Black in UK, and Middle Eastern participants as compared to the non-Hispanic White participants. The study was relatively large, however, and ignored multiple other personal and socio-economic factors such as habitual, demographic, and economic factors.

There are few studies that have been carried out at the national or the macro level, such as Stojkoski, et al. [4] and Coccia [17] which explored the factors that can affect the COVID-19. However, we have only included the individual-level studies because of their direct relevance to our study.

To our knowledge, to date (October, 2023) no study has found the socio-economic and habitual determinants of COVID-19 recovery in Pakistan. Most of the studies have been carried out in China, where mostly epidemiological and clinical factors have been explored. As we have stated earlier, the factors that can affect the COVID-19 recovery or fatality rate may differ from country to country because of the heterogeneous environment. Therefore, we believe our study contributes to the existing literature significantly and provides in-depth insight for policymakers. The countries that match with Pakistan in terms of customs, environment, economic conditions, and other population characteristics, such as India, Bangladesh, Nepal, Iran, and Afghanistan, may also get policy directions from our study.

3. Methodology

3.1. Data

We developed a short questionnaire to collect the data. The generated link was sent to the COVID-19-recovered patients through different social media channels such as Email, WhatsApp, Facebook, and other communication sources. We asked 34 questions, which could have taken around 7 minutes to answer. Only those patients were contacted who were willing to participate in the research study: they were further requested to provide consent to use their data for research purposes only. They also had options to exit the survey at any point, as well as the option to hide their identities or personal data. We collected data from 229 respondents, excluding incomplete cases, leaving us with 170 observations. The respondents were mainly from big cities in Pakistan, such as Karachi, Lahore, Faisalabad, and Peshawar. In total, we collected data from almost twenty cities in Pakistan. The questionnaire was also translated to the Pakistani national language (Urdu) so that the maximum number of patients could understand the questions. However, our cohort has high level of education, with an average schooling age of 14. Secondly, our sample has the mean household expenditure (a proxy of income) equal to PKR 65,565 (USD 234 (exchange rate 25th October, 2023), this is higher than the average national household expenditure of PKR 41,545 (USD 148)[4]. Because the data was collected via the internet, only those patients who were able to operate and afford expensive gadgets were contacted. Therefore, our sample is also considered a resourceful sample and has less variation in education and income. Thus, there was a beneficial trade-off between bias and homogeneity of patients under consideration.

3.2. Variables

We generated the dependent variable "Disease Days" by subtracting the diagnosis date from the date of recovery. According to the laboratory test results, both dates were available. The variable was a continuous variable with a minimum of 10 days and a maximum of 43 recovery days. The mean number of recovery days was 21, with a standard deviation of 5.6. All other variables given in the Table 1 and 2 were considered independent variables. Only schooling years and household expenditures were continuous variables, and the remaining variables were considered as categorical variables. The minimum age of the respondents was 17, and the maximum age was 77 years. Meaning that among our cohort, the survivors ages ranged from very young to old. However, the virus can seriously damage the organons or even cause death to a patient of any age, race, gender, weight, education, and income group.

We have taken two habitual variables, such as currently smoking and exercising; refer to Table 2 for details. Moreover, we have included other variables such as area, gender, marital status, admission to the hospital, medicine taken, and any other pre-existing diseases. We calculated the body mass index (BMI) using the respondents' weight and height and categorized them as follows: Underweight means below 18.5 BMI, healthy or normal weight ranges 18.5 to 24.9 BMI, overweight ranges 25 to 29.9 BMI, and obese means 30 and above 30 BMI. The number of respondents in each category can be seen in Table 2.

[4] https://www.ceicdata.com/en/pakistan/household-integrated-economic-survey-average-monthly-income-household/average-monthly-income-household

Table 1.
Description of the continuous variables.

Continuous variables	Observations	Mean	Std. deviation	Min.	Max.
Disease days (Dependent variable)	170	21.42	5.656	10	43
Schooling years	170	14.95	2.07	8	20
Monthly exp (PKR)	170	65,565	47,053	10,000	300,000

Table 2.
Description of the categorical variables.

Factors variables	Frequencies		Total
Age	Age 17-25 = 33 (19.4%) Age 26-35 = 81 (47.6%)	Age 36-45 = 35 (20.6%) Age 46-above = 21 (12.4%)	170
Gender	Male = 121 (71.2%)	Female = 49 (28.8%)	170
Area	Urban = 128 (75.3%)	Rural = 42 (24.7%)	170
Marital status	Single = 60 (35.3%)	Married = 110 (64.7%)	170
Any other disease	Yes = 60 (35.3%)	No = 110 (64.7%)	170
Light exercise (Walk)	Yes = 65 (38.2%)	No = 105 (61.8%)	170
Admitted to the hospital	Yes = 18 (10.6%)	No =152 (89.4%)	170
Medicine taken	Yes = 153 (90.0%)	No = 17 (10.0%)	170
Smoking	Yes = 38 (22.4%)	No = 132 (77.6%)	170
BMI-categories	Normal BMI = 76 (44.7%) Obese = 34 (20.0%)	Under BMI = 3 (1.8%) Over BMI = 57 (33.5%)	170

3.3. Statistical Analysis

For statistical analysis, we applied ordinary least squares (OLS) method to examine the association between COVID-19 recovery days and the independent variables. The regression predicts, how many days a patient would require to be COVID-19 negative. The OLS method is widely used in the literature, and recently few studies, such as Ayyoubzadeh, et al. [18]; Kass, et al. [19] and Xiong, et al. [20] have used this method for predicting the impact of various factors upon COVID-19.

Equation 1 represents the econometric expression:

$$y_i = \beta_0 + \beta_i x_i + \varepsilon \quad (1)$$

Were,

y_i = Disease days (the number of days a respondent was COVID-19 positive).

β_0 = Intercept terms / constant term.

β_i = The coefficients of independent variables.

x_i = All explanatory variables (age, gender, education, living area, marital status, log of income, any other disease, exercise, hospital admission, medicine taken, smoking, and BMI).

One of the primary limitations of the Ordinary Least Squares (OLS) method is its susceptibility to generating erroneous estimates when the fundamental assumptions of the model are violated. Specifically, the resulting estimates can be both biased and inconsistent when certain conditions, such as the presence of correlations among explanatory variables and with the error term, are not satisfied. Therefore, we made sure that our model's assumptions adhered to the following key criteria:

1. Linearity in Parameters: Our analysis maintains the crucial assumption of linearity in parameters, signifying that the relationships between the independent and dependent variables are accurately captured.
2. Zero Mean of Residuals: The model adheres to the requirement that the residuals exhibit a zero mean, ensuring that the model's predictions are centered around the observed data points.
3. Homoscedasticity: We have assessed and confirmed homoscedasticity, which signifies that the variability of the residuals remains constant across the range of the independent variables. This assumption is integral to the reliability of our estimates.
4. Independence between Variables and Residuals: Our results maintain the assumption that the independent variables and residuals are uncorrelated. This independence is vital for the model's reliability and interpretability.
5. Mitigation of Multicollinearity: Addressing the issue of multicollinearity, the analysis has effectively managed potential correlations among explanatory variables. This careful handling ensures that the estimates remain unbiased and interpretable.

We executed the analysis using RStudio, primarily leveraging two key packages: "dplyr" and "tidyverse." These tools played a pivotal role in data manipulation and visualization, facilitating a comprehensive and rigorous assessment of the model's compliance with the specified assumptions. This rigorous adherence to the model's assumptions strengthens the validity and robustness of our analytical results, enhancing the trustworthiness of the findings and their potential for meaningful interpretation.

4. Results and Discussion

Table 1 presents the basic statistics of the continuous variables, such as monthly household expenditures in PKR (a proxy for income) and the number of schooling years. As mentioned earlier, our cohort exhibits relatively higher income and education levels compared to the average individuals in the country. We primarily attribute this to our data collection methods. We collected data through Facebook, Instagram, WhatsApp, and email, all of which require access to gadgets, an internet connection, and the ability (in terms of education and awareness) to use these applications. Consequently, our cohort exhibits homogeneity in terms of education and income. We calculated our main dependent variable, "disease days," by subtracting the date of testing negative from the date of testing positive for COVID-19. we noted that the mean duration of remaining positive for COVID-19 was three weeks.

Table 2 presents the description of categorical variables. All of these variables are self-explanatory. However, we also asked questions about height and weight, which allowed us to calculate the Body Mass Index (BMI) of the individuals. The results showed that the majority of individuals had a normal BMI (44%), with only 20% falling into the obese category. Only 1.8% of the individuals met the BMI criteria for underweight.

Tables 3 and 4 unveil the results of our regression analyses, shedding light on the factors influencing recovery days among COVID-19 patients. Initially, we conducted twelve simple regressions to assess the individual impact of each independent variable on the recovery period. Table 3 illuminates the findings, indicating that age, marital status, the presence of pre-existing conditions, and obesity emerged as significant determinants of recovery days. Recognizing the multifaceted nature of recovery, we subsequently performed a multiple linear regression analysis in the second stage to account for the potential interplay of these factors. Table 4 presents the results of this comprehensive analysis.

Our examination revealed intriguing insights into the relationship between various factors and the duration of recovery. For instance, we found that patients aged 36 to 45 years required an additional three days for recovery compared to those aged 17 to 25 years, with a confidence interval ranging from -0.33 to 6.05. Furthermore, patients aged 46 and above experienced an even more extended recovery period, necessitating seven extra days compared to the younger cohort, within a confidence interval of 3.62 to 10.93. we may attribute this observation to a diminished immune response in older individuals, making them more vulnerable to the virus. These results align with prior research, echoing the findings of studies by Jin, et al. [9] and Chen, et al. [7] which also identified age as a significant factor influencing COVID-19 recovery.

Notably, patients residing in urban areas exhibited a shorter recovery period, requiring 1.5 days less for recuperation compared to their rural counterparts, with a confidence interval spanning from -3.34 to 0.27. urban regions typically have more accessible and advanced healthcare facilities, which highlights the critical role of healthcare infrastructure in managing and expediting recovery.

The presence of pre-existing conditions, such as diabetes, cardiovascular disease, liver infections, and hypertension, was associated with a lengthened recovery period, with patients requiring an additional 1.7 days for recuperation (95% C.I = -0.22 – 3.72) compared to those without pre-existing conditions. This finding resonates with previous studies by Jin, et al. [9] and Chen, et al. [7] which underscore the heightened risk faced by individuals with underlying health conditions.

Furthermore, our analysis unveiled that current smokers experienced a two-day increase in recovery time (95% C.I = 0.03 – 3.88) when compared to non-smokers. Researchers, posit that smoking, a known risk factor for lung diseases and various infections, exacerbates health issues and hinders recovery.

Obesity, defined as having a BMI of 30 or higher, was also associated with a prolonged recovery, with obese patients requiring an additional 2.6 days for recuperation (95% C.I = 0.51– 4.66) compared to patients within the normal weight range (BMI 18.5 to 29.5). Obesity's role in increasing the risk of respiratory infections and impeding the recovery process mirrors the findings of studies by Cai, et al. [14] and Stefan, et al. [15].

Remarkably, income and education levels remained non-significant in both the simple and multiple linear regression results. This implies that variations in income and education levels do not significantly impact the speed of recovery from COVID-19 in Pakistan. There could be several reasons for this observation. First, the government of Pakistan's subsidization of medical testing and treatment may have mitigated the impact of income disparities, ensuring that patients from both higher and lower income groups have equitable access to care. Second, the lack of significant findings related to income and education might be attributed to data limitations, including the predominance of higher-income data, which may not provide enough variation to yield statistically significant results.

In terms of education, it is possible that better-educated individuals are more successful in preventing infection through increased awareness and adherence to safety guidelines. However, once infected, the analysis suggests that educational attainment does not confer a significant advantage in terms of recovery duration, as educated and less educated individuals appear to have similar recovery trajectories.

In sum, these regression analyses offer valuable insights into the determinants of recovery from COVID-19 in Pakistan, highlighting the nuanced interplay of age, urban-rural disparities, pre-existing conditions, smoking, and obesity. While income and education did not emerge as significant factors, the study underscores the multifaceted nature of COVID-19 recovery and the importance of tailored healthcare interventions for specific patient demographics.

Table 3.
Simple linear regression results (OLS with one variable).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Age 26-35	0.284 (1.043)											
Age 36-45	3.019* (1.225)											
Age 46-above	8.095*** (1.409)											
Age 17-25 (Reference category)												
Gender male		0.022 (0.961)										
Year of schooling			-0.314 (0.209)									
Area urban				-1.208 (1.005)								
Marital status Single					-1.788** (0.900)							
Log income (Proxy)						0.844 (0.740)						
Any other disease Yes							4.033*** (0.856)					
Exercise Yes								-0.910 (0.893)				
Hospital admission Yes									0.458 (1.414)			
Medicine taken Yes										-0.771 (1.449)		
Smoking Yes											1.488 (1.038)	
Obese												2.574** (1.157)
Over weight												0.947 (0.983)
Under weight												-2.298 (3.302)
Normal weight (Reference category)												
Constant	19.7*** (0.879)	21.4*** (0.811)	26.1*** (3.154)	22.3*** (0.872)	22.1*** (0.535)	12.2 (8.081)	20.0*** (0.508)	21.8*** (0.552)	21.4*** (0.460)	22.1*** (1.375)	21.1*** (0.491)	20.6*** (0.643)
Observations	170	170	170	170	170	170	170	170	170	170	170	170
R2	0.218	0.000	0.013	0.009	0.023	0.008	0.117	0.006	0.001	0.002	0.012	0.034

Note: Authors' calculation, standard errors are in parenthesis, P-value <0.005 ***, < 0.05 ** < 0.10 *.

Table 4.
Multiple linear regression results (OLS with multiple variables).

Variables	Coef.	Std. error	t-statistic	P-values	95% C.I	
					Lower	Upper
Age 26-35	0.443	1.225	0.362	0.718	-1.98	2.86
Age 36-45	2.855*	1.616	1.766	0.079	-0.34	6.05
Age 46-above	7.274***	1.851	3.929	0.000	3.62	10.93
Age 17-25 (Reference category)						
Gender male	-0.324	0.899	-0.36	0.72	-2.10	1.45
Year of schooling	-0.135	0.205	-0.657	0.512	-0.54	0.27
Area urban	-1.537*	0.915	-1.68	0.095	-3.34	0.27
Marital status single	0.79	1.06	0.745	0.457	-1.30	2.88
Log income (Proxy)	0.367	0.703	0.523	0.602	-1.02	1.76
Any other disease yes	1.750*	1.001	1.748	0.082	-0.23	3.73
Exercise yes	-0.726	0.805	-0.903	0.368	-2.32	0.86
Hospital admission yes	-0.163	1.375	-0.118	0.906	-2.88	2.55
Medicine taken yes	-0.107	1.331	-0.081	0.936	-2.74	2.52
Smoking yes	1.957**	0.973	2.011	0.046	0.03	3.88
Obese	2.585**	1.049	2.465	0.015	0.51	4.66
Over weight	0.469	0.946	0.496	0.621	-1.40	2.34
Under weight	-1.636	3.102	-0.527	0.599	-7.76	4.49
Normal weight (Reference category)						
(Intercept)	17.534**	7.689	2.28	0.024	2.34	32.73
Observations	170					
R^2	0.306					
Adjusted R^2	0.234					
Residual std. error	4.953 (df = 153)					
F statistic	4.221*** (df = 16; 153)					

Note: Authors' calculation, C. I= Confidence intervals, P-value <0.005 ***, < 0.05 ** < 0.10 *.

Emphasizing the intricate link between the severity of the disease and the outcome of COVID-19 is crucial. In cases where the virus has severely infected a patient, the process of recovery may extend over a period of several months or, regrettably, may even culminate in a fatal outcome.

The most common symptoms among our cohort of COVID-19 patients, were fever and fatigue. These were followed by a cascade of additional symptoms, including the loss of taste and smell, bodily aches, persistent headaches, coughing, sneezing, sore throat, digestive issues like diarrhea, respiratory distress, and chest pain. The diversity and intensity of these symptoms underscore the complexity of COVID-19's impact on individuals, highlighting that the disease can affect multiple organ systems, emphasizing the need for multifaceted medical management and support for patients during their recovery journey. Furthermore, recognizing these variations in symptom presentation is critical for both healthcare providers and the broader community, as it underscores the importance of early detection, timely intervention, and vigilance in the face of this evolving pandemic.

5. Conclusion

In conclusion, the COVID-19 pandemic has undeniably imposed substantial health and economic burdens on nations across the globe, compelling governments and healthcare systems to adopt various strategies to increase the recovery rate and minimize its devastating impact. Although we have made a significant progress in understanding the epidemiological and clinical aspects of COVID-19, we still need to thoroughly investigate a crucial area, particularly in Pakistan—the association between COVID-19 and patients' socioeconomic attributes.

As we have discovered, factors like income and education surprisingly appear to have little influence on the recovery time for COVID-19 patients. This finding may be attributed to government subsidies for testing and treatment, ensuring that individuals from both lower and higher income groups have nearly equal access to necessary care. However, our research highlights the critical role of other factors such as age, pre-existing medical conditions, smoking, and obesity in significantly slowing down the recovery process. To address these findings and improve the recovery rate in Pakistan, it is imperative for policymakers to consider the following avenues for further investigation and intervention:

Prioritizing Elderly Patients: Our research underscores the importance of giving extra care and attention to older COVID-19 patients. We warrant tailored healthcare strategies for older individuals, as they appear to face a more protracted recovery process. This might include dedicated healthcare facilities, home healthcare services, and targeted information campaigns to safeguard the elderly.

Managing Pre-existing Conditions: Patients with pre-existing medical conditions such as diabetes, cardiovascular diseases, hypertension, and respiratory diseases are at a higher risk and experience a slower recovery. To mitigate these impacts, the government should focus on improved management of these conditions, including regular check-ups and medication adherence. Telemedicine and home care services may prove to be invaluable tools in this context.

Smoking Cessation Policies: Recognizing the negative impact of smoking on COVID-19 recovery, the government should invest in comprehensive smoking cessation policies. These can include awareness campaigns, support services, and stricter regulations on tobacco products to reduce the prevalence of smoking.

Tackling Obesity: Given the significant influence of obesity on the recovery process, implementing policies and interventions to address this issue is crucial. Promoting healthier lifestyles, such as encouraging physical activity and regulating food marketing, can help lower obesity rates and subsequently improve the recovery rate for COVID-19 patients.

Long-Term Socioeconomic Impact: Although our study did not find a direct link between income and education and recovery time, it is important to consider the long-term socioeconomic implications of the pandemic. Future research should explore the pandemic's broader effects on employment, education, and income disparities, as these factors can have indirect consequences on recovery and overall well-being.

In summary, the fight against COVID-19 extends beyond the immediate medical response to a broader understanding of the social and economic determinants of health. To enhance the recovery rate in Pakistan and worldwide, policymakers should heed these research findings and invest in strategies that prioritize vulnerable populations, manage comorbidities, and promote healthier lifestyles, thus paving the way for a more resilient and robust response to current and future pandemics.

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