Human Travelling and COVID-19 Pandemic

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ABSTRACT

Objective: To determine whether there is a relationship between the extent of human travel and the number of COVID-19 cases in Thailand.

Materials and Methods: The data set on monthly COVID-19 in Thailand between January and July 2020 were retrieved from the Ministry of Public Health, Thailand. Data regarding people's travel in Thailand during the COVID-19 pandemic and for the same period of 2019 were retrieved from Open Government Data of Thailand. A paired t-test was used to compare the differences between the number of journeys made in each mode of transport in 2019 (January - July) and 2020 (January - July). Pearson's product-moment correlation coefficient was used to examine the relationships among studied variables.

Results: A Paired Samples t-test showed that from January until July 2020, the number of journeys made by public buses, ships, and airplanes declined by more than 50% from the previous year ($p < 0.05$). Pearson correlation coefficients showed that the mean monthly number of COVID-19 cases was significantly and inversely correlated with the number of public bus journeys made ($r = -0.897$, $p < 0.01$), the number of train journeys ($r = -0.834$, $p < 0.05$), ship journeys ($r = -0.890$, $p < 0.01$), and airplane journeys ($r = -0.911$, $p < 0.01$). There was no significant relationship between the number of COVID-19 cases and private car journeys ($r = -0.405$, $p = 0.367$).

Conclusion: During the pandemic, the number of journeys has been decreased. Moreover, the correlation between the number of journeys and COVID-19 cases has been shown in our analysis.

Keywords: Environment, travel, COVID-19, nationwide (Siriraj Med J 2021; 73: 562-569)

INTRODUCTION

The first primary pneumonia cases from an unknown source were identified in Wuhan, Hubie province, China, in December 2019.[1] The symptoms were designated COVID-19[2] caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).[3] The World Health Organization (WHO) has formally proclaimed that COVID-19 is a public health emergency of international concern.[4] By the end of December 2020, COVID-19 had taken around 1.7 million people's lives from all over the world, with about 81 million accumulated verified cases of the disease.[5] On January 13, 2020, Thailand announced the first COVID-19 case after China.[6] This country recently (December 29, 2020)

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had 6,440 confirmed COVID-19 cases with 61 deaths; 4,184 cases have recovered.[5] Simultaneously, various universities, healthcare institutions, and companies from several countries have developed COVID-19 vaccines to prevent this disease.[7]

Previous research has reported a number of general signs and symptoms of COVID-19 infection including, cough, sore throat, high body temperature, diarrhoea, headache, muscle or joint pain, weakness, and loss of sense of smell and taste. The average incubation period is 5-6 days, with the most prolonged incubation period being 14 days.[8-9] Restriction on travel, either international or domestic, has been established in several countries[10] including prevention of travel from high risk areas.[11] This limitation affects ordinary people's lives and those of vulnerable groups, such as those who have pre-existing health problems.[11] However, some experts have stated that there is no justification for measures that unnecessarily interfere with worldwide travel and commerce.[12]

A modelling exercise has suggested that, with original transmissibility (r =1) not reduced, a reduction in the travel of 90% to and from mainland China would only modestly affect the epidemic's trajectory.[13] Nevertheless, it can decrease the transmission of COVID-19 within the community by at least 50 %.[13] Accordingly, in addition to climatic conditions (temperature and humidity) and population density, it seems that people's travel is one factor that affects the spread of COVID-19.[14] However, there is a lack of evidence in Thailand regarding the association between human travelling and the spread of COVID-19. The current research, therefore, aimed to determine the relationship between human travelling and COVID-19 in that country. It is hoped that the results of the current study will contribute to efforts to prevent the spread of COVID-19 both in Thailand and elsewhere.

MATERIALS AND METHODS

Study area and data collection

In this correlational study, the data was obtained in Thailand, a country located in Southeast Asia, with a population of roughly 69 million, whose capital city is Bangkok.[15] The computerised data set on monthly COVID-19 cases in Thailand between January and July 2020 were retrieved from the Ministry of Public Health of Thailand (https://data.go.th/dataset/covid-19-daily).[16] Data regarding people's travel during the COVID-19 pandemic (January – July 2020) and during the same period of the previous year (January – July 2019) were retrieved from Open Government Data of Thailand (https://data.go.th/dataset/psgcovid19),[17] (Data ID: 54d62466-58ef-408c-bded-46f78103d6ae, Contact person: motoc@mot.go.th, License: DGA Open Government License). The right to use the data is subject to the terms and conditions for DGA Open Government License. Since the authors identified and reviewed data from open government data resources and did not involve human participants, therefore, Institutional Review Board approval is exempted.

The data consist of five main categories, and each category consists of different subcategories, as follow:

Category 1: The number of bus journeys made between January - July 2019 and January - July 2020, with four subcategories: 1) using public bus in Bangkok and suburbs, 2) using public bus between Bangkok and provincial cities, 3) using public bus between provinces, and 4) using public bus within a province.

Category 2: The number of private car journeys between January - July 2019 and January - July 2020, with two subcategories: 1) the number of private car journeys on main highways or roads and 2) the number of journeys on the expressway.

Category 3: The number of train journeys made between January - July 2019 and - July 2020, with two subcategories: 1) using the electric train in Bangkok and 2) using the intercity train in provincial towns and cities.

Category 4: The number of journeys made by ship between January - July 2019 and January - July 2020, with two subcategories: 1) using the ship in Bangkok and 2) using a ship in the provinces.

Category 5: The number of airplane journeys between January - July 2019 and January - July 2020 with three subcategories: 1) the number of passengers to and from Suvarnabhumi International Airport (for most long-haul international flights to and from Thailand), 2) the number of passengers to and from Don Mueang International Airport (for some international flights and a high volume of domestic flights), and 3) the number of passengers to and from regional airports.

Data analysis

In this study, the total number of journeys made within each transport category during the seven months January-July in each of the years 2020 to 2019 was averaged to give the mean number of journeys made per month in each mode of transport in each year. These means, along with standard deviations has shown in Table 1. A Paired Samples T-Test was utilised to test the differences between the number of journeys made in each mode of transport in 2019 (January - July) and 2020 (January - July). The value of t, degree of freedom (df), and significant value (p) was reported in Table 2. Furthermore, since data is a continuous level variable, the Pearson's product-

TABLE 1. The total number of journeys made within each category of transport during the seven months (January-July in each of the years 2019 to 2020)

Variables	January 2019 – July 2019		January 2020 – July 2020	
	Mean	SD	Mean	SD
The number of bus journeys made	64,318,906	3,380,337.69	31,245,393	14,054,263.18
The number of private car journeys	78,809,542	5,383,276.17	63,978,446	12,689,774.19
The number of train journeys made	34,863,981	1,708,978.44	23,928,388	12,459,165.70
The number of journeys made by ships	7,818,674	863,470.57	3,738,552	2,784,879.05
The number of airplane journeys	2,978,254	200,765.68	1,385,565	1,191,167.61

TABLE 2. The differences between the number of journeys made in each mode of transport in 2019 (January - July) and 2020 (January - July)

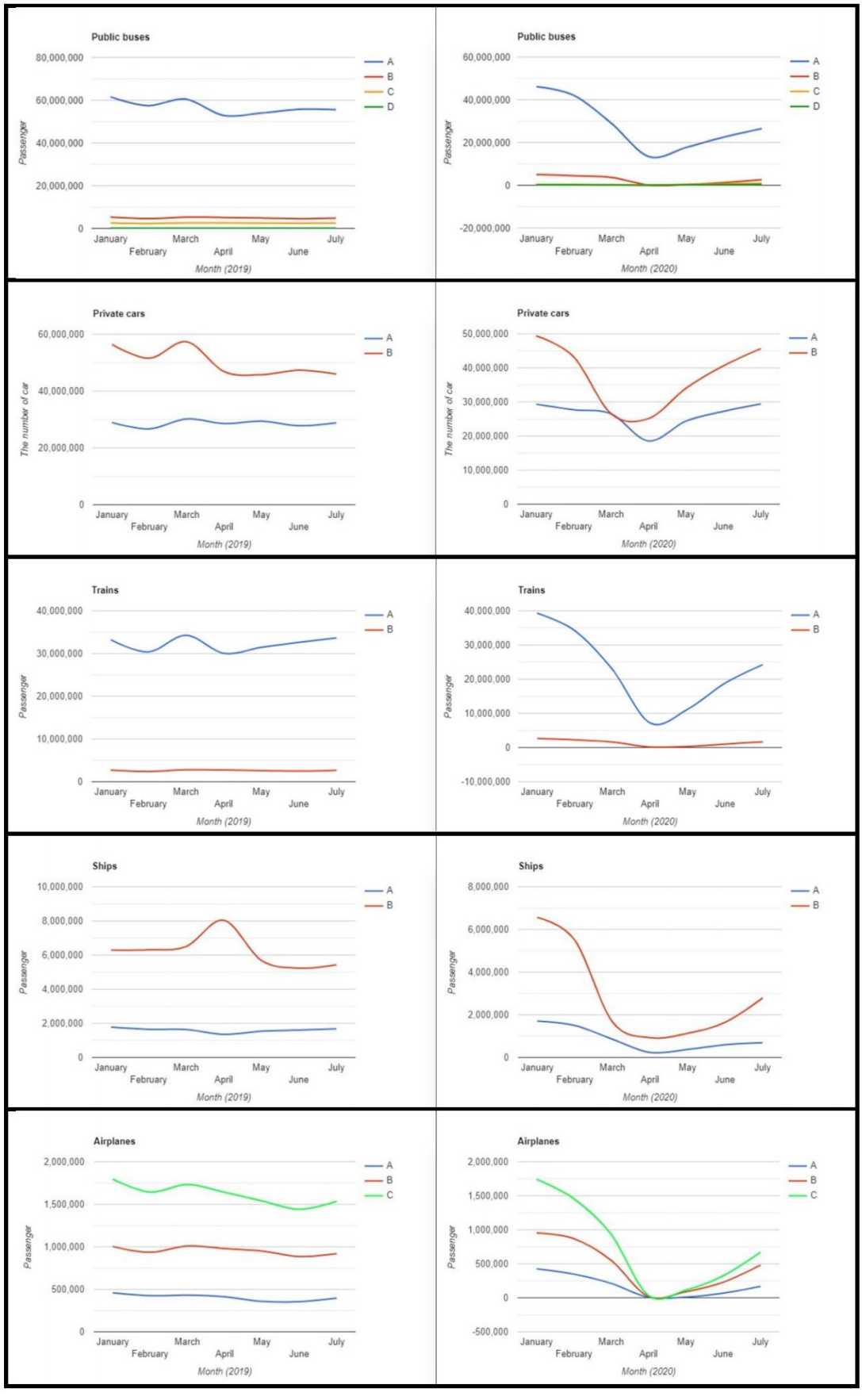
	Paired Differences					t	df	p
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1*	33,073,512.57	11,569,288.88	4,372,780.18	-43,773,320.20	-22,373,704.94	7.563	6	0.000
Pair 2**	14,831,096.14	13,446,020.74	5,082,118.14	-27,266,591.26	-2,395,601.03	2.918	6	0.027
Pair 3***	10,935,593.71	12,027,993.12	4,546,154.08	-22,059,632.02	188,444.59	2.405	6	0.053
Pair 4****	4,080,121.86	2,907,542.92	1,098,947.93	-6,769,150.57	-1,391,093.15	3.713	6	0.010
Pair 5*****	1,592,689.14	1,077,301.40	407,181.65	-2,589,026.76	-596,351.53	3.911	6	0.008

Note. *The number of bus journeys made in 2020 compared to 2019. **The number of private car journeys in 2020 compared to 2019. ***The number of train journeys made in 2020 compared to 2019. ****The number of journeys made by ships in 2020 compared to 2019. *****The number of airplane journeys in 2020 compared to 2019

moment correlation coefficient was used to examine the relationships between the number of journeys by each mode of transport made in the period January – July in 2020 and the monthly number of cases of COVID-19 (Table 3). The author followed Ratnasari and colleagues[18] regarding the correlation report's direction and strength. Statistical analyses were performed using IBM SPSS Statistics V. 20.0.

RESULTS

The number of journeys undertaken in each category (mode of transport) and subcategory (location of travel) in each of the months from January to July in the two years 2019 and 2020 is shown graphically in Fig 1. Overall, it can be seen that there is a pronounced dip for almost all modes of transport in April 2020. This was the month in which the government of Thailand imposed travel restrictions.



(1)

(A) Using public bus in Bangkok and suburbs
(B) Using public bus between Bangkok and provincial cities
(C) Using public bus between provinces
(D) Using public bus within a province

(2)

(A) The number of private car journeys on main highways or roads
(B) The number of journeys on the expressway

(3)

(A) Using the electric train in Bangkok
(B) Using intercity train in provincial towns and cities

(4)

(A) Using the ship in Bangkok
(B) Using a ship in the provinces

(5)

(A) The number of passengers to and from Suvarnabhumi International Airport
(B) The number of passengers to and from Don Mueang International Airport
(C) The number of passengers to and from regional airports

Note. (1) The number of bus journeys made ***(2)*** The number of private car journeys ***(3)*** The number of train journeys made ***(4)*** The number of journeys made by ships ***(5)*** The number of airplane journeys

Fig 1. The comparison between the number of journeys undertaken in each category (mode of transport) and subcategory (location of travel) in each of the months from January to July in the two years 2019 and 2020

Within each category of transport, the data for the subcategories were combined. The total number of journeys made within each category of transport during the 7-month period January-July in each of the years 2020 to 2019 was averaged to give the mean number of journeys made per month in each mode of transport in each year. These means, along with standard deviations, are shown in Table 1. It can be seen that the average monthly number of journeys made in each mode of transport was reduced in 2020 compared with 2019. The reduction is most marked for public transport; private car journeys declined relatively little (19%) in contrast with other modes of transport (over 50% for bus, ships, and airplanes, 31% for trains). In general, then, there was an apparent reduction in travel during the first half of 2020 as compared with 2019, thus indicating that government measures were effective in reducing the number of journeys made.

The data for the corresponding month of each year (e.g., January 2019 and January 2020) can be regarded as paired. Related t-tests were therefore utilised to test the differences between the number of journeys made in each mode of transport in 2019 (January - July) and 2020 (January - July). Table 2 shows the difference between each pair of means and the standard deviation of the difference, along with 95 percent confidence intervals, the value of t, degree of freedom (df), and p-value. Accepting the conventional level of statistical significance as $p < 0.05$, the reduction is significant for all modes except for transport by train, which just misses significance.

Fig 2 presents a comparison between the total number of travellers from all transportation forms from January until July 2020 and the number of COVID-19 cases and death in Thailand. The total number of journeys (summed across subcategories) made in each mode of transport during each month of the period January - July in 2020 is shown in the upper half of this figure, and the lower half shows the total 3,310 cases of COVID-19 and 58 deaths recorded in Thailand during each month of the same period. The result reveals that the number of travellers remains stable at the beginning of January, correspondingly with the number of COVID-19 cases and death. Nonetheless, as the number of travellers starts to decline from the beginning of February 2020, the number of COVID-19 cases drastically spike approximately 2-3 weeks later and continues to increase until July 2020. However, the number of deaths slightly changes along with the graph.

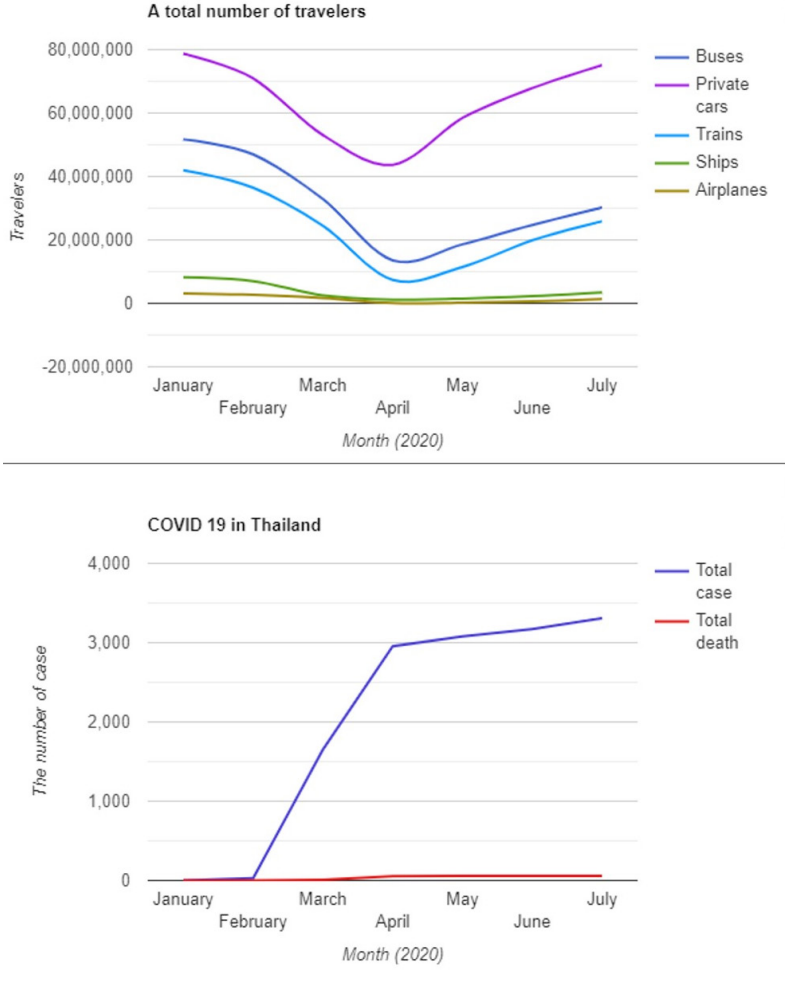


Fig 2. The comparison between the total number of travellers from all transportation forms from January until July 2020 and the number of COVID-19 cases and death in Thailand

To examine the relationships between the number of journeys by each mode of transport made in the period January – July in 2020 and the monthly number of cases of COVID-19, the Pearson correlation coefficient was used. The correlations between the monthly number of cases of COVID-19 and the total number of journeys made in each month by each mode of transport are shown in the correlation matrix of Table 3. It can be seen that there are strong correlations between each of the different modes of public transport, with coefficients almost all above 0.90 and significance levels above $p < 0.001$. The correlations between the number of car journeys and the number of journeys made by ships and the number of car journeys and the number of airplane journeys, however, are lower and generally not significant. Moreover, the mean monthly number of COVID-19 cases was significantly and inversely correlated with the number of public bus journeys made ($r = -0.897$, $p < 0.01$), the number of train journeys ($r = -0.834$, $p < 0.05$), ship journeys ($r = -0.890$, $p < 0.01$), and airplane journeys ($r = -0.911$, $p < 0.01$). In addition, there was no significant relationship between the number of COVID-19 cases and private car journeys ($r = -0.405$, $p = 0.367$).

DISCUSSION

It is suggested that postponing travel and staying home is the best way to protect people from exposure to COVID-19.[19] However, there is a lack of evidence in Thailand regarding the association between human travelling and COVID-19 exposure. Since public transport vehicles are relatively closed settings conducive to the transmission of COVID-19[20-21], several countries have reported that many clusters of cases with infections caused by respiratory viruses, including SARS-CoV-2, took place in public transport vehicles.[20] The Thai government has enforced travel restrictions since March 2020.[6], which more likely to be the main reason for the sharp reduction of the overall use of public transportations.

The fall of private cars' use is possible due to the forced closure of risk transmission areas such as shopping malls, schools, and universities, thus lessen the necessity of being out of the neighbourhood and driving private cars to other places. Moreover, as the awareness of the higher risk of infection via public vehicles as well as the fear of dying of COVID-19 is rising.[6], when people have to travel, they would prefer using private cars over public vehicles, leading to a relatively less reduction of

TABLE 3. The correlations between the monthly number of cases of COVID-19 and the total number of journeys made in each month by each mode of transport in the period January – July in 2020

Variables		(1)	(2)	(3)	(4)	(5)	(6)
The number of	Pearson Correlation	1	0.734	0.991**	0.962**	0.993**	-0.897**
bus journeys made	Sig. (2-tailed)		0.060	0.000	0.001	0.000	0.006
The number of	Pearson Correlation		1	0.800*	0.749	0.673	-0.405
private car journeys	Sig. (2-tailed)			0.031	0.053	0.098	0.367
The number of train	Pearson Correlation			1	0.950**	0.979**	-0.834*
journeys made	Sig. (2-tailed)				0.001	0.000	0.020
The number of	Pearson Correlation				1	0.950**	-0.890**
journeys made by ships	Sig. (2-tailed)					0.001	0.007
The number of	Pearson Correlation					1	-0.911**
airplane journeys	Sig. (2-tailed)						0.004
The monthly number	Pearson Correlation						1
of cases of COVID-19	Sig. (2-tailed)						

Note. **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

the use of private cars in comparison with that of public vehicles.

In respect of why April 2020 is the lowest point of the numbers of all passengers, the most likely reason is that since the number of new cases continued to increase, the Thai government took further action on April 3, including a nationwide curfew from 10 PM to 4 AM, a travel ban for all international flights entering Thailand, suspending intercity public transport, a ban on the sale of alcohol to reduce the risk of social gatherings and so forth[6], resulting prevented people from travelling to a great extent. Besides, the sharp increase of the infected cases in Thailand may lead to a greater degree of fear and caution in public, bringing about reduced travelling.

A substantial proportion of COVID-19 cases are asymptomatic, which may also have high viral loads similar to those in symptomatic patients.[22] An increasing number of reports indicated that SARS-CoV-2 might be transmitted from infected people, but asymptomatic.[23] Furthermore, since the incubation period of COVID-19 is variable and sometimes may take a long time (2-14 days)[20], the virus's transmission may have already begun before people can realise it. Simultaneously, the disease outbreak takes some time, thus explaining the sudden spike in the number of infected cases in February 2020 even after people had stopped travelling. This can possibly contribute to the rising number of infected cases in March 2020 despite of the restrictions and reduced travelling too, since it took time to make a definite diagnosis of the COVID-19, and during this period, the virus may have infected people around the host, resulting in an increase in infection rate.

The growth of the number of COVID-19 cases has been relatively slow since April 2020, on account that the government stepped up its efforts in almost every aspect to battle with COVID-19, such as quarantine, active case detection, physical distancing, and travel restrictions, which are quite efficient in hindering COVID-19 transmission in Thailand.[6] These drastic measures, along with people's increasing notion of how to take appropriate precautions against COVID-19 (e.g., high usage of face masks (93.3%) in Thailand)[24], prevented the rapid rise of the infected cases even when the number of travellers picked up substantially since April 2020.

This study has numerous limitations. Firstly, acknowledging that this is secondary data analysis, the authors are less able to correct the source's errors through data collection. Nevertheless, the authors handled the data from the government organisation with caution. Furthermore, given the retrospective nature of the data, inherent biases to such a study exist. Therefore, a further prospective study investigating the association between human travelling and COVID-19 transmission to develop an efficient procedure in preventing COVID-19 is recommended.

CONCLUSION

During the pandemic of COVID-19 from January until July 2020, the number of journeys made by public buses, ships, and airplanes has been reduced. Furthermore, our correlational analysis showed that the association between the number of public bus journeys made, the number of train journeys, ship journeys, and airplane journeys, and COVID-19 cases exist.

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Conflict of interests

There are no conflicts of interest to declare.

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