

RESEARCH ARTICLE



Impact of novel Coronavirus (COVID-19) pandemic on travel pattern: A case study of India

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Abstract

Background: The outbreak of coronavirus disease 2019 (COVID-19) has been declared a pandemic by the World Health Organisation (WHO). The outbreak not only affects human health but also travel psychology. **Objective and methodology:** In order to understand the impact of coronavirus on the travel pattern of Indian people, this study adopts descriptive research techniques to compare travel scenarios during the normal situation, pre-lockdown, and till the COVID-19 pandemic end. The questionnaire included the information for socio-demographic characteristics of the respondents, travel pattern during the normal situation, pre-lockdown and post-lockdown period. The respondent has to perceive the post-lockdown situation and give their responses accordingly. The questionnaire also has some policy-related questions on the five-point Likert scale. **Findings:** The results of this study are based on online survey responses from 3148 individuals. It is observed that during the pre-lockdown period, people are more dependent upon the personal mode of transportation and the use of shared mobility dropped (35% compare to the normal situation) significantly because of the high risk of virus transformation from close contact with unknown people and it is expected that, after the end of lockdown period, people will reduce their non-mandatory trips and higher income group will try to avoid travelling in public transport, taxi and other mass transport. This pandemic situation shows us the advantage of walk and bicycle (22% of growth was observed during pre-lockdown), as these modes provides a great way to stay healthy and also an efficient way to support social distancing and reduce the load on public transport. The high percentage of uses of private vehicle (like cars and two-wheeler) will increase congestion on roads and it will lead to more air pollution. The findings of this study will help transport planner and policymakers to plan effective policy strategies to facilitate smooth transportation service during this pandemic situation. The author also recommend the public transport systems to come up with technological upgradation to reduce the contacts in terms of vehicular space (seat arrangements) and automated ticketing and overcrowd warning signals.

Keywords: Coronavirus; COVID-19; travel pattern; lockdown; descriptive analysis

1 Introduction

The outbreak of coronavirus (also known as Covid-19) reported to have started in December 2019 from Wuhan, China, and rapidly spread all over the world. On 11th March 2020, the World Health Organisation (WHO) has declared it a global pandemic [1]. At present (30th June 2020) more than 10,117,000 people have been infected and around 502,278 have died in all around the world [2] whereas in India, more than 566,000 people are infected and more than 16,000 people died from the coronavirus [3]. Like several developed (Australia, France, Germany, Italy, UK, Israel, etc.) and developing (China, Argentina, Russia, South Africa, etc.) countries, India also enforced social distancing measures by imposing lockdown in the country (initially for three weeks from 24th March to 14th April 2020 and extended up to 17th May 2020; further extended till end of June in some states) to slow down the virus transmission. Figure 1 clearly demonstrates the importance of social distancing and control measures for minimizing virus transmission. So far social distancing and various control measures like closing schools, working from home, limiting large gatherings, avoiding public places, avoiding public transit and travel restriction, etc. are found to be efficient to control the spread of coronavirus. These control measures have a direct impact on travel patterns. As a result, most of the persons are working from home or temporarily unemployed and many people cancelled their non-mandatory (leisure, shopping, recreational, etc.) travels. Lockdown is not a long-term solution to prevent the community spread of pandemic coronavirus. It is expected that after the end of the lockdown period, people will start their mandatory travel but the fear of coronavirus will change people's daily commute frequency and travel psychology in terms of mode choice [4].

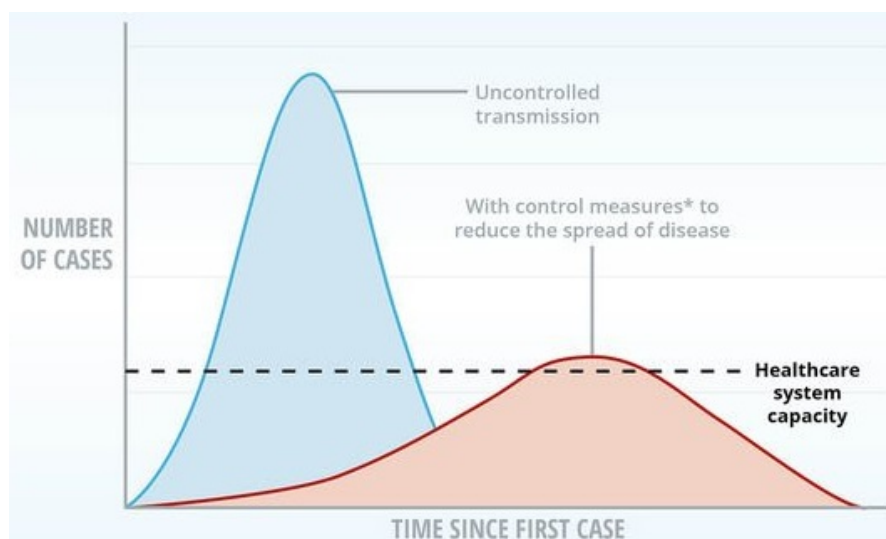


Fig 1. Effect of control measures like lockdown on number of cases

People might avoid travelling in public transportation and shared mobility because it increases the risk of acute respiratory infection [5] and may face social distancing challenges during this pandemic situation. Public transport operators should focus on making public transport a safer way of travelling and aiming to provide a minimum service to meet the demand for essential travel. In any case, if these operators are unable to provide safe services (may become a virus transmitter) then it causes a big impact on the local and national economies. This study tries descriptive research techniques to analyse the impact of coronavirus on the travel patterns of Indian people. The results of the study will help transport planners and policymakers to provide safe transportation services during this period.

The remainder of this presentation is divided into five sections. Section 2 discusses the data collection procedure and the methodology adopted for this study. Section 3 summarizes the results of the survey samples. Section 4 discusses the respondent's perception on policy-related questions and Section 5 provides conclusions and recommendations for future research.

2 Data collection and methodology

The objective of this study is to understand the impact of COVID-19 on travel pattern of Indian people by comparing the mode choice behaviour and frequency of various purposes of trips before the outbreak (in the normal situation, when there was no corona), during the outbreak or pre-lockdown (in the third week of March 2020, just before the lockdown period) and after the lockdown or post-lockdown period in the country. This study adopts descriptive research techniques to compare travel scenarios during the normal situation, pre-lockdown, and after the end of lockdown period. To capture the travel pattern, a questionnaire consists of four categories of questions namely, socio-demographic characteristics of the respondents, travel pattern during the normal situation, pre-lockdown and post-lockdown period was prepared. The respondent has to perceive the post-lockdown situation and give their responses accordingly. The questionnaire also has some policy-related questions on the five-point Likert scale varying from strongly agree (1) to strongly disagree (5). The empirical data was collected

during 24-31 March using an on-line survey (google form) and more than 3000 responses (total 3148) were received from tier 1, tier 2 and tier 3 cities of India. A majority of the responses comes from tier 2 cities (61.63 percent) followed by tier 3 (25.16 percent) and tier 1 cities (13.21 percent).

3 Results of the surveys

3.1 Socio-demographic characteristics and travel profile of the respondents

The socio-demographic characteristics and travel profile of the respondents (Table 1) include gender, age, average monthly income of individual, educational qualification and occupation, average commuting distance, and frequency of using public transportation for the daily commute (before the outbreak of corona). Nearly 72% of the total respondents were male and only 28% were female. Maximum 60% of the respondents belong to the age group of 18-25 years, followed by 35% in the age group of 26-50 years, 3% in the age more than 50 years and rest 2% belong to the age less than 18 years. Approximately 50% of the respondents' monthly income is less than 15000 ₹, followed by 20% of the respondents belongs to the income group of 15,000-50,000 ₹per month, nearly 20% in the income group of 50,000 – 1 Lakh ₹per month and the remaining 10% of the respondents have monthly income of more than 1 Lakh. Around 57% of the respondents are students, followed by 19% have a government job (other than medical staff), 16% are working in the private sector, nearly 3% of respondents have their own business and it is interesting to note that only 1.3% of the responses come from medical sector (doctor/nurse) respondents, this is may be because these people are extremely busy in their duties during this pandemic situation.

Table 1. Socio-demographic characteristics of the respondents

Category	Count	Percentage
Gender		
Male	2264	71.9%
Female	884	28.1%
Age		
Less than 18 Years	56	1.8%
18-25 Years	1888	60%
26-50 Years	1108	35.2%
More than 50 Years	96	3.0%
Average monthly income of individual		
0 to 15000 ₹	1588	50.4%
15,000 - 50,000 ₹	644	20.4%
50,000 – 1 Lakh ₹	616	19.6%
1 Lakh – 1.5 Lakh ₹	112	3.6%
More than 1.5 Lakh ₹	188	6.0%
Education qualification		
Matriculation	24	0.8%
Higher secondary	532	16.9%
Graduate	1448	46.0%
Master	872	27.7%
Doctorate	216	6.8%
Other	56	1.8%
Occupation		
Student	1784	56.6%
Govt. employee (other than medical staff)	604	19.2%
Medical staff (Doctor/Nurse)	40	1.3%
Business employee	92	2.9%
Private employee	500	15.9%
Other	128	4.1%
Average commuting distance		
Less than 2 km	784	24.9%
2-5 km	964	30.6%
5-10 km	536	17.0%
More than 10 km	864	27.5%
Frequency of using public transportation		
Once in a day	760	24.1%
Once in a week	764	24.3%

Continued on next page

Table 1 continued

Category	Count	Percentage
Once in a month	828	26.3%
Never	796	25.3%

Approximately 25% of the respondent commute less than 2 kilometre (maybe this group belongs to student category which is residing inside the college campus), 30% of the respondent commute 2-5 kilometre, 17% of the respondents commute 5-10 kilometre and rest 28% of the respondents commute more than 10 kilometre on a daily basis. The uses of public transportation for daily commute is always an important matter of concern for transport planners. During normal situation (before the outbreak of corona), almost 24% of the respondent were using public transport at least once in a day, nearly 24% were using at least once in a week, approximately 26% were using once in a month and rest 25% never used public transportation for their daily commute. Now after this pandemic situation, it is interesting to observe the uses of public transportation and mode shifts during the outbreak (when there was no lockdown) and after the lockdown period.

3.2 Impact on the uses of various mode of transportation

Figure 2 shows the mode used by the respondents for daily commute during the normal situation (before corona outbreak), pre-lockdown (during outbreak but no lockdown) and preferred mode of transportation after post-lockdown period (when still some positive cases in the surrounding).

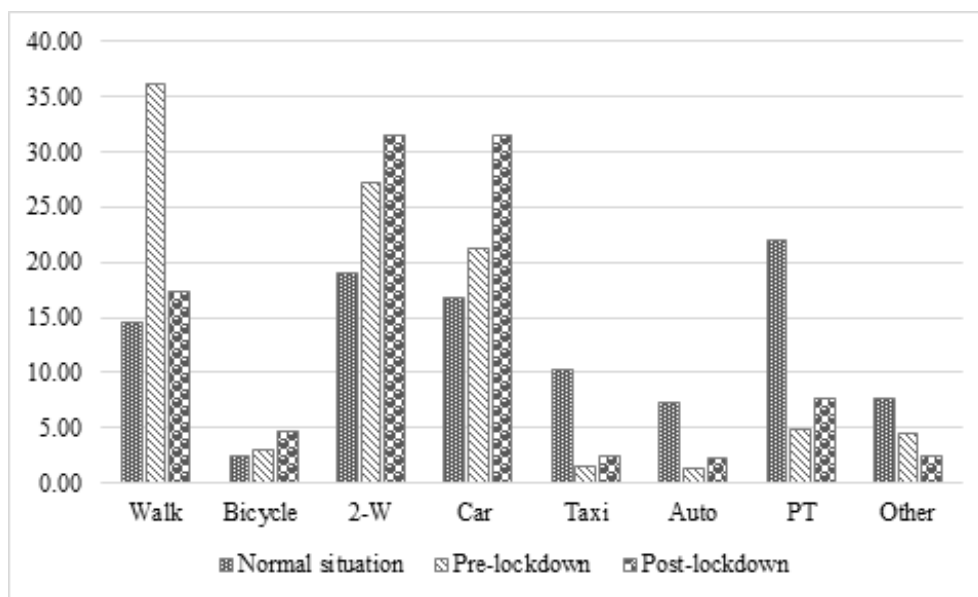


Fig 2. Mode used for daily commute during the normal situation, pre-lockdown and post-lockdown period

During normal situation, nearly 15% of people were using the walk as a primary mode of travel; whereas, before lockdown (pre-lockdown), more than 35% of people are using a walk and around 17% of people think that they will use the walk for daily commute after the lockdown ends (post-lockdown). In India, very less percentage (less than 5%) of people are using a bicycle for daily commute [6]. Despite that, there is a little amount of growth was observed in bicycle mode during pre-lockdown as compared to the normal situation and it is expected that after the lockdown, nearly 5% of people going to use a bicycle as a primary mode of transportation. Expectedly, the use of two-wheelers is increased during the pre-lockdown (27%) compared to before the normal situation (19%) and nearly 32% of people feel that they are going to use two-wheeler as a primary mode of travel after the end of coronavirus lockdown. Similarly, the use of personal car is increased during the pre-lockdown (21%) compared to the normal situation (17%) and it is expected to be increased more significantly (31%) during the post-lockdown period. The uses of taxi (1.5%), auto-rickshaw (1.2%), public transport (5%) and other mass transport (4.5%) is decreased during the pre-lockdown as compared to the normal situation (uses of taxi 10%, auto-rickshaw 7.3%, public transport 22% and other mass transport 7.6%).

It was observed that people are more dependent on a personal mode of transportation (walk, bicycle, two-wheeler and car) during the pre-lockdown period but due to a high level of virus transmission risk associated with public transportation, taxis, auto-rickshaws and other mass transport were less preferred. People shifting from shared mobility to private vehicles (car and two-wheeler) may be because they feel safe in their own vehicles (fewer chances of virus transmission) compare to sitting over in a shared vehicles that carry several other passengers in a day.

3.3 Mode shift during pre-lockdown and after the lockdown ends based upon income level

Generally, mode choice decision highly depends upon the income level and we looked for the mode shifts based upon individual income. Figure 3 depicts the mode choice for daily commute during the normal situation. Figure 4 shows during the pre-lockdown period and Figure 5 shows after the lockdown ends (based upon perception). As expected, the use of cars increases, and public transport decreases with the increase in income level.

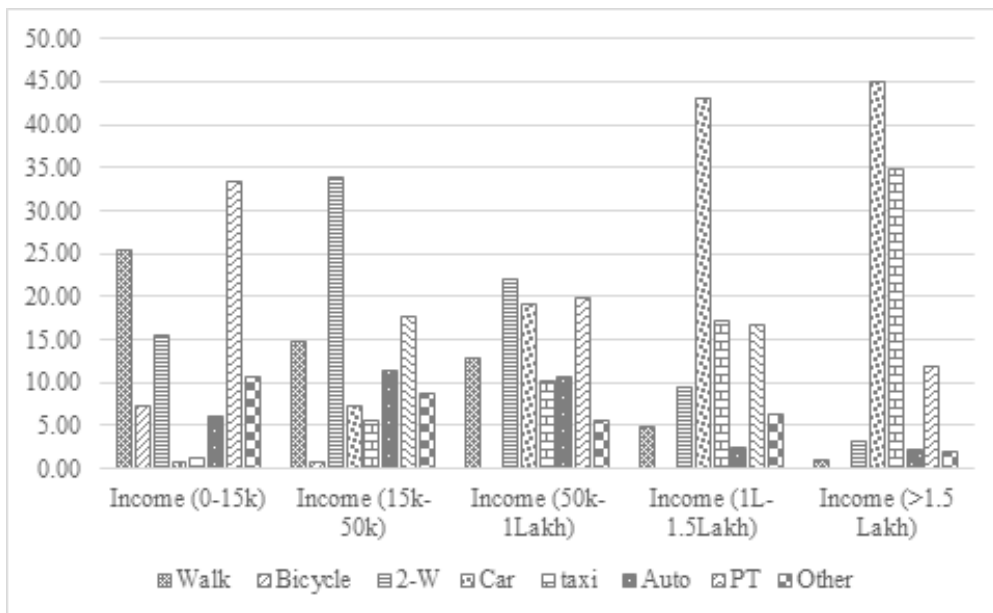


Fig 3. Mode choice segregation based upon individual income during normal situation

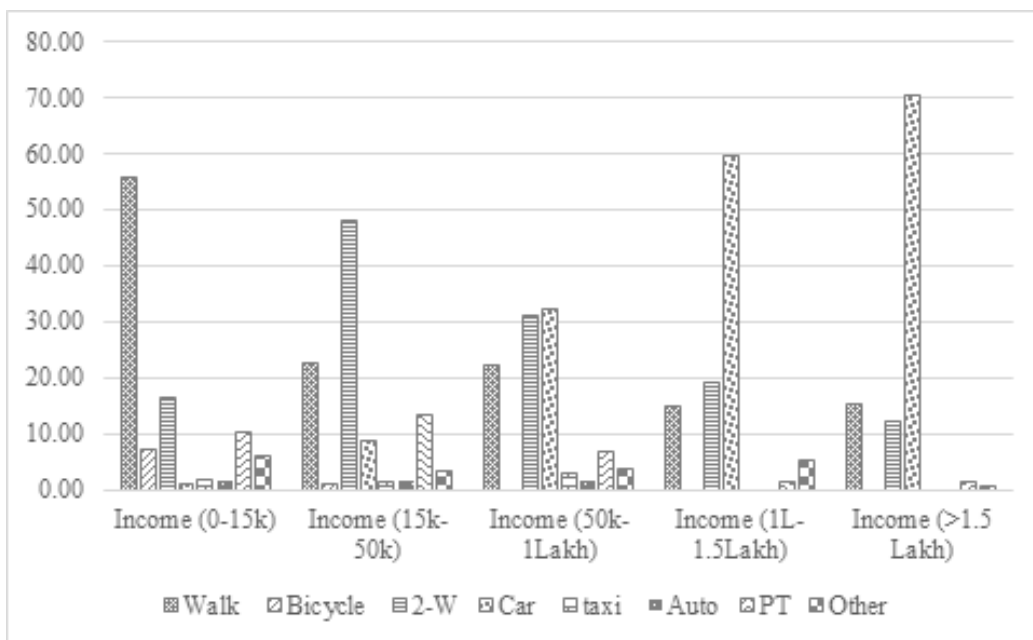


Fig 4. Mode choice segregation based upon individual income during pre-lockdown period

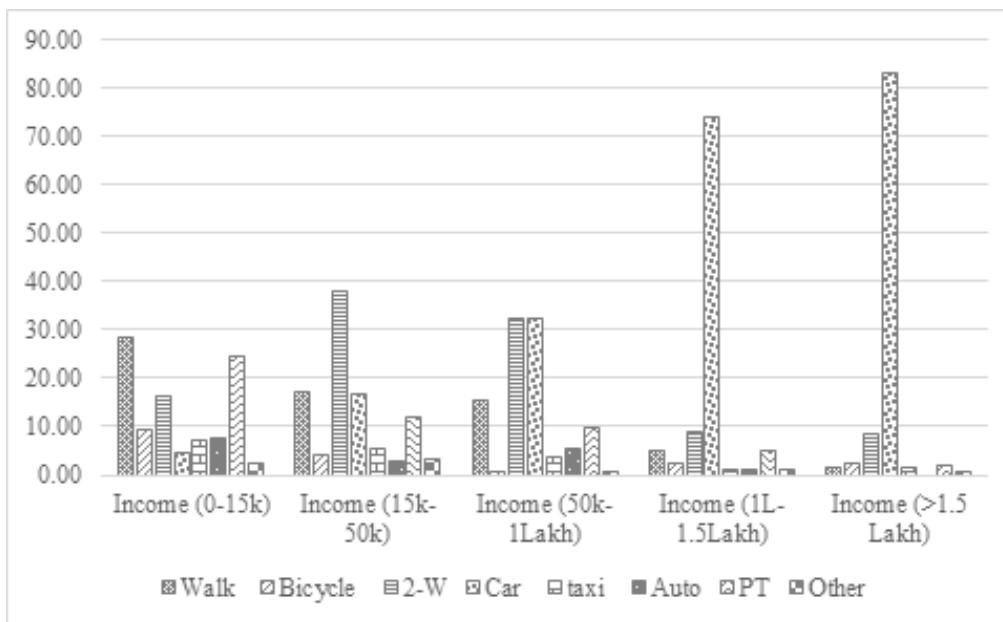


Fig 5. Mode choice segregation based upon individual income after the end of lockdown period

Income category of less than 15,000 ₹ (mostly students) depends upon public transport (33%), walk (25%), two-wheeler (15%), bicycle (7%), taxi (6%) and other mass transport (11%) during the normal situation; whereas during pre-lockdown period, more than 55% of people of this income group were using a walk, followed by two-wheeler (16%), public transport (10%) and bicycle (7%) for the daily commute and it is expected that 10% of people will shift from shared mobility to personal mode of transportation after the end of lockdown period. It was observed that even low income category people are using two-wheeler in a reasonable percentage. It may be because of this category group comprises of mostly students and their mode choice decision are also influenced by socio-economic characteristics of their households. People of income category 15,000-50,000 ₹ was using two-wheeler (34%), public transport (18%), walk (15%), auto-rickshaw (11%) and other mass transport (9%) for daily commute during the normal situation whereas during pre-lockdown period, 16% of people shifted over the two-wheeler and cars and it is expected that more than 75% of people will use personal transport (two-wheeler 38%, cars 17%, walk 17% and bicycle 4%) compare to share mode (public transport 12%, taxi 6%, auto-rickshaw 3% and other mass transport 3%) of transportation after the end of lockdown period. It is observed approximately 20% of people will switches from shared mode to personal mode for daily commute.

People of income category 50,000-1 lakh ₹ was using two-wheeler (22%), public transport (20%), car (19%), walk (13%), taxi (11%) and auto-rickshaw (10%) for daily commute during the normal situation; whereas, during pre-lockdown period, nearly 13% of people shifted on car, 9% on two-wheeler and 9% on walk from the shared mobility and it is expected that after the end of lockdown period more than 80% of people will use personal mode of transportation.

In normal situation, nearly 43% of people of income category 1 lakh – 1.5 lakh was using car, followed by 17% taxi, 16% public transport, 10% two-wheeler and 6% other mass transport for their daily commute but during the pre-lockdown period, 16% of growth is observed in cars, 10% in walk and 9% in two-wheelers and it is expected that more than 90% of people of this income category will use personal transport with respect of shared mode of transportation.

3.4 Impact on the uses of public transportation

In order to access the impact of covid-19 on public transportation respondent were enquired about frequency and reason of using public transportation during normal situation and frequency of using public transport after the end of lockdown period. During normal situation, more than 75% of the respondents (24% at least once in a day, almost 24% at least once in a week, nearly 26% at least once in a month) were using public transport and remaining 25% of the respondents never used public transport for their commute. Figure 6 demonstrates the primary reason of using public transport during normal situation; approximate 10% of people feels that they didn't have any other option of travelling, around 5% perceive it is convenient, 6% of people are using because of cheaper option, 5% of people are using because they are not able to afford personal vehicle.

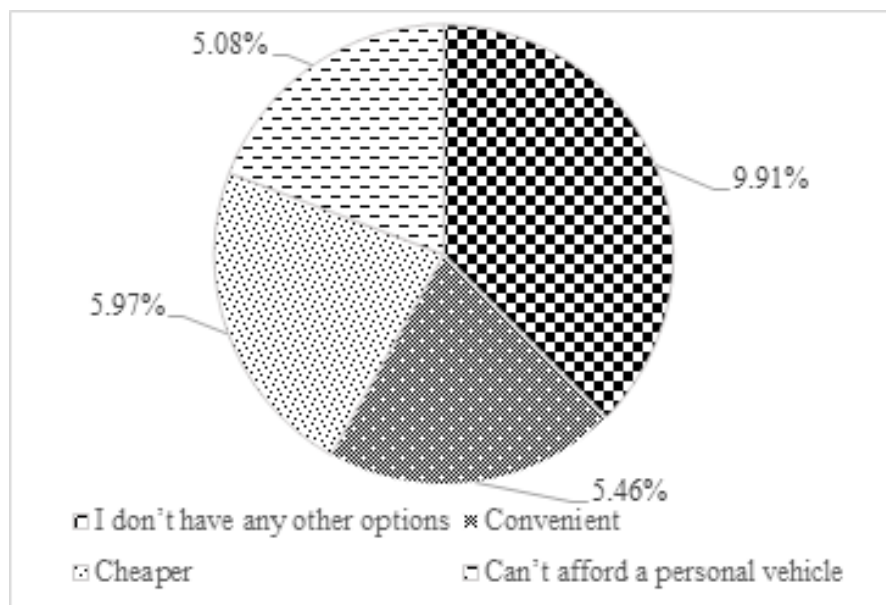


Fig 6. Reason of using public transport during in normal situation

During the pre-lockdown period, only 5% of the respondents were using public transport for their daily commute. The reduction in the uses of public transport was observe during this period because most of the people are in quarantine and avoiding unnecessary travel. After the end of lockdown period it is expected that only 8% of the respondents will resume their travel in public transportation. Those that do not have other options than using public transport might try to avoid crowded buses and trains by travelling during off-peak hours.

In order to understand the perception regarding public transportation during the outbreak of corona, respondents were asked to response their attitudinal behaviour on the statements related to public transportation on five-point Likert scale varying from strongly agree (1) to strongly disagree (5). The results in Table 2 shows that, more than 70% of the respondents are feeling unsafe to travel in public transportation while only 8% of the respondents are feeling safe during this outbreak period. Approximately 50% of the respondents do not agree with the statement that they are satisfied with clean and tidy conditions in the public transport. About 90% of the respondent agrees that public transport uses will increase the performance of virus transmission. Whereas, nearly 65% of the respondent feels that travelling in public transportation has increased their stress and anxiety level during the outbreak of corona. As most of the respondent are with perceived high risk of association with public transport; therefore, it is expected that, after the end of lockdown period (or even when situation is with in control) most of them will prefer personal mode of transport and avoid travelling in share mobility.

Table 2. Perception related to Public Transportation during the outbreak of Corona

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Feeling safe traveling on public transport	96 (3.05)	156 (4.95)	408 (12.96)	648 (20.58)	1840 (50.46)
Satisfied with clean and tidy conditions in public transport	148 (4.70)	472 (14.99)	916 (29.10)	876 (27.83)	736 (23.38)
Public transport will increase the performance of virus Transmission	2128 (67.60)	704 (22.36)	132 (4.20)	92 (2.92)	92 (2.92)
Traveling in public transportation is increased my stress and anxiety level	960 (30.50)	1084 (34.43)	764 (24.27)	188 (5.97)	152 (4.83)

Note: Values in parenthesis shows the percentage of responses in each category

The respondents also enquired about the frequency of travelling in public transportation after the lockdown period (Figure 7). More than 75% of respondent feels that the outbreak of corona will reduce their frequency to travel in public transportation (at least for a month) after the outbreak of corona whereas around 7% of people will travel as before outbreak and nearly 17% of people maybe change their frequency of travel in public transport.

It is highly probable that the covid-19 outbreak will have long-term impact on our travel behaviour and it may lead to decline travel demand of public transportation. The uses and frequency to travel in public transportation may increase if government will increase safety measures (checking every person before boarding) and reduce risk of virus transmission by proper sanitization of common surfaces in public transportation. If there are high number of positive cases in particular area then public transport operator should reduce their services during this pandemic period.

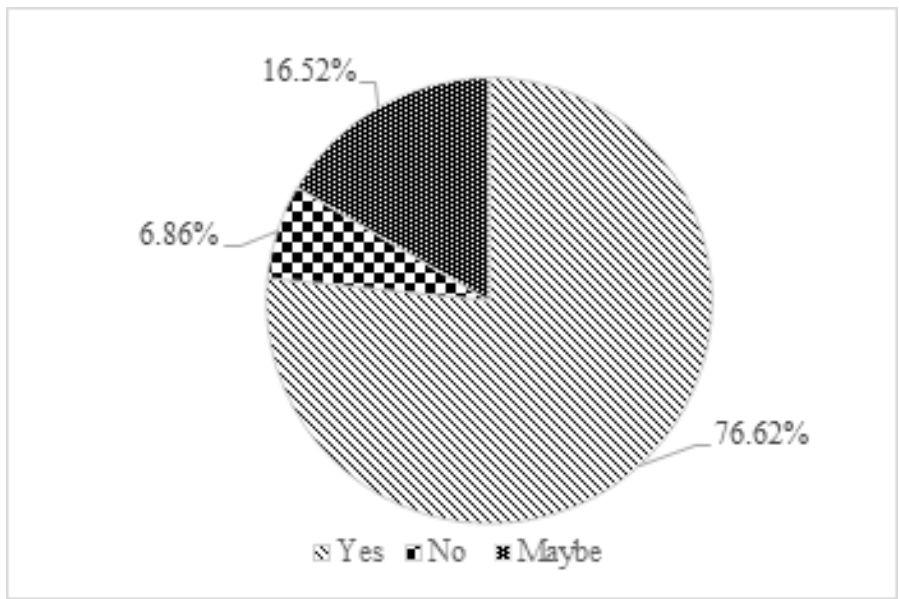


Fig 7. Frequency of using public transportation after the end of lockdown period

3.5 Impact on the frequency of non-mandatory trips

Figure 8 shows that the frequency of non-mandatory (shopping, leisure, movie, sports and social, etc.) travel in a week during normal and pre-lockdown period. Nearly 60% of people avoiding non-mandatory travel and staying inside their home. As expected, the frequency of non-mandatory travel less than 3 times in a week is reduced to half during the pre-lockdown period (70%) compare to the normal situation (35%) and approximately 90% of the trips whose frequency more than 3 times in a week reduced during the pre-lockdown period compare to normal situation.

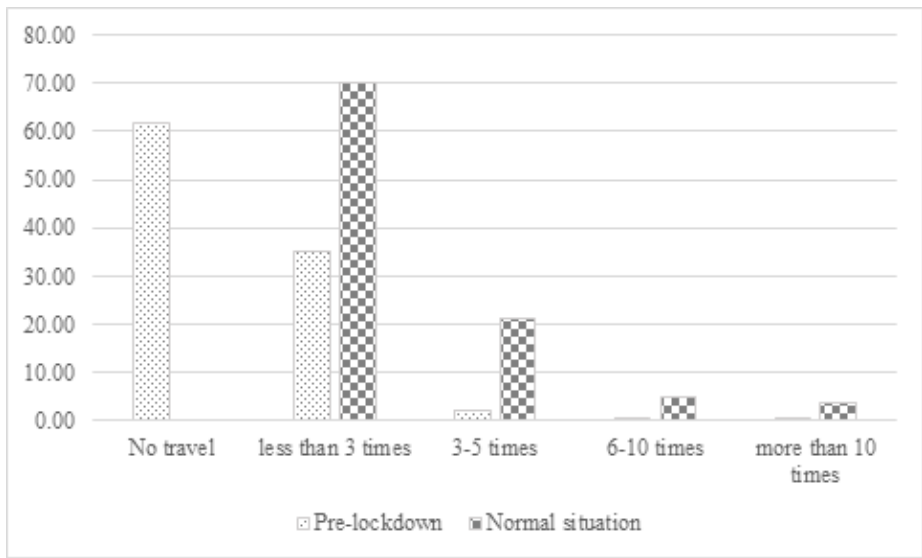


Fig 8. Frequency of non-mandatory travel in a week

The reduction in non-mandatory travel shows that people are avoiding unnecessary travel during this pandemic time because of fearing the risk of infection.

3.6 Impacts on the average trip length:

Figure 9 shows the average daily travel distance (comprising for work, study, shopping, and leisure, etc.) during the normal and pre-lockdown period.

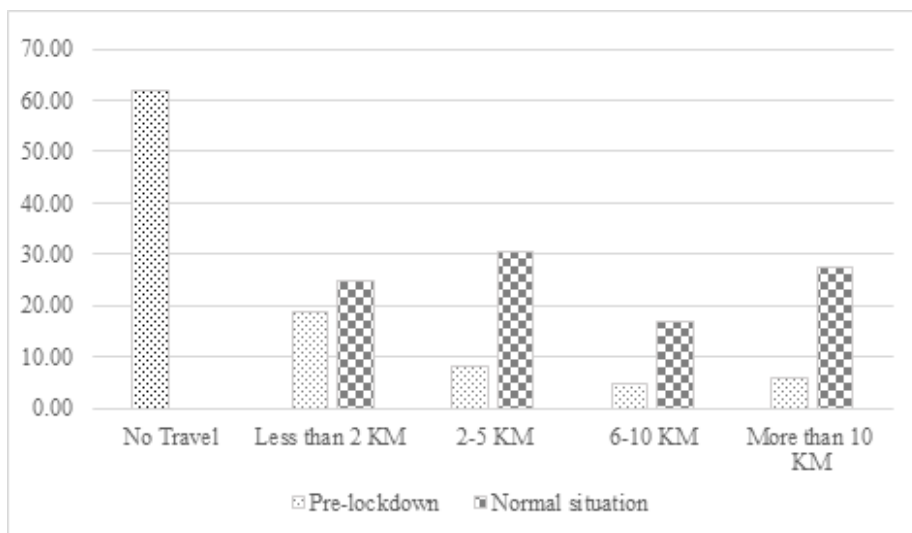


Fig 9. Average commuting distance during the normal and pre-lock down period

Nearly 60% of people are avoiding daily traveling and staying inside the home during the pre-lockdown period. As expected, nearly 62% of trip length is reduced (6% in less than 2 km, 22% in 2-5 km, 12% in 5-10 km and 22% in the trip length more than 10 km) during the pre-lockdown as compare to the normal situation. The reduction in trip length is because of the awareness among people about the coronavirus impact on different parts of the world and those who are going out during pre-lockdown period are only for mandatory purposes.

3.7 Impact on the Future travel Plan

The Covid-19 has not only endangered our health but also affects pre-booked travel plans. Table 3 presents the response of respondent’s about how corona outbreak has affected their travel plans. Nearly 40% of the respondents cancelled their booked travel tickets (23.28 % of train tickets, 11.05% domestic flight tickets and 4.70% International flight tickets) and around 25% of the respondents feel that they are unable to plan their future trips because of the outbreak, whereas nearly 37% of people are travelling only for mandatory purposes like grocery, vegetables etc.

Table 3. Responses about how corona outbreak has affected daily travel

Statement	Count	Percentage
Cancelled train booked tickets	736	23.38%
Cancelled Domestic flight booked tickets	348	11.05%
Cancelled International flight Booked tickets	148	4.70%
Unable to plan future trips	768	24.40%
Travel only for mandatory grocery purchase	1172	37.28%

As the coronavirus continues to spread all around the world, people are cancelling or changing their future travel plans. It is obvious that people will not travel as they travel during the normal situation. To understand the travel behaviour after the lockdown, respondents were enquired about their plan about resuming daily travel as before in normal situation (Figure 10).

More than 25% of people feels that they will resume their daily travel as normal situation after the end of lockdown period, nearly 43% of people reduce their travel frequency and around 31% people may resume their daily travel as before, according to outbreak situation (number of positive cases) in their traveling area.

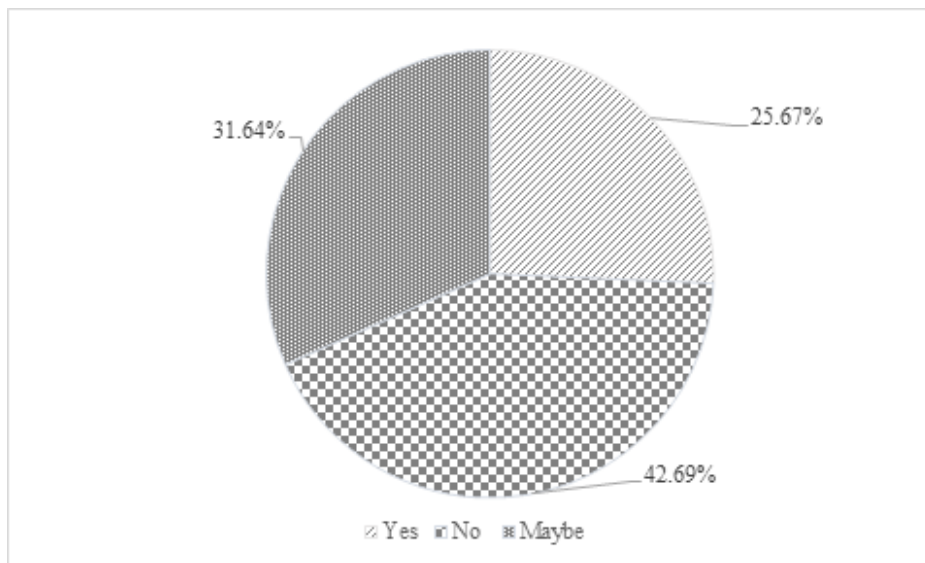


Fig 10. Perception about resuming daily travel as in normal situation after the end of lockdown

3.8 Perception about safest mode of transportation during the outbreak of coronavirus

The respondents were also enquired about the perception about safest mode of transportation during the outbreak, where more than 70% of people feels that car is the safest mode of transportation followed by walk (40%), two-wheeler (33%), bicycle (28%) and very few percentage (3.5%) of people feels that taxi, auto-rickshaw and public transport are safest mode of transportation. It shows that, more than 95% of people are feeling personal transport is the safest (due to lower risk of virus transmission) as compared to public transport, taxi and auto-rickshaw.

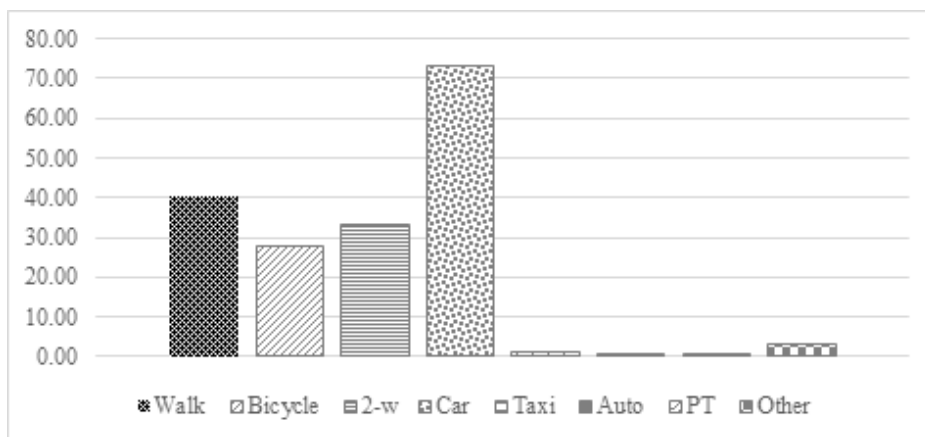


Fig 11. Safest mode of transportation during the outbreak of Corona

4 Respondent perception on policy related questions

Air transportation is a major facilitator of spreading out coronavirus all over the world; whereas domestic air travel and public transportation are the biggest contributor of virus transmission within the country [7]. The countries which were regularly connected (through air travel) with China are mostly affected by the coronavirus [6, 8]. India will resume their domestic and international travel after the lockdown period. After the end of the lockdown period, like other countries (China, Australia, New-Zealand, etc.), India will also resume domestic air travel and public transportation. Now it is very important to understand the peoples’ perception about policies which could be adopted by travel operator during outbreak situation.

Table 4 represents the responses to the questions that are designed to capture the perception towards transport policies after the lockdown period. More than 85% of respondents agree that public transport should be provided with proper sanitisation and diagnosis measures and

every person should be properly checked before boarding. For this, public transport operators should follow proper cleaning routines and increase their focus to disinfect common surfaces and spots in public transportation and stations.

Table 4. Responses to the policy related questions

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Public transport should be provided with proper sanitisation and diagnosis measures and every person should be properly sanitized and check before boarding.	1908 (60.61)	804 (25.54)	252 (8.01)	104 (3.30)	80 (2.54)
At least one medical staff in every public transport station.	1284 (40.79)	980 (31.13)	636 (20.20)	184 (5.84)	64 (2.03)
Limited International transport, with proper checking and sanitization of persons coming from abroad.	1948 (61.88)	732 (23.25)	224 (7.12)	124 (3.94)	120 (3.81)
Quarantine center should also be present at airports, for immediate quarantine.	2204 (70.01)	688(21.86)	160 (5.08)	60 (1.91)	36 (1.14)

Note: Values in parenthesis shows the percentage of responses in each category

Approximately 70% of the respondents agree that every public transportation station have at least one medical staff to check the suspicious affected traveller before boarding in the public transportation. Nearly 80% of the respondents agree that there should be limitation of international travel and proper checking and sanitization of person coming from abroad at the airport. Whereas, 90% of the respondents agree that quarantine centers should be present at the airport for immediate quarantine of suspicious persons.

5 Key findings and policy implications

This study used descriptive research techniques to investigate the impact of coronavirus on travel patterns of Indian people. The outbreak of COVID-19 has a significant impact on the mode choice behaviour. It is observed that during the pre-lockdown period, people are more dependent upon personal mode (walk, bicycle, two-wheeler and car) of transportation and the use of shared mobility have dropped significantly due to a fear of close contact with unknown people. It is expected that, after the end of lockdown period (during the outbreak), people will travel less (significantly reduce the frequency of non-mandatory trips) and try to avoid travelling in public transport, taxi and other mass transport instead of that they can prefer to walk and bicycles for shorter distance commute as they provide a great way to stay healthy and also an efficient way to support social distancing and reduce the load on public transport. Also, this pandemic situation shows us the significance of walk and bicycle (significant growth was observed during pre-lockdown) for less distance commute, hence transport planner and government authorities should plan bicycle and pedestrian network to shift shorter personal vehicle trips into walk and bicycle mode.

Income levels of the people is going to play a significant role in the selection of mode after the end of the lockdown period. It is expected that the low-income category group and those do not have any other option of travel will use public transport for their daily commute. At the same time, public transport operators need to maximize their service so that, they would be able to maintain social distancing inside public transport and in their stations. As most of us perceive public transport as unsafe during this pandemic situation, public transport operator should provide proper sanitization and diagnosis measures and every person should be properly sanitized and checked before boarding. E-ticketing/ automatic system or card swiping will eliminate person to person contact during travel to an extent. If India will resume international travel then it should be in a limited manner with proper checking and sanitization of persons coming from abroad and airport operator should provide quarantine facilities for persons suspected to have coronavirus disease (COVID-19). Further research is needed to understand the long-term effect of coronavirus on travel behaviour.

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