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PII: S0264-2751(23)00261-5

DOI: https://doi.org/10.1016/j.cities.2023.104449

Reference: JCIT 104449

To appear in: *Cities*

Received date: 17 November 2022

Revised date: 14 June 2023

Accepted date: 18 June 2023

Please cite this article as: A. Ilgaz and M. Saltan, The impacts of Covid-19 pandemic on the sustainable mobility of university members in Turkey, *Cities* (2023), https://doi.org/10.1016/j.cities.2023.104449

**The Impacts of Covid-19 Pandemic on the Sustainable Mobility of University Members in Turkey**

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# The Impacts of Covid-19 Pandemic on the Sustainable Mobility of University Members in Turkey

**Abstract:**
The global Covid-19 pandemic had a devastating impact on our lives. The pandemic led to sudden and momentous changes in mobility styles and travel habits. Many users started preferring to travel via private vehicles, which is contrary to sustainability policies. Strict measures were implemented against the Covid-19 pandemic in Turkey during this process, as was the case all over the world. Taking into consideration these realities, the aim of the present study was to examine the impacts of the Covid-19 pandemic on the travel modes (public transportation, walking, and bicycle), anxiety and stress perceptions, and working conditions of individuals. A survey was conducted to measure the impacts of the pandemic and the measures taken. The sample of this study consists of people who regularly attended Suleyman Demirel University in Isparta and Akdeniz University in Antalya, Turkey, before the pandemic. An online survey was conducted for the case study during the May-June 2021 semester, and the survey was representative of the study population with a total of 556 participants. The travel time for both different university students decreased during the pandemic period. The percentage of those traveling to the university with their own cars increased to 77% in AU and 66.8% in SDU. The use of public transportation dropped to 6.1% in AU and 11.8% in SDU. 56.97% of AU participants and 51.15% of SDU participants reported that their walking habits decreased. It was reported that 52.73% of the respondents in AU and 55.75% of the respondents in SDU did not change their bicycle usage frequency. 64.24% of AU and 74.42% of SDU reported that their anxiety levels increased during the pandemic period. And for each of these analyses, there was no statistical difference between the two different university students.

**Key Words:** Covid-19 pandemic, mobility, public transport, t-test, ordinal logistic regression

## 1 Introduction

### 1.1 Overall Situation

The new Covid-19 (also known as the coronavirus) pandemic led to global chaos and caused significant changes in our daily routines [1,2]. Covid-19 first emerged in China in December 2019 and the World Health Organization (WHO) declared Covid-19 as a global pandemic on March 11, 2020 [3]. The first case was observed on March 11, 2020 in Turkey with the first Covid-19 related death taking place on March 17, 2020 [4]. On March 9, 2020 Italy became the first European country to implement a national quarantine for reducing the spread rate of Covid-19. National quarantine implementation was adapted by other governments following Italy and China which led to a decrease in mobility to reduce the spreading rate of Covid-19 [5]. This emergency resulted in severe social and economic outcomes in countless sectors including transportation, travel and mobility. Many governments were forced to limit unnecessary mobility to preserve health and control the spreading of the virus in addition to making adaptations on the mobility of the required workers and goods [6].

Following the global pandemic declaration, Turkey took additional measures such as suspending education, limiting or discontinuing intercity and urban transportation, suspending or limiting public transportation, and encouraging working from home or flexible working hours, as was the case in many other countries. The travel quarantine imposed in Wuhan, China, on January 23, 2020, delayed the transmission of the general pandemic by 3 to 5 days, but had no significant international impact, with case importation reduced by about 80% until mid-February. As a result of the transportation study, it was concluded that the limitations reduced the virus's spread rate [7]. The "stay at home" campaign in Turkey aimed to reduce socialization and collective life to slow the spread of Covid-19 [8]. The number of cases increased in April 2021 as a result of new mutated variants and

higher infectiousness rates. To manage the community health and public order risks posed by the virus, as well as to keep the virus's spread rate under control, new measures had to be implemented. Based on the decisions made, a two-week partial quarantine was imposed beginning on Wednesday, April 14, 2021. However, as the number of daily cases increased to a maximum of 61.967 on April 21 [9], new measures were added to the partial quarantine measures, triggering the full quarantine period from April 29 to May 17. During the quarantine period, full lockdown measures were implemented to ensure that production, supply, and logistic chains, as well as health, agriculture, and forestry activities, were not hampered. During this time, food and beverage establishments could only provide delivery services, and intercity travel was prohibited. During this time, remote or alternating working systems were used, with the exception of critical services such as healthcare, security, and emergency, to ensure that services at public establishments could continue [10]. Following these stringent measures, the number of new cases on May 17 was reduced to 10.174 [9].

The Covid-19 pandemic prompted unprecedented measures that significantly altered travel habits in many countries. Many users began to prefer traveling in their own private vehicles, which runs counter to European cities' sustainability policies [11]. A study that looked at the effects of the Covid-19 pandemic on travel modes and travel mode preferences in Pakistan discovered that during the pandemic, the primary purpose of travel shifted from "work and education" to shopping. For distances less than 5 km, a significant mode shift from motorcycle to non-motorised modes of travel was observed. People shifted from public transportation to private cars for longer distances [12,13]. To make transportation plans for the future, it became necessary to gain a deeper understanding of changes in user travel habits, feelings toward the use of public transportation, and perceptions related to using sustainable urban mobility modes. As a result, changes in people's mobility styles, as well as dramatic changes in activity, travel habits, predispositions, and lifestyles, became even more visible [2,14]. As a result, it became critical for transportation authorities to focus on improving perceptions of public transportation during the pandemic in order to attract users in the long run [15]. Public transportation companies have also altered their operations to ensure the safety of their customers. To allow passengers to practice social distancing, agencies implemented backdoor boarding policies and limited vehicle occupancy [16]. During this time, Beliaev et al. (2020) recommended using financial incentives to save public transportation in the long run while taking user preferences into account [15].

All of the aforementioned measures can be categorized as "social distancing," which is a non-pharmaceutical measure against diseases that spread primarily through respiratory droplets and necessitate close proximity [17]. Social distancing or reducing interactions between individuals in order to slow the spread of the virus, became the new norm [2]. Preventive measures such as social distancing imposed by advisory and regulatory institutions, combined with public fear, caused the majority of people to alter their daily routines. To avoid crowds and physical interactions, significant transitions were made from in-store shopping, business meetings, and long-distance trips to online shopping, remote working, and road trips [11]. Social distancing policies have a significant impact on activity participation. Avoiding social contact may result in significant changes in the number of activities that people engage in outside of their homes, as well as the types of activities that people engage in and how they access them. Travel demand is decreasing, resulting in significant reductions in traffic congestion and air pollution in many countries. This also results in less frequent service by public transportation vehicles, with dramatic reductions already observed. However, because social distancing can lead to social isolation and limited physical activity, it can be harmful to one's health. As a result, walking or riding a bike for fun or for benefits may be a good way to maintain a healthy and happy lifestyle [2]. Furthermore, during a pandemic like Covid-19, walking and cycling appear to be the most sustainable and feasible modes of transportation. As a result, planners must adopt an accessibility-based approach during the planning and execution phases, rather than one based on mobility or public transportation. It is also thought that the areas created by reduced traffic during the pandemic could be used for non-motorized modes of transportation [13].

### 1.2 Purpose of the Study

Another important sector that has been affected by Covid-19, which has spread globally in a very short period, is education. Following the first case in Turkey on March 11, 2020, preschools, primary schools, secondary schools, high schools, as well as university and graduate studies, were temporarily suspended, after which a transition from face-to-face learning to remote learning was made in accordance with a decree issued on March 23, 2020 [18,19]. The purpose of this study was to investigate the effects of the Covid-19-related pandemic on the use of sustainable travel modes (that is, public transportation, walking, and bicycles) by university members (academics, employees, and students) during the pre-pandemic/pandemic periods during the remote learning implementation at universities in Turkey, as well as to examine their opinions and identify their stress and anxiety levels. The current study focuses on how and to what extent individuals' mobility styles and customary travel behaviours changed during the pandemic. Participants in the questionnaire designed for this purpose are a sample of people who regularly attended their universities before the pandemic in Turkey's Isparta and Antalya, and who are now working "full-time, remote, or flexible" during the pandemic period due to the shift of universities' education system to a distance education system.

University campuses, for example, are places where a specific group of employees and students come and go on a regular basis. One of our study areas, AU, is a state university in Antalya. Its campus is situated on a large plot of green land. The city where the campus is located has a Mediterranean climate (hot and dry in the summer and mild and rainy in the winter), and it has a surface area of 1,417 km2. On the AU campus, there are over 65,000 students and university employees [20,21,22]. SDU, the second study area, is a state university in Isparta with a sprawling campus. The city's climate is a transitional climate between the Mediterranean Climate and the Continental Climate (cool and rainy in winters and hot and dry in summers), and the city's surface area is 558 km2. On the SDU campus, there are approximately 60,000 students and university employees [23]. These two cities are distinguished by distinct geographical and climatic characteristics. Furthermore, the two cities differ in structure and size. Antalya is a tourist destination, so the density of motorized vehicles is higher. Isparta is a smaller city with a better-organized public transportation system than Antalya. Because of these disparities, the student and faculty profiles at these two universities differ. Transportation distances and modes of transportation differ in these two cities as well. For the first time, this study examined and compared sustainable travel modes, stress and anxiety levels of employees and students in two different cities and university campus areas during the pandemic period.

The remainder of the article is organized as follows: in Section 2, we conduct a review of the fundamental literature on individuals' mobility-travel behaviours during the pandemic. Section 3 includes general explanations of the collected data as well as detailed information on the survey application. Section 4 provides an overview of the participants' characteristics, as well as percentages and analyses of their responses. Following that, we interpret and discuss the findings before finalizing potential future research directions.

## 2 Literature Review

### 2.1. Mobility:

Covid-19 is a contagious respiratory system virus that spreads either directly through contact between people or indirectly through infected surfaces [24,25]. Because the primary source of contamination is the inhalation of droplets from coughs and sneezes [24,26,27], physical distance between infected and non-infected individuals is critical to preventing virus transmission [24,25]. It is unknown whether or not Covid-19 can be transmitted through the respiration of suspended virus as an aerosol (via air). According to recent reports, closed spaces increase the likelihood of Covid-19 contamination [28]. Because the primary global response to slowing the spread of the virus is limiting

people's mobility, such a pandemic will have significant implications for transportation systems. The restriction of mobility reduces the number of passengers in all cities [24,25].

Prior to Covid-19, the primary goal of these plans following the approval and implementation of the Sustainable Urban Mobility Plans around the world was to encourage citizens to change their habits in order to be more active and less reliant on cars for their daily trips [29,30]. Mobility options are linked to travel data and are affected by a variety of factors including "age, gender, family status, life stage, having a driver's license or not and access to a car, accessibility, wages, travel time, comfort, safety, timeliness, reliability, directness, multimodality, sustainability, and so on" [6].

Although Covid-19 is a global crisis, it is also a rapidly evolving event with limited and fruitless scientific proofs in areas such as virus transmission methods and measures to reduce/prevent virus spread [31]. When confronted with a new virus with pandemic potential, community relief strategies generally include ready interventions to slow the virus's spread, with social distancing being one of the most important measures. Public policies related to social distancing include "emergency notifications, prohibitions on meetings with more than a certain number of participants, school closures, workplace restrictions, and stay-at-home orders" [32]. Transportation is one of the sectors that has been hit the hardest by Covid-19, and the implemented travel bans have had a significant impact on people's mobility habits. The current requirement for social distance may alter mobility habits even after the quarantine period has ended [33]. According to Fatmi's (2020) mobility study, the proportion of people participating in activities outside their homes has decreased by more than 50% during Covid-19. While the majority of long-distance trips have been made by private vehicle [34]. A mobility survey conducted in Chile during the Covid-19 pandemic found that the subway (55%), ride hailing (51%), and buses (45%) had the greatest decreases, with a 44% decrease in trips in Santiago. Motorcycle (28%), automobile (34%), and walking (30%), were the modes of transportation that experienced the least decrease. [35]. People's perceptions of the risk of being exposed to the virus are a factor underlying many of the transportation preferences during the pandemic. According to a survey of 1200 people conducted in the Chicago metropolitan area, bicycles and walking are the second and third modes of transportation with the lowest risk of exposure after personal vehicles [1]. Finally, during the pandemic, mobility behavior has become unrecognizable.

The Covid-19 pandemic compelled city administrations to reconsider the relationships between mobility, urban area, and health in order to provide physical separation while meeting urban dwellers' transportation needs. As a result, cities in all four corners of the globe are already contributing to the transformation of mobility through new sustainable transportation models [36].

**2.2. Public transportation.**

The fact that people infected with Covid-19 are contagious before they show any symptoms is concerning, especially if they were exposed to the virus in public places [37,38]. Public transportation is one of the industries most affected by Covid-19 [24]. Prior to the pandemic, Schönfelder and Axhausen (2010) conducted transportation behaviour studies, reporting that transportation behaviours are based on routines and do not change frequently [39]. When the results of a study conducted in Wuhan after Covid-19 [7] are compared with data from 131 countries, it is clear that the change in transportation behaviours occurred in a short period of time [40]. Furthermore, during a pandemic, public transportation can be hazardous because the virus can easily spread among crowds in enclosed spaces such as buses and subways [41]. This has resulted in abrupt changes in public transportation behaviour. Furthermore, it is known that social distancing measures in public transportation and the use of masks reduce the risk of infection with Covid-19 [8,42]. According to data obtained in Sweden, public transportation drivers are among the most dangerous professions in terms of infection [43].

**- Spreading of Covid-19 in public transportation (social distancing, face masks, multiple surfaces-hygiene, sanitation, ventilation, air conditioner)**

During a pandemic, public transportation plays a crucial role and is viewed by some as an ideal environment for the spread of Covid-19. Multiple surfaces (doors, chairs, etc.) increase the likelihood of the spread of Covid-19 [24,31] due to the lack of physical space in public transportation stations and vehicles, which causes people to be confined in tight quarters. It has been observed that the Covid-19 virus remains infectious on various surfaces for hours and days. Therefore, frequent cleaning of the most frequently encountered surfaces in public transportation vehicles can be considered a precaution [31]. Internal cleaning and sanitation of public transportation vehicles is one of the measures suggested by authorities [44] based on epidemiological studies.

Current research indicates that maintaining a social distance from others as a precaution works in outdoor environments with short exposure times, but is insufficient for enclosed spaces, and that the virus can infect a noninfected person even from a great distance [31]. A single asymptomatic infected individual without a mask in the Chinese province of Ningbo infected 22 passengers with the Covid-19 virus over the course of two 50-minute bus rides with 67 passengers. Except for the passenger sitting next to the Covid-19 patient, none of the other passengers seated near the bus windows were infected. In addition, neither the bus driver nor the passengers seated near the bus door were infected, and only one passenger seated next to a window was infected [28]. Current studies acknowledge that the duration of exposure to the virus during long-distance versus short-distance travel is associated with the probability of the virus's spread [45,46], but it is still unclear precisely how the probability of spread increases. In conclusion, the number of infected individuals can be reduced using face masks, the implementation of social distancing, and the cleaning of the environment in public transportation [31].

It is still unknown whether the use of air conditioners will result in the longer-distance spread of the Covid-19 virus [47]. According to findings from related studies, ventilation plays a crucial role in preventing the spread of the virus in enclosed spaces. As a preventative measure, it is suggested that air-conditioned public transportation vehicles be frequently ventilated [48]. It is important to emphasize that substantial evidence for the spread of Covid-19 in public transportation under different rules of use and operation (such as through the implementation of Covid-19 preventive strategies) is lacking and that new ways of understanding are expected to be gained in the coming months [31].

**- Financial dimension**

Examining the financial aspect of public transportation reveals that people have abandoned public transportation since the Covid-19 pandemic, but that higher-income individuals have abandoned public transportation in greater numbers. According to the findings of a survey conducted in March 2020 in Santiago, while public transportation usage decreased by 30 to 40 percent among individuals from households with the lowest income, public transportation usage decreased by more than 70 percent among households with the highest income. It has been reported that the majority of people who abandoned public transportation are telecommuters and online shoppers [49]. The negative impact on the financial conditions of transportation service providers, which is largely dependent on the latest duration of the Covid-19 crisis [31] is the greatest issue that may arise because of the reduced demand for public transportation and the subsequent financial pressure.

During the pandemic, the top priority for public transportation agencies was to restore service levels to levels comparable to those prior to the outbreak. In a March report published in the United States, it was estimated that public transportation agencies would incur annual losses of nearly $ 38 billion due to the loss of fare revenue and additional costs associated with the coronavirus. Therefore, researchers and specialists emphasized that financial incentives for agencies could play a significant role in the revitalization of public transportation services. Consequently, as required by the Covid-19

Relief and Economic Security Act, a cash flow of $25 billion was provided to public transportation systems in order to finance operations, compensate for revenue loss, and preserve jobs [50].

**-Public transportation passenger behaviours**

During the Covid-19 pandemic, two online surveys with 1,000 participants in South Korea revealed that 75.4% and 88.7% of users avoid public transportation [51]. Analysis of the effects of Covid-19 on the daily number of public transportation passengers conducted in the spring of 2020 in the three most densely populated regions of Sweden (based on card identities and ticket verification data) indicated a decline in the number of passengers. In addition, while passengers began to favor single tickets and travel funds over Traveller's monthly periodic tickets, the use of short-term tickets, which were primarily used by tourists, became virtually non-existent [43]. In ten U.S. states, the effects of the pandemic on passengers of public transportation were studied, revealing that the number of passengers was reduced by 62 to 87% in April 2020 compared to April 2019 [24]. In addition, many individuals continued to rely on public transportation because they had no other options [52]. In many Italian cities, micromobility and public transportation decreased by 70-90%. The continuation of public transportation services in urban areas was necessary to ensure the accessibility of all social classes [53].

**-Agency measure**

During the Covid-19 pandemic, it is crucial to maintain a minimum passenger-to-passenger distance of 1.5 meters in public transportation, which corresponds to an over 80% reduction in capacity [54]. Diverse suggestions have been made by authorities regarding the use of public transportation as a response to the Covid-19 pandemic. Particularly in the United Kingdom, the Netherlands, and the United States, clear recommendations have been made, such as "you should consider other modes of transportation before using public transportation" [31]. Beginning with the Covid-19 period, there has been a decline in the number of public transportation vehicles, likely due to both governmental restrictions and passenger preferences [43]. In order to reduce the number of passengers with mobility restrictions, a number of public transportation agencies have preserved their primary routes and shut down their secondary routes. As an illustration, the Washington Metropolitan Area Transit Authority (WMATA) closed 19 of 91 subway stations and reduced train service to three or four per hour [24]. The number of passengers in cities in North America decreased by more than 90 percent by the end of March 2020 due to government quarantine policies [51]. Australia and New South Wales reduced the capacity of standard 12-meter-long buses and rail cars to 12 and 32 passengers, respectively, in May 2020 [55]. In a few Chinese cities, the bus capacity was reduced to just 50% [56]. In order to reduce public health risks, the public transportation sector is currently focused on adhering to physical distance requirements, vehicle and station cleaning, and government regulations [31].

**2.3. Cycling and walking:**

Cycling is a simple way to incorporate physical activity into one's daily routine. It is also a way to reduce operational costs while avoiding traffic congestion, so long as commute times are not excessively long. Prior to the Covid-19 pandemic, there was in fact a favourable trend toward cycling [57,58]. Because of this, authorities from all over the world have adopted policies that aim to expand shared micro-mobility services while prohibiting the use of private vehicles on intercity travel corridors and enhancing bicycle infrastructure [59]. Even before the Covid-19 pandemic, bicycle use and bicycle sharing services had increased in numerous urbanized areas, thereby transforming the

nature of urban mobility. Obviously, bicycle use and sharing influence public transportation and the use of private vehicles, as well as the existing infrastructure and socioeconomic outlook. During the pandemic, bicycles are viewed by many cities as a solution that is healthy, environmentally friendly, and socially acceptable. Milano, the epicentre of the pandemic in Italy, is currently contemplating the redesign of a 35-kilometer-long street to make it more bicycle-friendly with speed limits of 30 kilometers per hour and wide bicycle lanes; many other cities are also contemplating similar approaches [33]. Considering the current situation in the United States of America, the demand for the bicycle sharing program in New York has increased by 67%. In 2019, 310.132 bicycles were utilized; by 2020, this number has increased to 517.780. Similarly, the number of bicycle sharing program trips in Chicago doubled between 2019 and 2020 [60]. According to a survey conducted in Germany during the first Covid-19-related lockdown in the spring of 2020, the pandemic has had minimal effects on bicycle purchase decisions. Approximately 5% of survey respondents indicated they intend to purchase a bicycle or an e-bike in response to the Covid-19 pandemic [61]. In accordance with the findings of a survey conducted by Amsterdam University in 2020 with 1,014 participants, 55% of those who drive do not miss going to work, whereas 91% of those who ride bicycles do [62].

A survey conducted in Spain with 3800 participants during the period of restrictions revealed a 16.8% and 58.2% decrease in walking during the pandemic, with men reducing their walking time significantly more than women [11]. Using the defined and individual data of Argus (Azumio), a smartphone APP (application) for healthcare, between January 19, 2020 and June 1, 2020, a study was conducted examining the changes in the number of steps taken before and after the declaration of Covid-19 as a global pandemic. During the study period, a total of 19,144.639 steps per day were recorded for 455.404 single users from 187 countries. While the average number of steps decreased by 5.5% in the 10 days following the declaration of the pandemic, the average number of steps decreased by 27.3% in the 30 days following [63]. The walking models of 1.62 million anonymous users from 10 metropolitan regions in the United States were determined by analyzing the mobility data collected from their mobile devices. The data range from mid-February 2020 (prior to the lockdown) to the end of June 2020 (when the lockdown measures were eased). Seventy percent fewer walks were taken, and the average walking distance was reduced by fifty percent in all metropolitan areas. Even though it was approximately 18% below its pre-pandemic value, walking continued to increase steadily beginning in mid-April 2020, when certain commercial activities resumed [64].

Regular walking or cycling reduces the risk of chronic diseases like coronary artery disease, stroke, cancer, obesity, and type 2 diabetes. A study using survey data from sixty-six university students in China during the most intense phase of the Covid-19 pandemic revealed that physical activity decreased negative emotions during the pandemic, a finding that has far-reaching effects beyond physical health [65]. However, according to information gathered from locations with lockdowns during the pandemic, walking and cycling are either prohibited or strongly discouraged. In an open, signed letter to the government of the United Kingdom, it was stated that walking and cycling are socially adaptable with social distance [44]. Outdoor areas with public access, such as parks, walkways, and bicycle routes, are among the numerous low-risk areas that can be easily accessed by individuals during the "Stay at Home" restrictions during the Covidian-19 pandemic [66]. Walking and cycling may benefit from the acceleration during the Covid-19 crisis if it is accompanied by the intelligent and courageous reallocation of such spaces (new bike/walkways) [6,67]. During the early days of the pandemic, there were significant discussions regarding the redesign of sidewalks and pedestrian crossings in response to the recommendations for social distance [68]. Boston, London, Portland, and Vancouver began to restructure to accommodate a larger number of cyclists and pedestrians [69,70].

### 2.4. Working from Home and Flexible Working Time:

Community reduction activities, also known as nonpharmaceutical interventions, are among the measures that individuals and communities can implement to slow the spread of infectious diseases

like Covid-19. The transition of individuals to work from home or a flexible work schedule is one of the reduction strategies [32]. Prior to the pandemic, it was determined that working from home and flexible working time policies have the potential to reduce traffic congestion and vehicle emissions, particularly during the busiest hours of the day, and that public transportation occupancy rates have also decreased [71,72]. As a result of the measures taken by numerous nations in the fight against the Covid-19 pandemic [62], the mobility of millions of people was restricted in a manner that had never been seen before. Due to the sudden onset of the pandemic, companies were forced to make this transition almost overnight [62,73], contrary to the unrealized predictions that have been made for years regarding the transition to working from home. According to data from various nations, including the United States [74] and Canada [75], working from home during the pandemic is predominantly a perk of high-income jobs. A mobility survey conducted in Chile during the pandemic revealed that while 77% of low-income workers were required to leave their homes and go to work, 80% of high-income employees were able to work from home [35].

A survey conducted in the Chicago metropolitan area with the participation of 1200 individuals revealed that while 71% of participants had no experience working from home prior to the pandemic, 37% have stated that they do not [1]. A survey conducted by Amsterdam University in 2020 with 1,014 participants included individuals who have been working from home since the outbreak of the pandemic. 72% of those who never miss a trip expressed a desire to work more from home in the future, while 69% of those who miss going to work expressed a desire to return to their previous work routines [62]. Elldér (2020) demonstrated that individuals who work remotely during the pandemic make significantly fewer and shorter trips and are more likely to drive a car than those who do not work remotely. In addition, those who work part-time from home tend to travel more frequently than those who work full-time [76].

In Turkey, a survey was conducted to determine the perspectives of graduate students enrolled in distance education during the pandemic. Students reported that during the Covid-19 era, processes such as physical preparation and intercity/urban travel were eliminated. They have indicated that they are able to spend time during the pandemic without spending a significant amount of time traveling to and from class and without incurring significant financial costs [77].

### 2.5 Private Vehicle Use and Vehicle Sharing

While the pandemic reduced the daily number of trips and mobility as measured by shorter distances per trip, it initially reduced passenger car traffic by 60 percent. Following the gradual easing of mobility restrictions, the proportion of total trips and total distance covered by private automobiles increased [61,78,79].

Prior to the Covid-19 pandemic, carpooling with co-workers was a more comfortable alternative to bus or bicycle travel than taking the bus or riding a bicycle. This opportunity also presented itself through carpooling and car club programs, resulting in reduced trip and fuel costs for those sharing a vehicle as opposed to driving separate vehicles [80]. During the pandemic, those who utilize road transportation realized that these options are unsafe due to the possibility of virus contamination [52,81]. Such actions may increase demand for private vehicles. Consequently, ride hailing, carpooling, and other applications that are part of the "shared economy" are anticipated to face significant workability issues during the quarantine period due to revenue loss and decreased demand [82].

In the spring of 2020, a survey was conducted in Germany to examine the effects of the initial quarantine on mobility and travel habits. Despite a decline in demand for travel during the quarantine period, the proportion of individuals who drove a car remained constant at a high level. Prior to lockdown, 53% of participants utilized a private vehicle, but this proportion increased to 66% during the most stringent quarantine measures. Moreover, survey results identified automobiles as a significant "wellbeing" factor, and the proportion of respondents who rated automobiles as more

suitable than before the pandemic increased. 33% of non-car owners yearned for a vehicle during the quarantine period, and 6% even considered purchasing one [61].

Prior to the onset of the Covid-19 crisis, Santiago buses carried an average of 28 to 65 passengers, but the average occupancy rate of the vehicles ranged from 1.4 to 1.5 people/veh [83]. When a passenger car equivalent (PCE) of two to three cars per bus is considered, it is estimated that car users occupied 10 to 15 times more road space than bus users. Even though the average bus occupancy rate can be reduced significantly, it is still a more efficient mode than driving a private vehicle in terms of road space utilization. Taking these findings into account, congestion may increase during non-quarantine periods as passengers switch from public transportation to private vehicles. As congestion worsens, operational measures to support public transportation will be more important than ever [31].

## 3. Method

### 3.1. Data collection: Survey Application

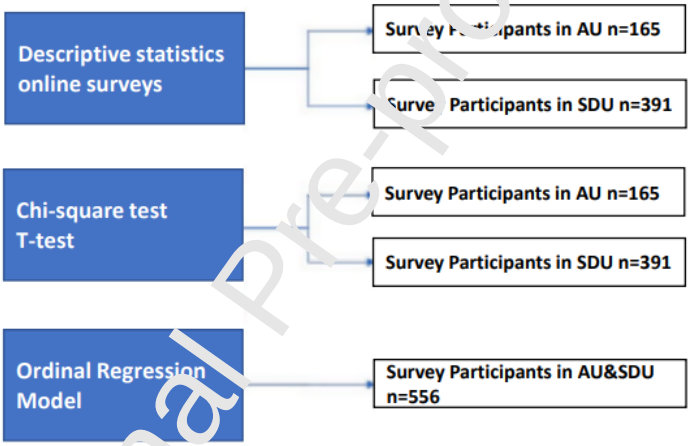
In the present study, we designed a travel behaviour survey that focuses on the dynamics of daily travel behaviours prior to and during the Covid-19 period, as well as the numerous aspects of individuals' long-term travel behaviours, attitudes, and preferences. In addition to focusing on walking and riding a bicycle, the survey also inquired about the perceived concerns and stresses of individuals during the Covid-19 pandemic. During the development of the questionnaire, the study group was comprised of individuals working "full-time, remotely, or flexibly" as a result of the transition of universities in Turkey to a distance education system during the Covid-19 pandemic. The study's sample group was selected using a method of convenience sampling. Convenience sampling is typically employed when the researcher is unable to use other sampling techniques, as well as when other sampling techniques are impractical [84]. The survey was conducted at two universities in Turkey, Suleyman Demirel University (SDU) in the province of Isparta and Akdeniz University (AU) in the province of Antalya, with participants representing "academics, administrative personnel, and students." Because face-to-face interviews were not possible during the pandemic, surveys created with Google forms were distributed to all members of both universities with an e-signed over script from the electronic document management system of Suleyman Demirel University administration. In addition, surveys were mailed to every member of the university. The data collection process occurred between May 3, 2021 and July 14, 2021. The study group consisted of 556 individuals (number of valid surveys). The online survey was divided into six sections and comprised a total of twenty-two questions.

•Section 1: Socio-demographic data; “age groups, gender, last graduation, current university, duty at the university, city of residence, healthcare personnel/or not, driver’s license/or not, having a car/or not, distance from place of residence to the job”.
•Section 2: Travel data before and during the pandemic; “Means of commuting to work before/during the Covid-19 pandemic and weekly trip times”
•Section 3: Mobility habits data; “habits of riding a bicycle and walking during the pandemic”
•Section 4: Public transportation habits data before and during the pandemic: frequency of using public transportation vehicles before/during the pandemic, reasons for not preferring public transportation vehicles before the pandemic, reasons if a decrease has taken place in public transportation use during the pandemic or if you have abandoned it completely”
•Section 5: Data on the state of anxiety and stress during the pandemic: “anxiety level/stress level”
•Section 6: Work related data: “means of working during the pandemic, perspectives on the necessity of remote working”

### 3.2. Data Assessment and Analysis

For the statistical analysis of the acquired data, SAS 9.4 was used. The descriptive statistics for the quantitative variables of the study determined through measurement were the mean and standard deviation, whereas the descriptive statistics for the qualitative variables determined through counting were the number and percentage. The Shapiro-Wilk test was used to determine the data's compliance with the normal distribution before assessing the skewness coefficients. As a result of the tests, it was determined that the data have a normal distribution, and parametric tests were utilized for statistical analysis. The independent samples t-test was utilized to compare two-category variables. Chi-square analysis was performed to demonstrate the relationship between qualitative variables. In the final section, the "Ordinal Logistic Regression" method was used for questions in which the dependent variable was observed to determine whether the variables have an impact or not, and those variables without an impact were eliminated after significant variables for these dependent variables were identified. Throughout the study, a level of significance of 0.05 was considered. Figure 1 depicts the data collection and analysis methodology utilized to achieve the study's objectives.

Figure 1 Sources of Data And Types Of Analyses Used




## 4. Results

### 4.1. Characteristics and percentages of survey participants

Based on the demographic information (Section 1), 38.13 percent of survey respondents were female, and 61.87 percent were male. 29.9% of the participants were aged 18-30, 50.5% were aged 31-45, and 23.1% were aged 46-60. There were 10 participants (1.8%) over the age of 60. Examining the participants' levels of education revealed that 17.45% had completed high school, 31.11 % had graduated from college, and 51.44 % had completed graduate school. 40.29 percent of respondents were academic staff, 40.65 percent were administrative staff, and 19.06 percent were students. Due to the nature of their duties, 8.63% of these individuals were healthcare workers who could not be forced to stay at home. 91.37% of the participants held a valid driver's license, and 70.32% owned a vehicle they can operate. Only the average value was calculated for the distance between their homes and workplaces, as it may vary depending on where each individual resides (mean value: 14.43).

The travel data indicate (Section 2) that while the average weekly trip time of survey participants was 9.30 hours prior to the pandemic, it decreased to 5.11 hours during the pandemic. When asked how they commuted to work prior to the Covid-19 period, 64.2% of participants preferred their own vehicles, 22.7% preferred public transportation, 5.2% preferred walking, and 3.1% used shuttle buses. During the Covid-19 period, 69.8 percent of participants preferred their own vehicles, an increase of 5.6 percent compared to the period preceding the pandemic. While the result for public transportation was 10.1%, 12.6% of respondents preferred public transportation during the pandemic.

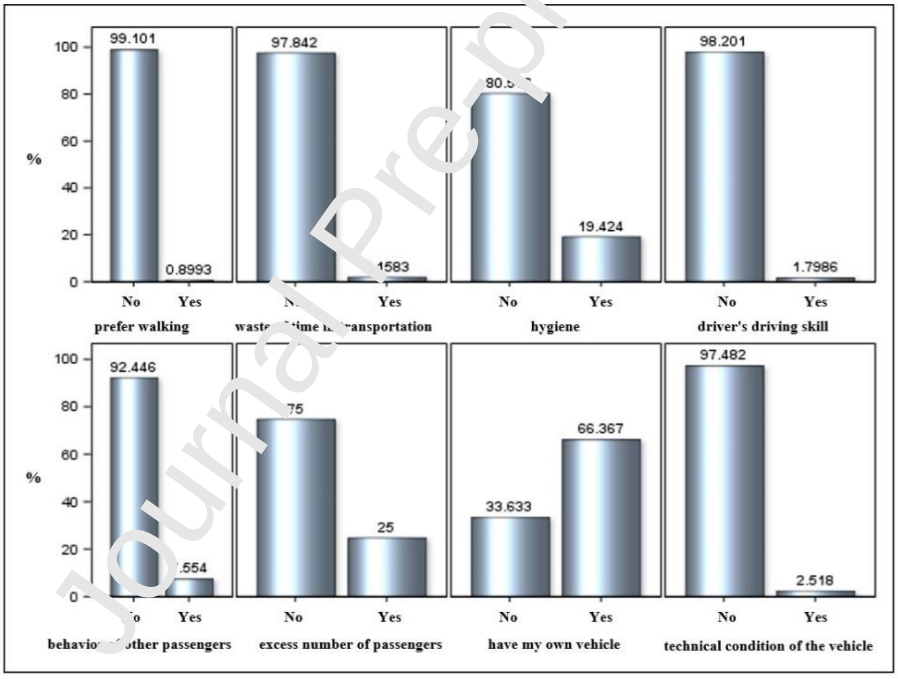
5.6% of participants prefer to walk to work, while 4.1% who work from home do not use any form of transportation.

Based on the mobility habits data (Section 3), 20.68 percent of participants reported an increase in walking during the pandemic, while 52.88 percent reported a decrease. 36.15% of participants reported that their bicycling ratios decreased during the pandemic, while 54.86 % reported that these activities did not change.

Based on the public transportation data (Section 4), 23.21 percent of those who participated in the survey prior to the pandemic stated that they use public transportation daily, while 13.85 percent stated that they use it several times per week. Only 7.74% of passengers used public transportation less frequently, while 55.2% did not use it at all.

Participants were asked "What were the reasons for preferring public transportation vehicles prior to Covid-19?" Graph 1 displays the factors that influence the reasons why participants do not prefer public transportation based on feelings of comfort and safety. According to Graph 1, 66.37 percent of respondents indicated that owning a vehicle was the primary reason for not preferring public transportation. In addition to cleanliness, the number of other passengers in the vehicle is also an important consideration.

Graph 1. Reasons for not preferring public transportation vehicles prior to Covid-19 (%)

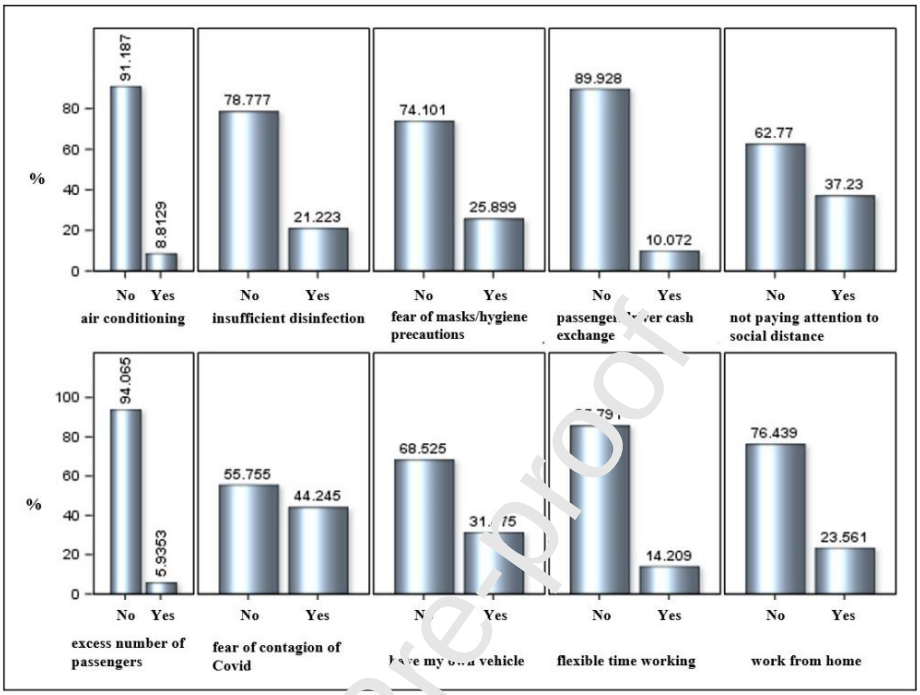



During the pandemic, 7.74% of survey respondents reported using public transportation daily, representing a decrease of 15.47%. 11.87% of the population utilized public transportation multiple times per week, whereas only 3.24 % did so less frequently. 76.44% did not use public transportation at all, indicating a decrease of 21.22% in the use of public transportation vehicles.

Participants in the survey were asked, "Did your use of public transportation decrease during the pandemic, and if so, why?" The factors influencing the participants' sense of comfort and safety are presented in Graph 2 below. According to Graph 2, the most common response (44.24%) among those who limit their use of public transportation was highlighting the Covid-19 infection risks. In addition, 37.23 percent of participants reported that there are no social distance rules in public transportation vehicles. 31.47 percent of those who said they benefit from public transportation indicated that they switched to private vehicles. In addition, 24.90% of respondents emphasize the significance of considering masks and hygiene measures in public transportation. For 23.56 percent of the participants, their limited mobility in public transportation was a result of fulfilling their

responsibilities by working from home, while 21.22 percent cited their fear of inadequate disinfection in the vehicles.

Graph 2. Decrease if any in public transportation vehicle use during the Covid-19 period and its reasons (%)




71.4 percent of participants reported an increase in anxiety during the pandemic, while 25.90 percent reported no change. The stress levels increased by 70.86%, while 26.80% of the participants did not experience any change (Section 5)

Based on employment data (Section 6), 33.45% of participants maintained full-time employment during the Covid-19 period, while 32.91 % reported working from home. While 33.63 percent of respondents said they only work flexibly on certain days of the week. Participants were asked, "Do you agree with the suggestion of continuing remote working procedures during the Covid-19 period to reduce daily trip requirements and maintain isolation?" The following response ratios were obtained: 36.33 percent agreed, 27.88 percent strongly agreed, 15.83 percent were neutral, 12.77 percent disagreed, and 7.17 percent strongly disagreed. Considering these findings, the majority of respondents believe that remote work is essential during the pandemic.

### 4.2. Paired Comparisons for the Responses of Participants from 2 Different Universities (variables with two categories)

Cross analyses and t-tests were conducted as part of Pearson's chi-square test to compare the responses of participants from two universities regarding the Covid-19 pandemic. The first variable was "demographic characteristics," and the second was "university." Table 1 displays the chi-square and t-test P values. The differences between "graduation, duties at the university, and age averages" were found to be statistically significant, whereas no statistically significant differences were found between "gender, healthcare personnel or not, having a driver's license or not, having a private vehicle or not, and distance of residence from the workplace" among the participants from these two universities.

Table 1. Chi-square and t-tests for "Demographic characteristics" and the "university" variables

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Chi-square test** | | | |
| **Gender** | | | |
| Male | 104 (063.03%) | 240 (061.38%) | 0.71 |
| Female | 061 (036.97%) | 151 (038.62%) | |
| **Last Graduation** | | | |
| Doctorate | 035 (021.21%) | 116 (029.67%) | <0.001*** |
| Undergraduate | 048 (029.09%) | 072 (018.41%) | |
| High School | 019 (011.52%) | 078 (019.95%) | |
| Graduate | 031 (018.79%) | 104 (026.60%) | |
| College | 032 (019.39%) | 021 (005.37%) | |
| **Duty at the university** | | | |
| Academic | 050 (030.30%) | 174 (044.50%) | <0.001*** |
| Administrative | 103 (062.42%) | 123 (031.46%) | |
| Student | 012 (007.27%) | 094 (024.04%) | |
| **Healthcare employee or not** | | | |
| Yes | 015 (009.09%) | 033 (008.44%) | 0.80 |
| No | 150 (090.91%) | 358 (091.56%) | |
| **Has a driver's license or not** | | | |
| Yes | 156 (094.55%) | 352 (090.03%) | 0.08 |
| No | 009 (005.45%) | 039 (009.97%) | |
| **Has a vehicle or not** | | | |
| Yes, but I do not drive | 008 (004.85%) | 027 (006.91%) | 0.08 |
| Yes, I drive | 127 (076.97%) | 264 (067.52%) | |
| No | 030 (018.18%) | 100 (025.58%) | |
| **t-test** | | | |
| **Age** | | | |
| Mean (SD) | 42.36 (9.84) | 37.03 (10.24) | <0.001*** |
| **Distance of residence to the workplace** | | | |
| Mean (SD) | 12.35 (17.57) | 15.30 (36.63) | 0.20 |

***Note:***

* *P value less than 0.05*

** *P value less than 0.01*

*** *P value less than 0.001*

Cross analyses and t-tests were conducted in this section as part of Pearson's chi-square test to compare the trip data of the participants. Before and during the Covid-19 pandemic, Table 2 displays the weekly trip times for AU and SDU participants. The p values indicate that there are no statistically significant differences between AU and SDU travel times before and during the pandemic. Moreover, there was a decline in the average weekly travel time between the two universities' employees. In addition, the table displays the chi-square test for the responses of AU and SDU participants to the question "how they commute to work" before/during Covid-19. Before the pandemic, 72.7% of AU employees and 60.6% of SDU employees indicated that they commuted to work using their own vehicles, and the proportion of participants who commute using their own vehicles was greater than that of the others. Similarly, 15.2% of AU employees and 25.8% of SDU employees indicated that they commute to work using public transportation. The P values indicate that there were no statistically significant differences between the mean commuting distances of employees from two different universities prior to the pandemic. While the percentage of employees from both universities who drive their own vehicles to work has increased slightly (reaching 77% for AU and 66.8% for SDU), the percentage of those who use public transportation has decreased since the pre-pandemic period (falling to 6.1% for AU and 11.9% for SDU). When p values are considered, there are no statistically significant differences between the mean commute times of employees from different universities during the pandemic.

Table 2. “Trip data” and “university” t- test, chi-square test

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Chi-square Test** | | | |
| **Transportation to work prior to Covid19** | | | |
| Public transportation | 25 (15.2%) | 101 (25.8%) | 0.028 |
| Private vehicle | 120 (72.7%) | 237 (60.6%) | |
| Shuttle | 3 (1.8%) | 14 (3.6%) | |
| Walking | 8 (4.8%) | 21 (5.4%) | |
| Bicycle | 3 (1.8%) | 6 (1.5%) | |
| Vehicle of a friend | 1 (0.6%) | 8 (2.0%) | |
| Motorcycle | 5 (3.0%) | 4 (1.0%) | |
| **Transportation to work during Covid19** | | | |
| Public transportation | 10 (6.1%) | 46 (11.8%) | 0.064 |
| Private vehicle | 127 (77.0%) | 261 (66.8%) | |
| Shuttle | 2 (1.2%) | 7 (1.8%) | |
| Walking | 7 (4.2%) | 24 (6.1%) | |
| Bicycle | 4 (2.4%) | 9 (2.3%) | |
| Vehicle of a friend | 1 (0.6%) | 18 (4.6%) | |
| Motorcycle | 7 (4.2%) | 6 (1.5%) | |
| Taxi | 0 (0.0%) | 1 (0.3%) | |
| Family vehicle | 1 (0.6%) | 2 (0.5%) | |
| Work from home | 6 (3.6%) | 17 (4.3%) | |
| **t-test** | | | |
| **Weekly trip time prior to Covid19 (hours)** | | | |
| Mean (SD) | 10.60 (16.08) | 8.75 (14.66) | 0.19 |
| **Weekly trip time during Covid19 (hours)** | | | |
| Mean (SD) | 5.87 (10.91) | 4.79 (10.34) | 0.27 |

In Table 3, the Chi-square test and p values for the walking and bicycle riding ratios of AU and SDU participants during the pandemic period based on their "mobility habits data" are provided. During the pandemic, 56.97% of AU participants and 51.15 % of SDU participants reported a decrease in their walking habits, and there were no statistically significant differences between the changes in walking habits of AU and SDU participants during the pandemic. During the pandemic period, the proportions of AU and SDU participants who rode bicycles remained unchanged at 52.73 and 55.75 percent, respectively. There were no statistically significant differences between the changes in the bicycle riding ratios of participants from two different institutions.

Table 3. “Mobility habits data” and “university” Chi-square Test

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Covid19 period walking** | | | |
| Increasing | 031 (018.79%) | 084 (021.48%) | 0.45 |
| Decreasing | 094 (056.97%) | 200 (051.15%) | |
| Does not change | 040 (024.24%) | 107 (027.37%) | |
| **Covid19 period bicycle riding** | | | |
| Increasing | 011 (006.67%) | 039 (009.97%) | 0.24 |
| Decreasing | 067 (040.61%) | 134 (034.27%) | |
| Does not change | 087 (052.73%) | 218 (055.75%) | |

In this section, analyses were conducted on the participants' public transportation data. Table 4 displays the results for the two variables of "frequency of public transportation use before and during the pandemic" and "university at which they are employed." Prior to the pandemic, 69.7% of AU participants and 49.10% of SDU participants reported never having used public transportation.

Examining the table also reveals that the frequency with which participants from the two universities utilized public transportation prior to the pandemic was different. In contrast, the value revealed that the differences are statistically significant. During the pandemic, there was a significant increase in the proportions of AU and SDU participants who never used public transportation (AU increased to 83.64 percent and SDU increased to 73.4 percent, respectively). The P value indicates that there is no statistically significant difference between the two universities' responses.

Table 4. "Public transportation habits data 1: frequency of use" and "university" Chi-square Test

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Public transportation use before Covid-19** | | | |
| Several times per month | 003 (001.82%) | 021 (005.37%) | <0.001*** |
| Once per day | 003 (001.82%) | 009 (002.30%) | |
| 2–3 times per day | 019 (011.52%) | 031 (020.72%) | |
| More than 3 times per day | 005 (003.03%) | 012 (003.07%) | |
| Several times per week | 014 (008.48%) | 063 (016.11%) | |
| Never | 115 (069.70%) | 192 (049.10%) | |
| Rarely | 006 (003.64%) | 013 (003.32%) | |
| **Public transportation use during Covid-19** | | | |
| Several times per month | 001 (000.61%) | 009 (002.30%) | 0.12 |
| Once per day | 003 (001.82%) | 010 (002.56%) | |
| 2–3 times per day | 007 (004.24%) | 016 (004.09%) | |
| More than 3 times per day | 001 (000.61%) | 006 (001.53%) | |
| Several times per week | 011 (006.67%) | 055 (014.07%) | |
| Never | 138 (083.64%) | 287 (073.40%) | |
| Rarely | 004 (002.42%) | 008 (002.05%) | |

Participants from AU and SDU were asked, "What were the reasons for preferring public transportation vehicles before Covid-19?" The factors that influence the reasons why participants do not prefer public transportation vehicles are presented in Table 5, along with the results for the two variables. Compared to other responses, the "hygiene, driving skills of the driver, behaviour of other passengers, and technical condition of the vehicle" factors have a smaller impact on the participants' preference for private transportation vehicles. The p values indicate that the responses obtained from the two universities are not statistically distinguishable. 75.05% of AU employees and 62.66% of SDU employees stated that they do not prefer public transportation vehicles because they own private vehicles. Nevertheless, the p value indicates that the differences between the responses from the two universities are statistically significant, indicating that the ratio at AU is greater. In addition, 19.39% of AU employees and 27.37 % of SDU employees indicated that they do not prefer public transportation due to the "large number of passengers in the vehicle." Based on the p value, it can be observed that the difference between AU and SDU participants is statistically significant, with SDU having a higher ratio.

Table 5. "Public transportation habits data 2: "reasons for not preferring before Covid-19" and "university" Chi-square Test

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Hygiene** | | | |
| Yes | 026 (015.76%) | 082 (020.97%) | 0.16 |
| No | 139 (084.24%) | 309 (079.03%) | |
| **Driving abilities of the driver** | | | |
| Yes | 001 (000.61%) | 009 (002.30%) | 0.29 |
| No | 164 (099.39%) | 382 (097.70%) | |
| **Behaviours of other passengers** | | | |
| Yes | 008 (004.85%) | 034 (008.70%) | 0.12 |

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| No | 157 (095.15%) | 357 (091.30%) | |
| **Number of passengers in the vehicle** | | | |
| Yes | 032 (019.39%) | 107 (027.37%) | 0.047** |
| No | 133 (080.61%) | 284 (072.63%) | |
| **Having a private vehicle** | | | |
| Yes | 124 (075.15%) | 245 (062.66%) | 0.004** |
| No | 041 (024.85%) | 146 (037.34%) | |
| **Technical state of the vehicle** | | | |
| Yes | 002 (001.21%) | 012 (003.07%) | 0.25 |
| No | 163 (098.79%) | 379 (096.93%) | |

Participants from AU and SDU were asked, "What are the reasons if your use of public transportation has decreased, or you have completely abandoned it during the Covid-19 period?" The results for the variable "university" are presented in Table 6, along with the factors influencing these reasons. Based on the responses, it was determined that "air conditioner, large number of passengers, and transition to flexible working" had a lesser impact on not preferring public transportation during the pandemic compared to other responses, and that the differences between participants from two different universities are not statistically significant when p values are considered. "fear of Covid-19 infection" had the highest percentage of AU participants (36.97%) and SDU participants (47.31%) who did not prefer public transportation, and the differences between the two types of participants were statistically significant based on the p value. 33.94% of AU participants and 38.62% of SDU participants indicated that they did not prefer public transportation because "rules of social distancing are not considered," with the difference between the two groups not being statistically significant according to the p value. 36.36% of AU participants and 29.41% of SDU participants indicated a preference for their own vehicle as a mode of transportation; however, the differences were not statistically significant. In addition, 25.45% (AU participants) and 26.09% (SDU participants) of the respondents indicate that masks and hygiene are not prioritized on public transportation, with no statistically significant differences between the two groups. 13.94% of the AU participants and 27.62% of the SDU participants indicated that their limited mobility in public transportation is a result of fulfilling their responsibilities by working from home. Based on the p value, the differences were statistically significant, indicating that the proportion of those working from home is higher in SDU. There is no statistically significant difference between the proportions of AU and SDU respondents who do not prefer public transportation due to concerns about inadequate disinfection. 4.24 % of AU participants and 12.53 % of SDU participants indicated that they do not prefer public transportation due to the contact between passenger and driver during cash exchange, and the statistically significant differences between the two groups are evident.

Table 6. “Public transportation habits data 3: reasons for decrease or abandoning of public transportation during Covid-19 period” and “university” Chi-square Test

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Air conditioner** | | | |
| Yes | 017 (010.30%) | 032 (008.18%) | 0.42 |
| No | 148 (089.70%) | 359 (091.82%) | |
| **Fear of insufficient disinfection** | | | |
| Yes | 027 (016.36%) | 091 (023.27%) | 0.07 |
| No | 138 (083.64%) | 300 (076.73%) | |
| **Fear of mask and hygiene measures in the vehicle** | | | |
| Yes | 042 (025.45%) | 102 (026.09%) | 0.88 |
| No | 123 (074.55%) | 289 (073.91%) | |

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Fear of contact between passenger-driver during cash exchange** | | | |
| Yes | 007 (004.24%) | 049 (012.53%) | 0.003** |
| No | 158 (095.76%) | 342 (087.47%) | |
| **Not taking into consideration the social distancing measures** | | | |
| Yes | 056 (033.94%) | 151 (038.62%) | 0.30 |
| No | 109 (066.06%) | 240 (061.38%) | |
| **Large number of passengers** | | | |
| Yes | 008 (004.85%) | 025 (006.39%) | 0.48 |
| No | 157 (095.15%) | 366 (093.61%) | |
| **Fear of Covid-19 infection** | | | |
| Yes | 061 (036.97%) | 185 (047.31%) | 0.025** |
| No | 104 (063.03%) | 206 (052.69%) | |
| **Having a private vehicle** | | | |
| Yes | 060 (036.36%) | 115 (029.41%) | 0.11 |
| No | 105 (063.64%) | 276 (070.59%) | |
| **Transition to flexible work** | | | |
| Yes | 022 (013.33%) | 057 (014.58%) | 0.70 |
| No | 143 (086.67%) | 334 (085.42%) | |
| **Transition to working from home** | | | |
| Yes | 023 (013.94%) | 108 (027.62%) | <0.001*** |
| No | 142 (086.06%) | 283 (072.38%) | |

The Chi-square test and p values for AU and SDU participants based on "anxiety and stress data during the Covid-19 period" are presented in Table 7. 64.24% of AU participants and 74.42% of SDU participants reported that their anxiety levels increased during the pandemic, with no statistically significant differences between the two groups. 59.39% of AU participants and 75.70% of SDU participants reported an increase in stress levels during the pandemic, and the differences were statistically significant. This indicates that the proportion of SDU participants who experienced an increase in stress during the pandemic is greater than that of AU participants.

Table 7. "Anxiety and stress data: anxiety and stress level during the Covid-19 period" and "university" Chi-square Test

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Covid- 19 period anxiety level** | | | |
| Increased | 106 (064.24%) | 291 (074.42%) | 0.05 |
| Decreased | 006 (003.64%) | 009 (002.30%) | |
| Did not change | 053 (032.12%) | 091 (023.27%) | |
| **Covid-19 period stress level** | | | |
| Increased | 098 (059.39%) | 296 (075.70%) | <0.001*** |
| Decreased | 007 (004.24%) | 006 (001.53%) | |
| Did not change | 060 (036.36%) | 089 (022.76%) | |

In this section, analyses were performed on the participants' study data. The results for the two variables "ability to continue working during the Covid-19 period" and "university" are presented in Table 8. According to the table, 39.39% of AU participants work full-time, 35.15 % have flexible hours, and 25.45 % work from home. While 36.06 percent of SDU participants work from home, 32.99 percent have flexible hours and 30.95 percent work full time. And it was observed that there is a statistically significant difference between the responses of the participants from the two universities. Similar results were observed when participants were asked, "Do you believe that remote working should continue during the pandemic in order to reduce travel needs and maintain isolation?" that 37.58 percent of AU respondents and 35.81 percent of SDU respondents concurred. There is no statistically significant difference between the shareholders, as 7.88% of the AU participants and

6.91% of the SDU participants disagree completely, and no statistically significant difference was observed.

Table 8. "Study data: opinions on the opportunities to continue working during the Covid-19 period and work" and "University" Chi-square Test

| | University | | P Value |
|---|---|---|---|
| | AU (N = 165) | SDU (N = 391) | |
| **Opportunities to continue working during the Covid-19 period** | | | |
| Flexible | 058 (035.15%) | 129 (032.99%) | 0.037** |
| From home | 042 (025.45%) | 141 (036.06%) | |
| Full time | 065 (039.39%) | 121 (030.95%) | |
| **Opinions on the necessity of remote working during Covid-19 period** | | | |
| Completely disagree | 013 (007.88%) | 027 (006.91%) | 0.22 |
| Agree | 062 (037.58%) | 140 (035.81%) | |
| Disagree | 028 (016.97%) | 043 (011.00%) | |
| Neutral | 024 (014.55%) | 064 (016.37%) | |
| Completely agree | 038 (023.03%) | 117 (029.92%) | |

### 4.3. Analysis of the Variables via Ordinal Logistic Regression

In studies in which the dependent variable is observed sequentially, "Ordinal Logistic Regression" analysis is the only alternative technique that yields meaningful parameter estimates. Ordinal Logistic Regression is a variation of Logistic Regression Analysis used when the dependent variable has more than two categories ordered as "low-moderate-high". It is a technique frequently observed in survey studies utilizing the Likert scale [85].

In logistic regression, the p and odds probability values of the variables are considered when interpreting the coefficient predictions. These probability values are derived from the Wald test, one of the statistical significance of the parameters' tests. Since variables with probability values less than 0.05 (p value) are statistically significant, interpretations are based on them [86,87]. When it is assumed that an event's realization probability is p, the ratio of this event to other events (1-p) is known as the relative probability ratio or odds ratio. It can also be expressed as the ratio between the probability that a particular outcome will occur and the probability that it will not. The value of the odds can take on values between 0 to +∞. It illustrates the likelihood of two events occurring relative to one another [88].

Because the variables "anxiety level, stress level, walking ratio, and bicycle riding ratio during the Covid-19 period" are sequential, the Ordinal Logistic Regression model was established in this section. Multivariate ordinal logistic regression was used to determine whether the variables in Tables 9, 10, 11, and 12 have an effect on these variables. Variables with no effect were eliminated, and significant variables for these dependent variables were identified, after which the acquired data was compared using logistic regression. 0.05 was accepted as the level of statistical significance throughout the study.

- **Anxiety Level Frequency Estimation by Ordinal Regression Model**
-

In this section, "anxiety level during the Covid-19 period" served as the dependent variable in a model with a 3-point Likert scale containing the categories "increased, decreased, and did not change" for the 3-category sequential variable. "Did not change" was used as a reference point. Using the Ordinal Regression Model, it was determined whether the independent variables in Table 9 have an effect on the dependent variable. Eliminating the independent variables with no effect (those with lower statistical significance based on their p values) identified the statistically significant variables for these dependent variables. Only four independent variables are statistically significant (with p values below 0.05) as shown in Table 9. The first of these variables is gender, which has two categories, male and female. Female was used as the reference category, and male was tabulated. According to the p value (0.0091), gender has a statistically significant effect on anxiety levels. The

anxiety level of men (0-0.725) is 27% lower than that of women. The variable "duty at the university" consists of three categories: student, academic/administrative staff, and administrative staff. Using student as the reference category, academic and administrative data were tabulated. According to the p value (0.0196), being an academic has a significant effect on anxiety levels. The academics' anxiety (1-1,302) was 30.2% greater than that of the students. "Fear of insufficient disinfection in the vehicles" is a two-category yes/no variable, with "no" serving as a reference and "yes" depicted in the table, when asked about reasons for a decrease in or abandonment of public transportation during the Covid-19 period. According to the p value (0.0160), the fear of inadequate disinfection in vehicles has a statistically significant effect on anxiety levels. Those with Fear of insufficient disinfection in the vehicles (1-1.607) experienced 60.7% more anxiety than those without this phobia. "Fear of Covid-19 infection" is a two-category variable, with "no" serving as the reference and "yes" being indicated in the table. According to the p value (0.0305), Fear of Covid-19 infection has a statistically significant effect on anxiety. Those with a fear of infection (1-1.444) have 44.4% higher anxiety levels than those without this fear.

Table 9. Parameter estimates for the anxiety level during the Covid-19 period

| Variable | ClassVal0 | Estimate | Std Error | Wald | p | Odds Rat | LCL | UCL |
|---|---|---|---|---|---|---|---|---|
| Intercept (anxiety level) | Increased | 3.3184 | 0.3234 | 105.2984 | <.0001 | | | |
| | Decreased | -1.9834 | 0.3349 | 35.0790 | <.0001 | | | |
| Gender | Male | -0.1608 | 0.0617 | 6.7988 | 0.0091 | 0.725 | 0.569 | 0.923 |
| Duty at the university | Academic | 0.2057 | 0.0881 | 5.4457 | 0.0196 | 1.302 | 0.911 | 1.862 |
| | Administrative | -0.1472 | 0.0765 | 3.6961 | 0.0545 | 0.915 | 0.661 | 1.267 |
| Do you own a vehicle | Yes, but I don't drive | 0.3489 | 0.1854 | 3.5417 | 0.0598 | 1.752 | 0.977 | 3.140 |
| | Yes, I drive | -0.1372 | 0.1251 | 1.2040 | 0.2725 | 1.077 | 0.757 | 1.533 |
| Reasons for preferring Public transportation vehicles prior to Covid-19 | | | | | | | | |
| Hygiene | Yes | -0.0898 | 0.0813 | 1.2200 | 0.2694 | 0.836 | 0.607 | 1.149 |
| Too many passengers | Yes | 0.1324 | 0.0774 | 2.9686 | 0.0849 | 1.306 | 0.964 | 1.769 |
| Having a Private vehicle | Yes | -0.0843 | 0.0754 | 1.2511 | 0.2633 | 0.845 | 0.629 | 1.135 |
| Reasons for decrease or abandoning of public transportation during Covid-19 period | | | | | | | | |
| Air Conditioner | Yes | -0.2173 | 0.1150 | 3.5719 | 0.0588 | 0.648 | 0.413 | 1.016 |
| Insufficient disinfection | Yes | 0.2373 | 0.0985 | 5.8058 | 0.0160 | 1.607 | 1.093 | 2.364 |
| Not taking into consideration social distancing measures | Yes | -0.1068 | 0.0908 | 1.3831 | 0.2396 | 0.808 | 0.566 | 1.153 |
| Too many passengers | Yes | 0.1612 | 0.1420 | 1.2899 | 0.2561 | 1.381 | 0.791 | 2.408 |
| Fear of Covid-19 infection | Yes | 0.1837 | 0.0849 | 4.6805 | 0.0305 | 1.444 | 1.035 | 2.014 |
| Do you agree with the necessity of remote working during Covid-19? | Strongly disagree | -0.2629 | 0.1480 | 3.1539 | 0.0757 | 0.487 | 0.321 | 0.738 |
| | Agree | 0.1509 | 0.0915 | 2.7176 | 0.0992 | 0.737 | 0.550 | 0.987 |
| | Disagree | -0.2196 | 0.1195 | 3.3804 | 0.0660 | 0.509 | 0.357 | 0.724 |
| | Neutral | -0.1249 | 0.1156 | 1.1663 | 0.2802 | 0.559 | 0.397 | 0.788 |

**Stress Level Frequency Estimation by Ordinal Regression Model**

"Stress level during the Covid-19 period" is a dependent variable in the model that has three categories: "increased, decreased, and did not change," with "did not change" serving as the reference. According to the implemented Ordinal Regression Model, the p values in Table 10 are less than 0.05, and only five independent variables are statistically significant. The first of these variables was gender, which consisted of two categories, female and male, with female serving as the reference and male being presented in the table. The p value (0.0019) indicates that gender has a statistically significant effect on stress level. The stress levels of men (1-0.696) were 30.4% lower than those of women. "Hygiene" is a two-category yes/no variable, with "no" serving as a reference and "yes" depicted in the table, when asked about reasons for a decrease in or abandonment of public transportation during Covid-19. According to the p value (0.0447), not preferring public transportation due to hygiene has a substantial effect on stress levels. The stress levels of those who selected the hygiene response option (1-0.724) were reduced by 27.6% compared to those who did not select the hygiene response option.

"Fear of insufficient disinfection in the vehicles" is a two-category yes/no variable, with "no" serving as a reference and "yes" depicted in the table, when asked about reasons for a decrease in or abandonment of public transportation during the Covid-19 period. According to the p value (0.0108), the fear of inadequate vehicle disinfection has a statistically significant effect on stress levels. Those who have a Fear of inadequate vehicle disinfection have stress levels (1-1.469) that are 46.9% higher than those who do not have this fear. The "University" variable contains two categories, AU and SDU, with SDU serving as the reference and AU being displayed in the table. The p value (0.0031) indicates that working at AU has a statistically significant effect on stress levels. The stress level at AU was (1-0.724) 27.6% less than that at SDU. According to the p value for the variable "distance of the places of residence to the workplace" (0.0230), it has a statistically significant effect on stress levels.

Table 10. Parameter estimates for stress level during the Covid-19 period

| Variable | ClassVal0 | Estimate | StdErr | Wald | p | OddsRat | LCL | UCL |
|---|---|---|---|---|---|---|---|---|
| Intercept (stress level) | Increased | 3.5393 | 0.3300 | 115.0435 | <.0001 | | | |
| | Decreased | -2.1160 | 0.3410 | 38.5047 | <.0001 | | | |
| Gender | Male | -0.1816 | 0.0584 | 9.7803 | 0.0019 | 0.696 | 0.553 | 0.874 |
| Healthcare personnel? | Yes | 0.1831 | 0.1028 | 3.1749 | 0.0748 | 1.442 | 0.964 | 2.158 |
| How did you work during the Covid-19 period? | Flexible | -0.0138 | 0.0739 | 0.0349 | 0.8518 | 1.118 | 0.875 | 1.430 |
| | From home | 0.1394 | 0.0815 | 2.9028 | 0.0884 | 1.303 | 0.992 | 1.713 |
| Reasons for preferring Public transportation vehicles prior to Covid-19 | | | | | | | | |
| Hygiene | Yes | -0.1615 | 0.0804 | 4.0312 | 0.0447 | 0.724 | 0.528 | 0.992 |
| Too many passengers | Yes | 0.1238 | 0.0745 | 2.7583 | 0.0968 | 1.281 | 0.956 | 1.716 |
| Reasons for decrease or abandoning of public transportation during Covid-19 period | | | | | | | | |
| Insufficient disinfection | Yes | 0.1921 | 0.0753 | 6.5035 | 0.0108 | 1.469 | 1.093 | 1.973 |
| Too many passengers | Yes | 0.1568 | 0.1329 | 2.1697 | 0.1408 | 1.479 | 0.879 | 2.490 |
| Do you agree with the necessity of remote working during Covid-19? | Strongly disagree | -0.2303 | 0.1464 | 2.4720 | 0.1159 | 0.636 | 0.425 | 0.951 |
| | Agree | -0.1455 | 0.0886 | 2.6958 | 0.1006 | 0.925 | 0.706 | 1.213 |
| | Disagree | -0.0142 | 0.1206 | 0.0138 | 0.9065 | 0.789 | 0.561 | 1.109 |
| | Neutral | 0.1239 | 0.1127 | 1.2099 | 0.2714 | 0.707 | 0.512 | 0.976 |
| University | Akdeniz | -0.1614 | 0.0545 | 8.7620 | 0.0031 | 0.724 | 0.585 | 0.897 |
| Distance of residence to workplace | | 0.0107 | 0.00473 | 5.1679 | 0.0230 | 1.011 | 1.001 | 1.020 |

- **Walking Ratio Frequency Estimation by Ordinal Regression Model**
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In this section, "What is the status of your Walking ratio during the Covid-19 period?" served as the dependent variable in a model with the three categories "increased, decreased, and unchanged." "Did not change" was used as a reference point. Using the Ordinal Regression Model, it was determined whether the independent variables in Table 11 have an effect on the dependent variable. Table 11 reveals that only seven independent variables have p values below 0.05 and are statistically significant. The first of these variables is the "What is your duty at the university" variable, for which a student was selected as a reference from the categories depicted in the administrative table. According to the p value (0.0002), administrative personnel had a significant influence on the walking ratio during the Covid-19 period. Those with administrative duties had a ratio of walking that was 51.3% less than that of students (1-0.487). "Are you a member of the healthcare staff?" has two categories of yes/no, with no serving as a reference and yes depicted in the table. The p value (0.0352) indicates that healthcare workers have a significant impact on the walking ratio. The walking ratio (1-0.581) of healthcare employees was 41.9% lower than that of other occupations. When asked the reasons for not preferring Public transportation vehicles prior to Covid-19, the "having a Private vehicle" variable consists of two yes/no categories, with "no" serving as the reference and "yes" being displayed in the table. Based on the p value (0.0150), individuals with private vehicles who did not prefer public transportation prior to the pandemic have a significant impact on the walking ratio. Those who own a private vehicle had a 79.2% greater impact on walking than those who do not own a private vehicle (1-1.792). When asked, "How frequently did you use public transportation vehicles during the Covid-19 period? ", "Rarely" was used as a benchmark, and "more than three times per day" was tabulated. Based on the p value (0.0394), those who use public transportation more than three times per day during the pandemic have a significant impact on the walking ratio, with their

impact on the walking ratio (1-3.780) being 278% greater than those who rarely use public transportation. Since the p value for those who responded "never" to the same question was 0.0186, those who do not use public transportation during the pandemic period have a significant impact on the walking ratio; their impact on the walking ratio (1-0.691) was 30.9% less than those who responded "rarely." The reference category for the question "Do you agree with the necessity of remote working during the Covid-19 period?" was "I strongly agree," while "I disagree" was tabulated. According to the p value (0.0245), those who strongly disagree have a substantial effect on the walking ratio during the Covid-19 period. Those who strongly disagreed had a 58.7% lower walking ratio (1-0.413) than those who strongly agreed.

Table 11. Parameter estimates for Walking ratio during Covid-19

| Variable | ClassVal0 | Estimate | StdErr | Wald | p | OddsRat | LCL | UCL |
|---|---|---|---|---|---|---|---|---|
| Intercept (Walking ratio) | Increasing | -2.2918 | 0.6119 | 14.0301 | 0.0002 | | | |
| | Decreasing | -0.2585 | 0.5959 | 0.1882 | 0.6644 | | | |
| Duty at the university | Academic | 0.1132 | 0.1115 | 1.0310 | 0.3099 | 0.827 | 0.521 | 1.312 |
| | Administrative | -0.4160 | 0.1106 | 14.160[illegible] | 0.0002 | 0.487 | 0.308 | 0.771 |
| Are you a healthcare personnel? | Yes | -0.2712 | 0.1288 | 4.4363 | 0.0352 | 0.581 | 0.351 | 0.963 |
| Do you own a vehicle? | Yes, but I do not drive | -0.3026 | 0.2019 | 2.2462 | 0.1339 | 0.513 | 0.260 | 1.012 |
| | Yes, I drive | -0.0628 | 0.1527 | 0.1693 | 0.6807 | 0.652 | 0.391 | 1.087 |
| Do you have a driver's license | Yes | 0.2228 | 0.152[illegible] | 2.1413 | 0.1434 | 1.561 | 0.860 | 2.836 |
| How did you commute to work prior to Covid-19? | Bicycle | 0.5126 | 0.5191 | 0.9749 | 0.3235 | 1.788 | 0.489 | 6.533 |
| | Vehicle of my colleague | 0.3271 | 0.[illegible]953 | 0.4192 | 0.5174 | 1.485 | 0.416 | 5.310 |
| | Private vehicle | 0.3[illegible]36 | 0.2371 | 2.2239 | 0.1359 | 1.525 | 0.720 | 3.230 |
| | Motorcycle | -1.284[illegible] | 0.5877 | 4.7766 | 0.0288 | 0.296 | 0.070 | 1.261 |
| | Shuttle | -0.2665 | 0.3954 | 0.4543 | 0.5003 | 0.820 | 0.288 | 2.335 |
| | Public transportation | 0.4263 | 0.2336 | 3.3298 | 0.0680 | 1.640 | 0.794 | 3.388 |
| Reasons for not preferring public transportation vehicles prior to Covid-19 | | | | | | | | |
| Too many passengers | Yes | 0.1233 | 0.0846 | 2.1249 | 0.1449 | 1.280 | 0.919 | 1.783 |
| Having a private vehicle | Yes | 0.2916 | 0.1198 | 5.9198 | 0.0150 | 1.792 | 1.120 | 2.866 |
| Technical condition of the vehicle | Yes | -0.3681 | 0.2332 | 2.4924 | 0.1144 | 0.479 | 0.192 | 1.195 |
| How frequently did you use public transportation vehicles during Covid-19 period? | Several times per month | -0.3286 | 0.4977 | 0.4358 | 0.5091 | 0.813 | 0.189 | 3.500 |
| | Once per day | 0.1052 | 0.4301 | 0.0598 | 0.8067 | 1.255 | 0.337 | 4.682 |
| | 2–3 times per day | -0.3836 | 0.3434 | 1.2480 | 0.2639 | 0.770 | 0.240 | 2.467 |
| | More than 3 times per day | 1.2076 | 0.5861 | 4.2445 | 0.0394 | 3.780 | 0.750 | 19.057 |
| | Several times per week | 0.0125 | 0.2414 | 0.0027 | 0.9587 | 1.144 | 0.404 | 3.242 |
| | Never | -0.4910 | 0.2087 | 5.5374 | 0.0186 | 0.691 | 0.253 | 1.888 |
| Reasons for decrease or abandoning of public transportation during Covid-19 period | | | | | | | | |
| Insufficient disinfection | Yes | 0.1926 | 0.1134 | 2.8879 | 0.0892 | 1.470 | 0.943 | 2.292 |
| Not taking into consideration the measures on the use of masks | Yes | 0.2753 | 0.1046 | 6.9296 | 0.0085 | 1.734 | 1.151 | 2.613 |
| Passenger/driver cash exchange | Yes | -0.1488 | 0.1320 | 1.2709 | 0.2596 | 0.743 | 0.443 | 1.246 |
| Do you agree on the necessity of remote working during Covid-19 period? | Strongly disagree | -0.5156 | 0.2292 | 5.0588 | 0.0245 | 0.413 | 0.226 | 0.755 |
| | Agree | 0.1888 | 0.1217 | 2.4077 | 0.1207 | 0.835 | 0.595 | 1.171 |
| | Disagree | -0.0452 | 0.1722 | 0.0688 | 0.7931 | 0.661 | 0.417 | 1.048 |

| Variable | ClassVal0 | Estimate | StdErr | Wald | p | OddsRat | LCL | UCL |
|---|---|---|---|---|---|---|---|---|
| | Neutral | 0.00262 | 0.1637 | 0.0003 | 0.9872 | 0.693 | 0.444 | 1.081 |
| University | Akdeniz | 0.1360 | 0.0812 | 2.8078 | 0.0938 | 1.313 | 0.955 | 1.804 |
| Covid19oncesihaftali | | 0.0112 | 0.00752 | 2.2143 | 0.1367 | 1.011 | 0.996 | 1.026 |
| Covid19donemihaftali | | -0.0218 | 0.0112 | 3.7885 | 0.0516 | 0.978 | 0.957 | 1.000 |

- **Bicycle Riding Ratio Frequency Estimation by Ordinal Regression Model**
-

In this section, "what is the state of your ratio of riding bicycle during the Covid-19 period?" is the model's dependent variable, which is a sequential 3-category variable with "increased, decreased, and did not change," for which "did not change" was used as the reference. The p value is less than 0.05, and only four independent variables are statistically significant, as shown in Table 12. Bicycle was tabulated from the categories of the first variable of "How do you commute to work during the Covid-19 period?" that referenced walking. Those who rode a bicycle to work prior to the pandemic have a statistically significant impact on the proportion of cyclists during the pandemic, as indicated by the p value (0.0007). Those who rode a bicycle to work prior to the pandemic were 561 percent more likely to ride a bicycle during the pandemic than those who walked to work. For the variable "How did you continue working during the Covid-19 period? ", "full-time employment" was used as a reference, and "flexible employment" was tabulated. According to the p value (0.0102), those who work flexible hours during the pandemic have a statistically significant impact on the proportion of people who rode bicycles during the Covid-19 period. The ratio of flexible-time workers who ride a bicycle was 60.2% greater than that of those who worked full-time. Based on the p value (0.0045), the "age" variable has a statistically significant effect on the ratio of bicycle riding. According to the p value for "weekly trip time prior to the Covid-19 period" (0.0167), this variable has a statistically significant effect on the proportion of bicycle riders.

Table 12. Parameter estimates for riding the ratio of riding a bicycle during the Covid-19 period

| Variable | ClassVal0 | Estimate | StdErr | Wald | p | OddsRat | LCL | UCL |
|---|---|---|---|---|---|---|---|---|
| Intercept (ratio of riding a bicycle) | Increasing | -0.9700 | 0.4841 | 4.0140 | 0.0451 | | | |
| | Decreasing | 0.2939 | 0.4775 | 0.3788 | 0.5382 | | | |
| How did you commute to work prior to the Covid-19 period? | Vehicle of my family | -0.4294 | 0.8312 | 0.2668 | 0.6055 | 1.000 | 0.151 | 6.626 |
| | Bicycle | 1.4591 | 0.4327 | 11.3728 | 0.0007 | 6.610 | 2.315 | 18.872 |
| | Working from home | -0.0774 | 0.3857 | 0.0402 | 0.8410 | 1.422 | 0.557 | 3.632 |
| | Vehicle of my colleagues | -0.3878 | 0.4128 | 0.8825 | 0.3475 | 1.043 | 0.379 | 2.869 |
| | Private vehicle | -0.0523 | 0.2293 | 0.0519 | 0.8198 | 1.458 | 0.740 | 2.874 |
| | Motorcycle | 0.1870 | 0.4613 | 0.1643 | 0.6852 | 1.852 | 0.615 | 5.581 |
| | Shuttle | -0.4952 | 0.5697 | 0.7554 | 0.3848 | 0.936 | 0.246 | 3.568 |
| | Taxi | 0.7440 | 1.3068 | 0.3241 | 0.5691 | 3.233 | 0.175 | 59.737 |
| | Public transportation | -0.5186 | 0.3045 | 2.9014 | 0.0885 | 0.915 | 0.413 | 2.028 |
| How did you work during the Covid-19 period? | Flexible | 0.2582 | 0.1006 | 6.5939 | 0.0102 | 1.602 | 1.132 | 2.268 |
| | From home | -0.0450 | 0.1078 | 0.1747 | 0.6760 | 1.183 | 0.816 | 1.716 |
| How frequently did you use public transportation vehicles during the Covid-19 period? | Several times per month | -0.2911 | 0.4862 | 0.3585 | 0.5493 | 2.002 | 0.387 | 10.349 |
| | Once per day | 0.7073 | 0.4030 | 3.0805 | 0.0792 | 5.434 | 1.195 | 24.713 |
| | 2–3 times per day | 0.5013 | 0.3243 | 2.3894 | 0.1222 | 4.422 | 1.089 | 17.965 |
| | More than 3 times per day | 0.6090 | 0.5134 | 1.4073 | 0.2355 | 4.925 | 0.919 | 26.386 |
| | Several times per week | -0.4149 | 0.2523 | 2.7049 | 0.1000 | 1.769 | 0.467 | 6.698 |
| | Never | -0.1262 | 0.2019 | 0.3911 | 0.5317 | 2.361 | 0.656 | 8.504 |
| Reasons for decrease or abandoning of public transportation during Covid-19 period | | | | | | | | |
| Air conditioner | Yes | 0.1732 | 0.1314 | 1.7372 | 0.1875 | 1.414 | 0.845 | 2.367 |
| Not taking into consideration | Yes | -0.0786 | 0.0810 | 0.9417 | 0.3318 | 0.855 | 0.622 | 1.174 |

| Variable | ClassVal0 | Estimate | StdErr | Wald | p | OddsRat | LCL | UCL |
|---|---|---|---|---|---|---|---|---|
| social distancing measures Too many passengers | Yes | 0.1686 | 0.1380 | 1.4925 | 0.2218 | 1.401 | 0.816 | 2.406 |
| Do you agree on the necessity of remote working during Covid-19 period? | Strongly disagree | -0.2531 | 0.2465 | 1.0543 | 0.3045 | 0.544 | 0.287 | 1.031 |
| | Agree | 0.1555 | 0.1258 | 1.5280 | 0.2164 | 0.818 | 0.585 | 1.145 |
| | Disagree | -0.0961 | 0.1841 | 0.2724 | 0.6018 | 0.636 | 0.394 | 1.028 |
| | Neutral | -0.1622 | 0.1747 | 0.8621 | 0.3531 | 0.596 | 0.376 | 0.944 |
| Age | | -0.0221 | 0.00777 | 8.0552 | 0.0045 | 0.978 | 0.963 | 0.993 |
| Weekly trip times prior to Covid-19 | | 0.0105 | 0.00437 | 5.7232 | 0.0167 | 1.011 | 1.002 | 1.019 |

## 5. Discussion

The current study illustrates the analyses of mobility changes before/during Covid-19 conducted at two universities in two provinces of Turkey that are involved in the process of distance education. The online survey-based study was conducted through statistical analysis and interpretation of the collected data. Following is a summary and interpretation of the findings:

Trip habits: Prior to the pandemic, participants' average weekly travel times were 9.30 hours, but they decreased to 5.11 hours during the pandemic. In transportation planning, commute travel time is traditionally viewed as a loss that should be minimized. Planners' ultimate objective continues to be the provision of swift and efficient transportation [62]. When viewed from this angle, it can be said that these results meet the objective. During the pandemic, Polish respondents reduced their travel time, according to a survey with 1,069 Polish participants. The decrease in travel time for students was 80.21%, whereas it was 49.82%-56.06% for blue-collar workers, 55.05%-80.8% for home-based workers, 65.64%-71.65% for white-collar workers, 61.22%-69.86% for pensioners, 63.42%-73.46% for housewives, and 50.14%-68.34% for the unemployed [89]. Prior to the pandemic, 64.2% of participants preferred driving their own vehicles to work. During the pandemic, this proportion increased to 69.8%. Before the pandemic, 22.7% of participants preferred public transportation; during the pandemic, that number dropped to 10.1% (there were no statistically significant differences between the AU-SDU trip data). Due to the risk of infection, road users do not feel secure during the pandemic and therefore prefer to drive their own vehicles to work. However, it is evident that the transition to private vehicles rather than public transportation should be slowed due to transportation and environmental concerns [11]. Within the scope of a different study, a questionnaire was designed and administered to 1,200 residents of the Chicago Metropolitan Area regarding their travel habits prior to and during the pandemic. The preference for personal vehicles during the pandemic period was associated with the lowest perceived risk of exposure (58%), according to the results [1].

While 20.68 percent of participants reported an increase in their walking habits during the pandemic, 52.88 percent reported a decrease. 36.15% of participants reported that their bicycle riding ratios decreased during the pandemic, while 54.86 % reported no change (there were no statistically significant differences between the data on mobility habits for all AU-SDU). Based on these responses, social distancing and social isolation force the majority of participants to engage in limited physical activity, such as walking and cycling. Based on the Ordinal Regression Model utilized in this study, the walking ratio of administrative personnel was 51.3% lower than that of students during the pandemic. The walking ratio of healthcare employees was 41.9% less than that of other employees. Those who did not prefer public transportation prior to the pandemic because they own a private vehicle walked 79.2% more frequently during the pandemic than those who do not own a private vehicle. During the Covid-19 period, those who used public transportation vehicles more than three times per day walked 278% more frequently than those who rarely used public transportation vehicles. Those who responded "never" to the same question had a 30.9% lower walking ratio than those who responded "rarely." During the Covid-19 period, the walking ratio of participants who completely disagree with the necessity of remote work was 58.7% lower compared to those who completely agree. Using the Ordinal Regression Model, the bicycle riding habits of those who bicycled to work

prior to the pandemic were 561% greater than those who walked to work prior to the pandemic. During the pandemic, flexible-time workers' bicycle riding habits were 60.2% greater than those of full-time workers. Chile conducted a second study during the Covid-19 pandemic. In Santiago, there was a 39% decrease in the number of tourists who walked [35]. The comparison of 2019 and 2020, including the lockdown periods of 2020, is the focus of a study comparing the percentile changes in bicycle use between EU countries and regions of the USA and Canada. In eleven EU countries, bicycle use increased by an average of 8%, but the weekend increase was significantly greater (+23%) than the weekday increase (+3%). In the United States, an average increase of 16% was observed, with a much greater increase during the weekends (+29%) than during the weekdays (+10%). In Canada, the average increase was 3%, with a larger increase for the weekends (28%) compared to a decrease of 8% during the weekdays [90].

Use of public transportation: Prior to the pandemic, 23.21% of participants reported daily use of public transportation; during the pandemic, this percentage dropped to 7.74%. Before the pandemic, 55.22% did not use public transportation (this ratio was 69.70% for AU and 49.10% for SDU); after the pandemic, this ratio increased to 76.44% (83.644% for AU and 73.4% for SDU). This result leads us to believe that participants do not prefer public transportation due to comfort, safety, and health concerns, but it may also be due to suboptimal public transportation organization systems in cities during the pandemic. In addition, the fact that the majority of survey respondents indicated they own private vehicles was also effective (66.37 percent of respondents owned a vehicle prior to the pandemic). Participants were asked, "What factors led to a decline or abandonment of public transportation during Covid-19?" 44.24% (36.97% of AU participants and 47.30% of SDU participants) of those who limited their use of public transportation cite fear of Covid-19 infection. While 37.23 percent of respondents indicated that social distancing rules are not taken into account, 31.47 percent reported switching to private vehicles as their primary mode of transportation (no statistically significant difference between AU and SDU data). Additionally, 12.53 percent of SDU employees stated that they do not prefer public transportation due to the cash exchange between passenger and driver. On the basis of these findings, it can be concluded that the participants feel less secure using public transportation during the pandemic due to their fear of contracting the virus, which has a significant effect on their attitude toward using public transportation vehicles in their daily lives. In a separate study, the population and service size impacts of Covid-19 on public transportation users in ten U.S. cities were analyzed. The number of passengers in April 2020 decreased by 62 to 87% compared to April 2019 [24] as a result of the lockdown orders in place for these cities during March 2020.

Tension and anxiety: The emergence of stress is contingent upon the internal and external response of the individual to the occurrences in his or her environment. Anxiety is an uncomfortable feeling such as worry or fear [91]. The fact that the pandemic attributed to the Covid-19 virus has resulted in a significant number of deaths on a global scale, combined with the insufficient knowledge of scientists and healthcare authorities regarding the means of containment and treatment of the disease, heightens the uncertainty surrounding the disease. Fear, anxiety, and stress manifest at both the individual and global levels in risk societies. Nevertheless, it is known that psychological problems may arise if fears and concerns about the pandemic reach pathological levels [92]. Moreover, even when social distancing rules are no longer in effect, individuals who influence activity participation and travel may still fear social contact [2]. In the present study, 71.4% of participants reported that their anxiety levels increased during the pandemic. In addition, using the Ordinal Regression Model, it was determined that gender has a significant effect on anxiety level and that male anxiety levels are 27% lower than female anxiety levels. Females experience greater anxiety than males. The study also revealed that the anxiety levels of academic staff members are 30.2% higher than those of students, indicating that students who were confined to their homes as a result of the transition to remote education have lower anxiety levels. During Covid-19, the anxiety levels of those who cited "Fear of insufficient disinfection in the vehicles" as the reason for abandoning or reducing their use of public transportation were 60.7% higher than those who do not have this fear. Similarly, the anxiety levels of

those who abandoned or reduced their use of public transportation due to "Fear of Covid-19 infection" were 44.4% higher than those who lacked this fear. The stress levels of 70.86% of the participants increased (59.39% for AU and 75.70% for SDU). The Ordinal Regression Model demonstrates that gender has a statistically significant effect on stress levels. The stress levels of males were 30.4% lower than those of females, indicating that females are more stressed than males. Those who did not prefer public transportation during the pandemic due to hygiene had stress levels that were 27.6% lower than those who did not specify hygiene as a reason. Comparatively, the stress levels of those who did not prefer public transportation during the pandemic due to "Fear of insufficient disinfection in the vehicles" were 46.9% higher than those who did not cite this reason. In addition, the stress levels of AU employees during the pandemic were 27.6% lower than those of SDU employees. Within the context of emotional states during the pandemic, a questionnaire was administered to 303 participants from various professions in Giresun, Turkey, as part of a second 2020 study. According to the results, the anxiety levels of 84% of the participants increased during the pandemic, while the perceived levels of stress among the participants were moderate. The study revealed a statistically significant, moderately positive correlation between perceived stress, situational anxiety, and trait anxiety [91].

While 32.91 percent of study participants reported working from home during the Covid-19 period (25.45 percent for AU and 36.06 percent for SDU), 38.63 percent reported working flexibly only on certain days of the week. 36.33% of participants strongly agreed that working from home was necessary during the pandemic, while 27.88% agreed. According to these results, the majority of respondents support the continuation of working from home. Participants may assert that encouraging work-from-home arrangements is one of the most important measures to reduce unnecessary travel. The recent increase in remote work as a result of Covid-19 highlights the need for additional study. It is uncertain to what extent restrictions on working from home that were lifted by many employers will be reinstated; however, working from home will likely be much more accessible than it was pre-Covid-19 and many employees will have significantly more experience in this regard [76].

In order to achieve sustainable urban planning [11], the present study's findings can be used as a guide for decision-makers considering the promotion of primary and public transportation, walking, cycling, and micro-mobility.

The limitations of the study discussed in this article are as follows: "(1) Of the respondents, 40.7% were academic staff, 22.2% were administrative staff, 14.4% were students, and 8.62% were healthcare personnel. In comparison to working individuals, students have limited Internet access and computer facilities, and they are less aware of their responsibilities in responding to the questionnaire sent to their e-mails. Due to these factors, the participation rate of students is lower than that of other participants. They did not have time to complete the questionnaire because they were responsible for Covid patients who were hospitalized in intensive care at the time.

(2) On both campuses, there were a total of 10 people (1.8%) over the age of 60, fewer than in the younger age group (people in this age group are already retired in Turkey). In addition, personnel aged 60 or older in Turkey were placed on administrative leave because of the pandemic.

## 6. Conclusions and Limitations and Future Research Elements

Numerous social and economic human activities were profoundly impacted by the Covd-19 pandemic. Mobility is one of these activities; during the pandemic, most people stayed at home, resulting in a significant decrease in traffic and an impact on model separation. Unfortunately, the use of sustainable means of commuting to work, such as public transportation and shared mobility services, decreased significantly. During lockdown periods, people began to favour automobiles, bicycles, and other vehicles for transportation over walking [6]. The gradual resumption of business, commerce, transportation, and other activities following the end of the Covd-19 lockdown compelled people to adopt more cautious methods such as walking or riding a bicycle [93]. In order to achieve their long-term objectives, local administrations strive to maintain a positive perception of walking

and bicycling throughout the pandemic [11]. To reduce risks to public health, it is crucial to effectively manage crowds, as physical proximity is currently regarded as a necessary condition for the spread of the virus.

Even though changes in transportation modes and travel times of urban residents are significant during the pandemic period compared to the pre-pandemic period, physical movement habits and anxiety/stress levels also influence these habits. During the pandemic period, there are numerous articles on "modes of transportation," "mobility habits," and "anxiety/stress level changes." However, there is a dearth of literature that analyzes and evaluates the data associated with these three topics in a single study. Moreover, a city-by-city examination of all humanitarian changes during the pandemic period may reveal varying outcomes. Thus, comparisons were made based on data collected from two cities with "different geographical features, climates, surface areas, and populations" that served as the basis for the research. There is a paucity of literature that has accessed, analysed, and compared the data of such diverse urban populations during the pandemic era. This study conducted during the Covid-19 pandemic contributes to the literature in terms of "data diversity and evaluation of various city residents during the pandemic."

Among the limitations of the present study is the absence of variables that can more accurately characterize localities at the city level. In addition, additional information regarding the distance between the participants' homes and the city centre, their income levels, whether or not they have experienced Covid-19, and whether or not they have been vaccinated against Covid-19 may increase the reliability of our analysis. By analysing this and similar data in their studies, future researchers can focus on capturing more specific and varied results.

In recent years, pandemic cases have increased significantly due to the rapid growth of the world's population. A resurgence can be expected for the Covid-19 pandemic until 2024 and even a further date [94,95]. Moreover, a "transition from public transportation to private vehicles" occurred, which contradicts the sustainability policies of cities. Therefore, it is necessary to examine in depth the effects of the Covid-19 pandemic on public transportation in order to provide a safe transportation environment for all segments of society [11]. In certain cities, new bicycle roads and urban areas that may provide road users with alternatives are already being developed in response to the challenges posed by public transportation systems. Encourage the use of technologies such as APP or ITS (Intelligent Transport Systems) for geographical localization [11,67] to implement these measures. During the pandemic, the design, construction, and use of public outdoor infrastructure and spaces should be made more secure. This may indicate that communities are adapting to the Covid-19 pandemic and potential future public health disasters [66].

During the pandemic, among forms of mobility that enable individuals to move in accordance with the rules of social distancing, walking is the predominant mode of transportation. In cities where walking is "uncomfortable" but bicycles are easily accessible, bicycles, scooters, etc. provide an excellent alternative that should be considered. Consequently, it will be necessary to identify protected bicycle routes [11,96]. Moreover, because the need to move is also a sport or a relaxing activity, walking or riding a bicycle during such a period may be the ideal way to combat stress [97].

Regardless of when the Covid-19 threat will end, new virus outbreaks and other pandemics will continue to cause uncertainty, which will likely result in a reduction in transportation and travel [82]. Moreover, the majority of debates [31] concern the post-lockdown period, during which activities that were halted because of Covid-19 are resumed, and the upcoming periods after the worst of the crisis has passed. The pandemic posed a threat to public transportation demand by shifting users to micro-mobility solutions (electric bicycles, e-scooters, etc.) [82]. Considering the factors that have an impact on both comfort and safety during the pandemic, the number of other passengers and their behaviours, as well as fears related to passengers who do not follow hygiene-related rules, are the most important factors in ensuring that public transportation passengers feel comfortable. During the pandemic, vehicle disinfection also became an extremely important factor. After the pandemic has been contained, the public's openness and willingness to resume using public transportation will be directly proportional to their perception of safety. Significant budget and image problems may result

from a loss of long-term confidence in public transportation. Therefore, it is necessary to ensure that passengers who return to public transportation feel safe. In addition, steps should be taken to ensure that groups that have abandoned this mode of transportation will return to it in the future. Furthermore, in-depth studies should be conducted that focus on the needs of the local populace, particularly during the upcoming pandemic waves. Therefore, local administrators should focus more on city residents, particularly during the pandemic, and create conditions for safe mobility. Otherwise, an indispensable private vehicle could completely eliminate this option and pave the way for a more intelligent and sustainable transportation system. The culture of sustainable mobility should be shaped gradually over time [6].

In numerous nations, mobility as a service (MaaS) encompasses public transportation, ridesharing (Uber, Ola, Didi, Taxiler), bicycle sharing, and car sharing [98]. During a pandemic, it is important to provide safe door-to-door travel options for those in high-risk groups, such as the elderly and critical employees, such as healthcare workers [31]. In Germany, regulations governing the special services provided to healthcare employees by shared mobility companies have been implemented [99]. Such regulations must be applicable in all nations for those in high-risk groups, such as healthcare workers, the elderly, etc.

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**Financial Disclosure**

"The Authors did not receive any specific funding for this work".

## HIGHLIGHTS

- A survey was conducted for measuring the impacts of the pandemic and the measures taken.
- The study group was comprised of shareholders in the remote education process at the Süleyman Demirel University in the Isparta province of Turkey and Akdeniz University in the Antalya province.
- The study group (number of valid surveys) consisted of 556 individuals. The online survey was classified into 6 sections and was characterized with a total of 22 questions.
- Normal distribution compliance tests for the data were first carried out using Shapiro-Wilk test followed by the assessment of skewness coefficients. It was understood as a result of the tests that the data display normal distribution and parametric tests were used for statistical analysis.
- The travel times of the participants had decreased during the pandemic and the percentage of individuals who drive to work with their own vehicles increased up to 69.8 %.
- The percentage of public transportation users decreased from 12.7 % to 10.1 %, while the ratio of those who do not use public transportation increased from 55.22 % to 76.44 %.