Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Household mobility in food purchasing during COVID-19 lockdown: Evidence from Torino, Italy

Beatrice Braut a, Matteo Miglieli a,b,c, Elisa Truant c

a University of Torino, Department of Economics and Statistics “Cognetti de Martiis”, lungo Dora Siena, 100, I-10153 Torino (TO), Italy
b Collegio “Carlo Alberto”, CeRP and OETT, piazza Arbarello, 8, I-10122 Torino (TO), Italy
c University of Torino, Department of Management, corso Unione Sovietica, 218bis, I-10134 Torino (TO), Italy

A R T I C L E   I N F O

Keywords: COVID-19
Lockdown
Transportation means
Food purchases

A B S T R A C T

During the first wave of COVID-19, lockdown restrictions limited people’s movements mainly to food purchasing. Using survey data collected in Torino, Italy, from university students, this study analyses the lockdown’s impact on the transportation means used for purchasing food compared to the pre-lockdown period. Food store businesses were not limited by the restrictions and people had to purchase food; however, national and local rules limited citizens’ movements, potentially leading to a different choices of transportation means than before the pandemic. The results show that both the lockdown and, perhaps, the fear of contagion, moved the preferences of people from public and shared means to foot and private vehicles. These findings can help in rethinking how transportation is organised in an urban environment, such as that in Torino. Ensuring the safety of public and shared transportation may help sustain mobility during health emergencies.

1. Introduction

The COVID-19 outbreak has caused unexpected changes in everyday life and required individuals to adapt to new ways of living. It has also forced countries to revise their budgets to free resources for fighting the pandemic, and allocate resources both to the health system and recovery programs. These resources are often diverted from other priorities, such as environmental sustainability.

Italy was the first European country to lockdown on 9 March 2020 in response to the rapid growth of COVID-19 cases. On that day, Prime Minister Giuseppe Conte, with the decree ‘Dpcm 8 marzo 2020 #iostacoacasa (#Istayathome)’, announced the establishment of Italy as a ‘protected area’. Until the 4th of May, the date of a gradual reopening, citizens were in lockdown. These emergency measures strongly affected mobility; citizens were only allowed to move for buying food from retailers, work (limited to permitted activities), or for health reasons. Notably, mobility decreased because in Italy, fines were levied on people found to have left home without any justified reason. Each person leaving home, upon request, had to provide police officers with a written justification under the penal responsibility of the declarant in the event of a false statement.

Following China and Italy, other governments imposed national lockdowns and policies to limit citizens’ mobility for reducing the COVID-19’s diffusion; purchasing food in shops, markets, and supermarkets, and other essential goods/services were allowed. Mobility and consumption were also affected by higher frequency of work-from-home. Thus, radical changes occurred in population lifestyles and preferences, particularly affecting eating habits and the “usual” everyday behaviours (Cho, 2020; Di Renzo et al., 2020).

Both the lockdown measures and the need to concentrate resources on fighting the pandemic have generated inevitable economic disruptions, affecting many industries, value chains, and trade exchanges (Bonaccorsi et al., 2020). The corresponding economic consequences, similar to those from large-scale natural and extreme natural disasters, have also affected households (Coronese et al., 2019; Inoue & Todo, 2019). Numerous job losses and income reduction for those dependent on commercial activities stopped by the lockdown occurred. To mitigate the impact of such adverse conditions, consumers may revise their practices, as the significant changes in countries heavily affected by the subprime financial crisis suggest (Voinea & Filip, 2011; Warde, 2015).

Food is essential for life. Therefore, its demand is generally very rigid, although it may be more elastic for some food categories than others. Households kept purchasing food during the lockdown, but where and when they bought food may have changed. That is,
consumers may have bought food in different shops and locations than before the lockdown both to minimise encounters with other people, and the distance between home and the shop, thereby complying with administrative provisions. While food retailers were generally exempt from lockdown and working/mobility restrictions, different adverse impacts were reported (Bène, 2020). Panic buying and limitations in shopping trips further complicated the management of the food system, which sought to respond to a change in the types and quantities of food bought. Despite the growing literature addressing the different facets and consequences of the COVID-19 pandemic, little is known about how households responded in terms of their spending (Baker et al., 2020) and mobility (Aloi et al., 2020), especially comparing behaviour before and during lockdown.

Pepe et al. (2020) find that due to the March 2020 restrictions, mobility fluxes between Italian provinces decreased by 50%. Moslem et al. (2020) examine two Sicilian cities and highlight that Italian mobility significantly changed during the pandemic; specifically, individual transport, especially walking, was favoured while public transport was penalised. Campisi et al. (2020) also focus on Sicily and show that daily travel remained limited even after the emergency due to the persistence of remote working, with an increasing interest in walking, cycling, or micro-mobility solutions. Finally, Caselli et al. (2020) find that in Italy, the local dimension is relevant due to different demographic features and local labour force composition, and different impacts on individual mobility once restrictive measures are removed. Despite a growing interest in mobility during the pandemic, very few studies specifically address household mobility in such an emergency (Aloi et al., 2020). Furthermore, to the best of our knowledge, no one has addressed this in the Italian context. However, mobility is ‘purpose-driven and the change in the purpose (leisure, work, education, shopping, etc.) alters the nature of individual mobility’ (Moslem et al., 2020, p.6). Therefore, this study deeply examines households’ mobility for food purchasing in an Italian urban context and how their habits changed during the outbreak. Indeed, it may be interesting to shed light on changes in habits that occurred during the lockdown will last in the long run. Therefore, persistent changes in different transportation means’ usage for food purchasing may have some impact on the pollution levels in towns and cities if factors incentivising greater sustainable transportation usage prevailed over those incentivizing increased private car usage. Otherwise, the lockdown’s effects in this sphere of everyday life can negatively affect the environment. This study focuses on the use of transportation means for food purchasing, as this was the only activity daily allowed for all the population, as before the pandemic, except for the recommendation of minimising the distance between home and the shopping locations. In particular, the population considered in the analysis is represented by the students (and their families) in a city, Torino, where they constitute almost 10% of the population. On the one hand, other cities in Europe and elsewhere are characterised by large shares of students; therefore, the policy recommendations of this study may be useful in contexts other than those studied here. On the other hand, students typically use public transportation means (as they generally have low income and to avoid congestion near departments and schools). This type of transportation was particularly affected by the restrictions enacted by local and national authorities, limiting the mobility opportunities of a particular category and increasing inequality of opportunities within the population.

Furthermore, a questionnaire survey was administered on students of the University of Torino, Italy, to understand whether and how the lockdown affected the mobility habits of their families in food purchasing. The possible limits arising from the choice of this particular population are discussed later in this study. Fig. 1 illustrates the steps involved in our research.

The remainder of this study is organised as follows. The next section presents a literature review of COVID-19’s impact on internal mobility. This is complemented with the literature on food consumption due to the strong ties between the two systems. Subsequently, the research method used to conduct the study is presented, followed by a presentation and discussion of the results. The study ends with concluding reflections and suggestions for future research.

2. Literature review

2.1. Mobility and COVID-19

Mandatory lockdowns have significantly affected citizens’ mobility globally. Very few activities were allowed, such as food supply, healthcare, and specific working activities. Consequently, mobility decreased in many countries because of official advice on limiting daily outdoor activities (Budd & Ison, 2020). The highest daily mobility was observed for routine shopping (usually food purchases), followed by work-related travel that, compared to the pre-pandemic period, increased for some occupations, such as health, sales, and services (Fatmi, 2020). Consequently, mobility and related transport alternatives represent one of the most critical issues because of their involvement in the rapid spread of COVID-19, especially in high-density urban contexts. However, research on urban mobility during a viral pandemic is still lacking, especially regarding changes in habits (Campisi et al., 2020; Meena, 2020; Pawar et al., 2020).
One key element that emerges and is recurring in the literature is that public transport was penalised due to safety issues and fear of contagion (Abdi, 2020; Aloi et al., 2020; Campisi et al., 2020; Honey-Roses et al., 2020; Moslem et al., 2020), affecting urban sustainability. Meanwhile, the pandemic has boosted private mobility modes' usage, such as cars or scooters, because they are considered safer (Moslem et al., 2020); notably, shared mobility dropped by 35% (Meena, 2020). However, active mobility based on walking and cycling also increased following the pandemic (Morita et al., 2020; Moslem et al., 2020; Venter et al., 2020).

To improve the use of the local transportation system, some cities are rethinking urban areas to provide alternatives. For example, developing or requalifying infrastructures to incentivise pedestrian and soft mobility (bicycle, scooters, etc.), or electric micro-mobility (Campisi et al., 2020; Honey-Roses et al., 2020; Li et al., 2020; Merkert et al., 2020), and promoting new digital applications to manage transport systems (Bonaccorsi et al., 2020). However, mobility patterns depend on the socioeconomic characteristics of travellers, such as gender, education, and family status (Ausi et al., 2019; Engle et al., 2020), and other criteria such as accessibility, fares, travel time, comfort, and safety (Redman et al., 2013), Bonaccorsi et al. (2020) examine mobility during the outbreak and note that where the pandemic accentuated social inequalities, changes in mobility among the population have been more evident: mobility contracted much more within municipalities where inequality increased and where individuals have lower income per capita, thereby inducing a segregation effect. Caselli et al. (2020) also find that individual mobility choices during the pandemic were locally diversified.

Therefore, lockdowns inevitably altered pre-COVID mobility trends, increasing long-term repercussions on sustainable mobility in urban areas. Some studies have highlighted the greater use of personal transport systems (Aloi et al., 2020; Hardt & Bogenberger, 2019) instead of public transport; the latter was dramatically limited because of the fear of contagion and anti-COVID measures (Aloi et al., 2020; Baker et al., 2020). However, in many urban contexts, shared mobility experienced a less significant ridership drop compared to public transportation, with an increase in the average trip duration (Teixeira & Lopes, 2020).

2.2. Mobility and food purchases

Increased fear of contagion and government-imposed containment measures reduced the number of household trips to grocery stores (Cranfield, 2020). Households continued visiting their regular food retailers (Ihle et al., 2020), thus increasing consumption within neighbourhoods. Households focused on fewer retailers and privileged those who guaranteed physical delivery of goods at home (Bougie et al., 2020). However, even in times of an increasing number of cases, many consumers still preferred purchasing in stores, instead of online (Grashuis et al., 2020), with inevitable impacts in terms of mobility and means of transportation.

Béné (2020) reveal a strong interconnection between mobility and food availability. Specifically, a 'two-way impact' on mobility and food purchasing systems has been observed: restrictive mobility measures affect consumers' demand for particular food items; simultaneously, the limitations in accessing specific food supply outlets (e.g., open air markets) in some cases forced consumers to stock up in more distant and more expensive places, such as supermarkets (Béné, 2020).

In line with previous evidence, Kolodinsky et al. (2020) and Worstell (2020) show that consumers radically change their food purchasing habits and preferences in response to reduced opening hours of some stores or limits on the number of people working in stores. Consequently, the change in the way and where households shop impacts the channels and venues used to purchase food (Cranfield, 2020). Studies have found that the mobility restrictions induced by the lockdown have considerably boosted food and beverage e-commerce (Cavallo et al., 2020; Reardon et al., 2021; Villa & Monzón, 2021). In Italy, online food purchases tripled compared to the pre COVID-19 period (Cavallo et al., 2020; ISMEA, 2020), while in Spain, the increase was greater than 200% (Villa & Monzón, 2021). In Canada, online grocery home delivery services expanded, while preferences for locally sourced foods increased (Hobbs, 2020).

Generally, demand increased for basic home goods for stockpiling (Baker et al., 2020). Simultaneously, this increased demand for easy-to-store food items (Cranfield, 2020). Other studies focused on the U.S. and China observed an increased consumption of red meat (Mitchell et al., 2020) and a decrease in ready-to-eat foods (Dou et al., 2020). Di Renzo et al. (2020) show that in Italy, home-made bakery food consumption increased, while that of snacks, processed meat, carbonated, and sugary drinks decreased. Instead, no substantial changes were observed for fresh food.

Alonso et al. (2015) show that in periods with strong perceived uncertainty about the future, overall consumption patterns register significant and, in some cases, disruptive changes, even if working class families are less exposed to drastic modifications. Household income reductions are highly linked with a higher degree of economising food purchasing, a phenomenon also observed during other types of shocks/crises (Cranfield, 2020). Others (Béné, 2020; Dou et al., 2020) noticed different types of adverse pandemic-induced impacts on households, affecting purchasing power, access to food, and risk of exposure to unsafe food:

- (temporary) loss of jobs and income,
- increased food costs (transportation, delivery price of food), and
- Limited possibility of choosing food outlets or access to cheap and more convenient food outlets

In conclusion, COVID-19 and lockdowns have strongly affected where and when people purchase food (Devereux et al., 2020). These behavioural changes also affected the transportation means used by consumers to purchase food. However, the direction of this impact—decrease/increase in sustainable transportation usage—is theoretically unclear; some consequences of the pandemic push toward greater private car usage, while others suggest that feet and bikes may be preferred. Therefore, an empirical investigation of this phenomenon is necessary to understand which force prevailed.

These behavioural changes may have persistent long-term effects, rendering the inquiry presented here relevant to better understanding some impacts of the lockdown in terms of sustainability and pollution. As Cohen (2020) remarks, in the aftermath of shocks/disasters, which change what people buy and consume, such effects may not end with the shock; people may forget 'how things used to be'. Cities that want to be smart by shifting toward a more sustainable and virtuous model of mobility may find non-trivial inertia to changes due to the consequences of this troubled period.

3. Data and methodology

3.1. Survey and data

To evaluate variations in mobility during the Italian lockdown, we collected data through an email survey run between 4 and 15 June 2020. The lockdown had just ended during this period: there was no possibility of changing behaviour, but its memory was still fresh.

The survey contained questions about which transportation means (foot, own car, public transportation, car sharing, and bike) interviewees used before and during the lockdown while shopping for food. Questions were asked in households as food purchases concern all the members of the household and to avoid null answers if the interviewee was not the person in charge of buying food. That is, the questionnaire was submitted to students, while food purchasing may be an activity carried out by other family members. Information about shopping locations for both long-lasting and fresh food shopping were also collected. Some
questions were on purchasing habits and lockdown behaviours for both long-lasting and fresh food: the preferred type of shop and the weekly frequency of shopping. Others were on meal habits and lockdown behaviours: eating habits and frequency of meals at bars, restaurants, or canteens. Sociodemographic information and attitudes toward risk and environment were also collected.

The survey was designed to detect differences in the use of different transportation means due to the lockdown, given the restriction of avoiding unnecessary movement. Therefore, it is built to account for related factors that can influence shopping and mobility behaviour during an epidemic, even in the absence of this restriction, from alimentary habits to risk preferences.

Fig. 2 shows the structure and contents of the survey.

Filling in the survey took no longer than 10 min. A copy of the survey, translated from Italian to English, is available in the Appendix.

The survey was sent to the institutional email addresses of the students registered at the University of Torino. The University is located in the city of Torino, the main town of the Piedmont region (northwest Italy) and the fourth largest Italian municipality by population. The province of Torino has approximately 2.26 million inhabitants (ISTAT, 2021). The University of Torino is relevant for several reasons: First, it is one of the most ancient universities in Italy, founded in 1440, with three Nobel Prize winners and two Italian presidents. Further, the university accounts for approximately 81,700 undergraduate and graduate students (61.6% female), mainly residing in Piedmont (approximately 80%). Finally, it can also be considered a city within the city of Torino, with 120 buildings and 22 libraries in different areas of the city, as well as in key urban locations in the entire region.

The Students’ Office of the central administration of the University

![Survey blocks](image-url)
sent a survey invitation to all students and presented this project as an official research project of the University itself. This strategy aimed at maximising the response rate, as it is generally low when this strategy of data collection is used. A total of 4700 students completed the survey (75% female, mean age 24 years). The recipients of the invitation were allowed 10 days to complete the questionnaire and received no compensation for this.

Table 1 summarises the interviewees' characteristics. 1 74% of the sample is female, reflecting the larger number of females in the university population. The mean age is 24 years, with some outliers representing the adult working students. The respondents' parents mostly have secondary or tertiary education diplomas, while many interviewees have at least one sibling. Half of the interviewees declared to being in a sentimental relationship, while prevalently, they do not have children. 30% of respondents declared that they were very concerned about environmental sustainability; eventually, 17% defined their family as very attentive to these issues.

Table 2 summarises the interviewees’ situation during the lockdown. The subjects lived with approximately two other persons, with 86% living with family members. Only 2% lived alone. 51% of the people who lived with respondents continued working outside the house during the lockdown, while only 6% of respondents themselves worked outside the house during the lockdown. 94% of the interviewees spent the lockdown in the same household they used to live. Few students (56) spent the lockdown abroad; we exclude them, as the situation in other countries was very different. The cities in which respondents lived varied: 34% lived in towns with 5 to 10,000 inhabitants, and 39% in centres with 74% of the interviewee’s households regularly ate outside home before the lockdown. A second variable of interest, on which food consumption at home depends, is whether the members of the interviewee’s household infrequently ate outside home, and zero otherwise. The

### Table 2

| Variable                         | Obs | Mean   | Std. Dev. | Min | Max |
|----------------------------------|-----|--------|-----------|-----|-----|
| Female (as a share)              | 3993| 0.739  | 0.439     | 0   | 1   |
| Age                              | 3993| 24.273 | 6.934     | 0   | 82  |
| Number of brothers               | 3535| 0.704  | 0.839     | 0   | 18  |
| Number of sisters                | 3611| 0.626  | 0.696     | 0   | 5   |
| Single (as a share)              | 3993| 0.445  | 0.497     | 0   | 1   |
| Number of children               | 192 | 1.688  | 0.77      | 1   | 5   |
| Secondary education fathers a    | 3993| 0.293  | 0.455     | 0   | 1   |
| Tertiary education fathers b     | 3993| 0.459  | 0.498     | 0   | 1   |
| Secondary education mothers b    | 3993| 0.231  | 0.421     | 0   | 1   |
| Tertiary Education mothers b     | 3993| 0.513  | 0.5       | 0   | 1   |

* a Referred only to the respondents with children.
* b As shares of the sample.

Table 3 presents the descriptive statistics of the use of transportation means before and during the lockdown. People substantially changed the transportation means used to shop for food, and preferred private vehicles and walking to public transportation and shared cars.

### Table 3

| Transportation means | Before the LD | After the LD | Significance |
|----------------------|---------------|--------------|--------------|
| Fresh food           |               |              | ***          |
| None (feet)          | 48.10         | 44.93        |              |
|                      | (0.72)        | (0.71)       |              |
| Car (own)            | 63.72         | 57.85        | ***          |
|                      | (0.70)        | (0.72)       |              |
| Car sharing          | 0.51          | 0.32         | *            |
|                      | (0.01)        | (0.08)       |              |
| Public transportation | 3.09          | 1.17         | ***          |
|                      | (0.27)        | (0.15)       |              |
| Bike                 | 3.66          | 2.08         | ***          |
|                      | (0.31)        | (0.18)       |              |
| Long-life food       |               |              | ***          |
| None (feet)          | 40.57         | 38.63        |              |
|                      | (0.71)        | (0.71)       |              |
| Car (own)            | 71.23         | 64.51        | ***          |
|                      | (0.66)        | (0.70)       |              |
| Car sharing          | 1.30          | 0.36         | ***          |
|                      | (0.17)        | (0.08)       |              |
| Public transportation | 3.45          | 1.11         | ***          |
|                      | (0.26)        | (0.15)       |              |
| Bike                 | 4.68          | 2.43         | ***          |
|                      | (0.30)        | (0.22)       |              |

Observations: 4,700. Signed-rank Wilcoxon tests.

* a Multiple answers allowed.

3.2. Empirical methodology

Interviewees were asked to state the weekly frequency of usage of different transportation means. However, the lockdown is likely to have affected this as the restrictions imposed by the Italian government may have shifted purchases from shops and supermarkets located far from home to the facilities present in the neighbourhood. Furthermore, both the restrictions on citizens' mobility and the fear of contagion may have reduced purchase frequency. Then, the analysis of absolute frequencies can be misleading as it would reflect both possible changes in habits, and the response to legal restrictions and fear. Therefore, we normalise the frequencies of use before and during the lockdown before taking the difference between the frequencies pre- and during the lockdown. This difference is calculated for each transportation mean (foot, own car, public transportation, car sharing, and bike) and is used as a dependent variable in the regressions presented in the next section. A second normalisation is also used: the weekly frequencies of use of the different transportation means are normalised to the sum of the maximum frequencies of all of modes in the sample. Consequently, we can assess the variation in the relative use of each transportation means because of the lockdown. This second specification of the dependent variable also serves as a robustness check for the results.

The two variables of interest which capture some economic effects of the lockdown are the variations in households' economic conditions and the change in weekly food purchases. The latter is measured as the number of times the interviewee's household shopped for food before and during the lockdown. A second variable of interest, on which food consumption at home depends, is whether the members of the interviewee's households regularly ate outside home before the lockdown. This variable is introduced as a dummy equalling one if the members of the household infrequently ate outside home, and zero otherwise. The
### Table 4
Transportation means used for purchasing fresh food. Odds ratios after ordered logit regressions on differences between normalised frequencies. Standard errors in parentheses.

| Specification | Feet | Car | Public transportation | Bike |
|---------------|------|-----|-----------------------|------|
| **Worse economic conditions** | | | | |
| 1.052 (0.0988) | 1.103 (0.105) | 0.380 (0.109)** | 0.247 (0.013)** |
| **Better economic conditions** | | | | |
| 1.172 (0.155) | 1.058 (0.114) | 1.237 (0.265) | 0.315 (0.027)** |
| **Increased consumption of food** | | | | |
| 0.932 (0.0959) | 0.994 (0.0638) | 1.893 (0.224)** | 1.921 (0.186)** |
| **Decreased consumption of food** | | | | |
| 1.220 (0.378) | 0.956 (0.0775) | 1.758 (1.355) | 3.547 (0.254)** |
| **Better ec. cond * decreased consumption** | | | | |
| n.a. | n.a. | n.a. | n.a. |
| **Worse ec. cond * increased consumption** | | | | |
| n.a. | n.a. | n.a. | n.a. |
| **Not used to eat outside home** | | | | |
| 0.804 (0.118) | 0.820 (0.0672)** | 4.825 (2.318)** | 8.379 (0.490)** |
| **Observations** | 2742 | 2742 | 2742 | 2742 |
| **Pseudo R-squared** | 0.002 | 0.001 | 0.063 | 0.100 |
| **Additional controls** | NO | NO | NO | NO |
| **Worse economic conditions** | | | | |
| 1.004 (0.146) | 1.116 (0.341) | 1.187 (0.618) | 0.436 (0.0530)** |
| **Better economic conditions** | | | | |
| 1.259 (0.196) | 0.691 (0.0906)** | 0.903 (0.179) | 0.172 (0.0159)** |
| **Increased consumption of food** | | | | |
| 0.809 (0.0794)** | 1.077 (0.191) | 11.03 (0.913)** | 5.674 (0.662)** |
| **Decreased consumption of food** | | | | |
| 1.230 (0.380) | 1.005 (0.254) | 2.822 (3.391) | 7.281 (0.630)** |
| **Better ec. cond * decreased consumption** | | | | |
| 0.0823 (0.118) | 14.24 (17.29)** | 3.099 (3.401) | 4.741 (1.692)** |
| **Worse ec. cond * increased consumption** | | | | |
| 1.013 (0.141) | 1.049 (0.452) | 0.0744 (0.0256)** | 0.240 (0.0254)** |
| **Not used to eat outside home** | | | | |
| 0.709 (0.0943)** | 0.933 (0.0844) | 4.928 (3.189)** | 10.14 (0.749)** |

| Specification | Feet | Car | Public transportation | Bike |
|---------------|------|-----|-----------------------|------|
| **Worse economic conditions** | | | | |
| 1.219 (0.179) | 1.004 (0.259) | 0.833 (0.313) | 0.406 (0.0277)** |
| **Better economic conditions** | | | | |
| 1.350 (0.174)** | 0.896 (0.0825) | 1.129 (0.129) | 0.288 (0.0313)** |
| **Increased consumption of food** | | | | |
| 1.046 (0.121) | 0.916 (0.147) | 9.569 (0.828)** | 4.510 (0.326)** |
| **Decreased consumption of food** | | | | |
| 1.383 (0.471) | 0.820 (0.0829)** | 1.481 (1.273) | 3.029 (0.258)** |
| **Better ec. cond * decreased consumption** | | | | |
| n.a. | n.a. | n.a. | n.a. |
| **Worse ec. cond * increased consumption** | | | | |
| n.a. | n.a. | n.a. | n.a. |
| **Not used to eat outside home** | | | | |
| 0.747 (0.115)** | 1.218 (0.442) | 0.0898 (0.0308)** | 0.263 (0.0278)** |
| **Observations** | 2742 | 2742 | 2742 | 2742 |
| **Pseudo R-squared** | 0.137 | 13.73 | 6.353 | 7.525 |
| **Additional controls** | NO | NO | NO | NO |
| **Worse economic conditions** | | | | |
| 1.004 (0.146) | 1.116 (0.341) | 1.187 (0.618) | 0.436 (0.0530)** |
| **Better economic conditions** | | | | |
| 1.259 (0.196) | 0.691 (0.0906)** | 0.903 (0.179) | 0.172 (0.0159)** |
| **Increased consumption of food** | | | | |
| 0.809 (0.0794)** | 1.077 (0.191) | 11.03 (0.913)** | 5.674 (0.662)** |
| **Decreased consumption of food** | | | | |
| 1.230 (0.380) | 1.005 (0.254) | 2.822 (3.391) | 7.281 (0.630)** |
| **Better ec. cond * decreased consumption** | | | | |
| 0.0823 (0.118) | 14.24 (17.29)** | 3.099 (3.401) | 4.741 (1.692)** |
| **Worse ec. cond * increased consumption** | | | | |
| 1.013 (0.141) | 1.049 (0.452) | 0.0744 (0.0256)** | 0.240 (0.0254)** |
| **Not used to eat outside home** | | | | |
| 0.709 (0.0943)** | 0.933 (0.0844) | 4.928 (3.189)** | 10.14 (0.749)** |

**Size of the settlement of the interviewee**

| (reference category more than 100,000) | (reference category more than 100,000) |
|--------------------------------------|--------------------------------------|
| < 25,000 | 0.938 (0.104) | 0.988 (0.132) | 39.18 (10.54)** | 6.158 (0.954)** | 25,000 | 0.957 (0.111) | 0.944 (0.0783) | 48.84 (19.40)** | 4.177 (0.0930)** |
| 25,000 - 50,000 | 0.826 (0.116) | 0.829 (0.0812)** | 21.60 (6.681)** | 4.577 (0.624)** | 25,000 - 50,000 | 0.814 (0.115) | 0.943 (0.122) | 28.71 (17.79)** | 4.302 (0.362)** |
| 50,000 - 100,000 | 0.467 (0.129)** | 0.922 (0.149) | 2.522 (1.172)** | 1.766 (0.539)** | 50,000 - 100,000 | 0.437 (0.115) | 0.853 (0.122) | 1.589 (17.99)** | 1.222 (0.362)** |
| City suburbs | 0.630 (0.0939)** | 1.017 (0.285) | 1.746 (0.140)** | 1.922 (0.0770)** | City suburbs | 0.647 (0.0365)** | 0.946 (0.205) | 1.718 (0.205)** | 1.931 (0.0193)** |
| Observations | 2742 | 2742 | 2742 | 2742 |
| Pseudo R-squared | 0.051 | 0.057 | 0.232 | 0.201 |
| Additional controls | 1 | 1 | 1 | 1 |

**Additionals.** (1): household size; variations in the number of weekly purchases in supermarkets and shops and from producers. (2): as (1) plus regional fixed effects.

*** p-value ≤ 0.01.
change in food purchases is captured by two dummies; one equalling one if the purchases increased (zero otherwise), and the other equalling one if the purchases decreased (zero otherwise). Then, the absence of any change represents the reference situation. Some specifications also include interactions between logically opposite phenomena. These interactions capture situations in which a better (worse) economic situation is accompanied by a decrease (an increase) in food purchases. The rationale is to disentangle the cases in which worsened economic conditions pushed households to decrease their food consumption. Worsened economic conditions may also increase food consumption if some member(s) of the household became unemployed and stopped working temporarily, and therefore, eat at home more often than before. Analogously, households with improved economic conditions may have increased the number of meals eaten outside home because, for instance, some member(s) become employed. The presence of these opposite trends in regressions without interactions may result in coefficients which are not statistically different than zero, while in reality, two opposite forces are at work. Given the tighter budget constraint of households with worsened economic conditions, increased food consumption may have shifted them from more expensive to cheaper transportation means even more than unchanged or decreased food purchases due to the same economic decline. The opposite may have occurred in the other situation, i.e., better economic situation and reduced food purchases.

By construction, the two dependent variables are defined on finite intervals; specifically, as they are normalised, both lie in the interval [−1, 1]. These variables are constructed to represent the differences between frequencies. Coxe (2012) shows that in such a case, ordinary least squares (OLS) regressions may be used as they provide robust and consistent results. Nevertheless, for small samples, the confidence intervals may be biased. Therefore, the author suggests using ordered logit regressions, which have two advantages over OLS: 1) unbiased confidence intervals can be calculated, and 2) maximum likelihood functions may be biased. Therefore, the author suggests using ordered logit regressions for small samples. Nevertheless, for small samples, the confidence intervals may be biased. Therefore, the author suggests using ordered logit regressions, which have two advantages over OLS: 1) unbiased confidence intervals can be calculated, and 2) maximum likelihood functions are bounded, while linear specifications behind OLS are not. Thus, following Coxe (2012), our regressions include some control variables, which are gradually introduced in the specifications for the sake of robustness checks. These controls include regional fixed effects: some of the interviewees reside outside Piedmont and the COVID-19 pandemic hit Italian regions differently, with the highest prevalence in the north and the lowest in the south and the islands. For a similar reason, dummies capture the size of the town where the interviewees and their families reside. This is achieved using five dummies clustering towns according to the number of inhabitants; cities with more than 100,000 residents are used as a reference category. In Italy, centres of this size are either large provincial chief towns or regional capitals, and therefore, are characterised by the presence of numerous commercial services (Mighelli, 2017). Finally, some regressions control for the variation in the number of weekly purchases of food in different types of stores, such as supermarkets, local shops, and stores located far from the neighbourhood where the household lives, local market, and producers (for fresh food). Changes in locations where food is purchased can affect the transportation means used to reach them. As the number of respondents using car sharing to purchase fresh goods is very small (37 out of 2742), this means of transportation is not included in the regressions when fresh foods are considered. Such a small number of users is indeed very likely to inflate the odds ratios of the ordered logit model, rendering them almost meaningless.

Following the extant literature, our main hypotheses are as follows:

**Hypothesis 1.** The lockdown shifted purchases from stores located far from home to local shops, thus reducing (increasing) car and public transportation (feet and bikes) usage.

**Hypothesis 2.** The fear of contagion reduced the use of promiscuous means, such as public transport and car sharing.

**Hypothesis 3.** Increased food consumption at home increased the use of transportation means other than walking.

**Hypothesis 4.** The fear of contagion decreased the number of weekly purchases, thereby increasing the average quantity bought per purchase.

The last two hypotheses suggest higher usage of owned cars and bikes. As the four hypotheses suggest, a clear direction of the change in different transportation usage habits considered here does not emerge because of the lockdown and the pandemic, as different forces push in opposite directions. Therefore, an empirical analysis of what happened is particularly interesting to evaluate how people changed their transportation habits.

4. Results

Separate analyses are performed for fresh and long-lasting foods, as the shops selling them may differ. Furthermore, purchases of long-lasting food may be concentrated a few times, while the same is less likely to occur for fresh products. Consequently, consumers may adopt different strategies for the two product categories. To present easy-to-interpret results, Tables 4, 5, 6, and 7 show only the odds ratios computed after ordered logit estimates values larger (smaller) than one indicate a relatively more (less) frequent use of a given transportation mean. For brevity, the tables that follow report only the odds ratios for the variables of interest, but not for controls. Instead, the absolute variations may have opposite signs. As the dependent variables are normalised differences between frequencies, the results represent the impact of the independent variables on the change in the relative use of each transportation mean considered. That is, values larger than one indicate that households have increased a given transportation mode's usage relative to the others, as a response to a variation in the considered independent variable. For example, an odds ratio of 1.5 relative to the variable 'Better economic conditions', when the change in private car usage is analysed, means that, on average, an improvement in a household's economic conditions increases private car usage by 50% relative to the use of the other transportation means.

4.1. Transportation means and fresh food purchases: normalised variations

Table 4 presents the estimates for the normalised differences in the use of various transportation means when fresh food is purchased. Improvements (deterioration) in a household's economic conditions decreases (increases) private car and bike usage, while the relative use of other transportation means is unaffected. Lower bike usage may be explained by the decrease in the number of weekly purchases due to the lockdown. As food consumption is likely to not have decreased because people were forced to stay home, thereby reducing the number of meals consumed outside, a decrease in the number of purchases entails larger quantities of food bought per purchase. Therefore, bikes may be an inadequate means to carry large quantities of goods. Indeed, the two dummies capturing the variations in the use of the transportation means due to variations in food consumption suggest that bike usage increased for decreased food consumption much more than in the opposite situation. The values in the table also show that public transportation usage increased during the lockdown compared to the other means and to the centres of cities. However, the large values of the odds ratios for towns below 50,000 inhabitants reflect the small number of respondents who used public transportation in those centres, where public transportation is less diffused. In large towns and suburbs of cities, the use of feet decreased compared to other transportation means, perhaps because of higher average quantities of food purchased.

Households with improved economic conditions and reduced food
### Table 5
Transportation means used for buying long-lasting food. Odds ratios after ordered logit regressions on differences between normalised frequencies. Standard errors in parentheses.

|                          | Feet | Car | Public transportation | Car sharing | Bike |
|--------------------------|------|-----|-----------------------|-------------|------|
| **Transportation means** |      |     |                       |             |      |
| **Worse economic conditions** |       |     |                       |             |      |
| 1.210                    | 1.302| 0.683| 0.457                | 0.891       |      |
| **(0.0967)**             | **(0.135)** | **(0.173)** | **(0.0371)** | **(0.0804)** |      |
| **Better economic conditions** |       |     |                       |             |      |
| 1.182                    | 1.459| 4.356| 1.507                | 2.294       |      |
| **(0.100)**              | **(0.171)** | **(0.881)** | **(0.0407)** | **(0.138)** |      |
| **Increased purchases of food** |       |     |                       |             |      |
| 0.804                    | 1.328| 1.505| 3.102                | 0.858       |      |
| **(0.0521)**             | **(0.116)** | **(0.122)** | **(0.120)** | **(0.0160)** |      |
| **Decreased purchases of food** |       |     |                       |             |      |
| 0.535                    | 0.800| 0.365| 0.937                | 0.192       |      |
| **(0.187)**              | **(0.0694)** | **(0.124)** | **(0.0778)** | **(0.0183)** |      |
| **Better ec. cond * decreased purchases** |       |     |                       |             |      |
| n.a.                     | n.a. | n.a. | n.a.                 | n.a.        |      |
| **Worse ec. cond * increased purchases** |       |     |                       |             |      |
| 1.102                    | 0.787| 1.879| 0.853                | 0.877       |      |
| **(0.0891)**             | **(0.104)** | **(0.419)** | **(0.0617)** | **(0.103)** |      |
| **Observations**         | 2742 | 2742| 2742                 | 2742        |      |
| **Pseudo R-squared**     | NO   | NO  | NO                   | NO          |      |
| **Specification 1**      |      |     |                       |             |      |
| **Worse economic conditions** |       |     |                       |             |      |
| 1.566                    | 0.884| 1.307| 0.310                | 1.144       |      |
| **(0.0554)**             | **(0.135)** | **(0.404)** | **(0.0169)** | **(0.100)** |      |
| **Better economic conditions** |       |     |                       |             |      |
| 1.053                    | 1.025| 9.004| 2.334                | 3.024       |      |
| **(0.0709)**             | **(0.111)** | **(0.924)** | **(0.271)** | **(0.220)** |      |
| **Increased purchases of food** |       |     |                       |             |      |
| 0.875                    | 0.915| 3.155| 2.003                | 0.705       |      |
| **(0.0969)**             | **(0.117)** | **(0.277)** | **(0.0734)** | **(0.0772)** |      |
| **Decreased purchases of food** |       |     |                       |             |      |
| 0.470                    | 0.874| 0.401| 2.580                | 0.190       |      |
| **(0.199)**              | **(0.142)** | **(0.483)** | **(0.319)** | **(0.00889)** |      |
| **Better ec. cond * decreased purchases** |       |     |                       |             |      |
| 0.955                    | 1.587| 2.981| 0.757                | 3.177       |      |
| **(0.652)**              | **(0.633)** | **(0.995)** | **(0.305)** | **(0.594)** |      |
| **Worse ec. cond * increased purchases** |       |     |                       |             |      |
| 0.573                    | 2.218| 0.346| 3.465                | 0.770       |      |
| **(0.0680)**             | **(0.375)** | **(0.0977)** | **(0.536)** | **(0.125)** |      |
| **Not used to eat outside home** |       |     |                       |             |      |
| 1.101                    | 0.810| 1.671| 0.569                | 0.797       |      |
| **(0.0727)**             | **(0.0898)** | **(0.418)** | **(0.0619)** | **(0.0810)** |      |
| **Size of the settlement of the interviewee (reference category more than 100,000)** |      |     |                       |             |      |
| < 25,000                 | 1.049| 1.028| 16.42                | 3.629       | 3.484|
| **(0.116)**              | **(0.102)** | **(5.026)** | **(0.482)** | **(0.499)** |      |
| 25,000 - 50,000          | 0.895| 1.334| 32.39                | 5.746       | 2.002|
| **(0.0803)**             | **(0.182)** | **(10.74)** | **(0.835)** | **(0.309)** |      |
| 50,000 - 100,000         | 0.827| 1.401| 36.13                | 3.922       | 5.658|
| **(0.137)**              | **(0.284)** | **(9.000)** | **(0.659)** | **(1.340)** |      |
| **City suburbs**         | 0.730| 1.084| 4.011                | 3.922       | 1.993|
| **(0.105)**              | **(0.151)** | **(0.390)** | **(0.420)** | **(0.119)** |      |
| **Observations**         | 2742 | 2742| 2742                 | 2742        |      |
| **Pseudo R-squared**     | 0.037| 0.037| 0.247                | 0.207       | 0.139|
| **Additional controls**  | 1    | 1   | 1                    | 1           | 1    |

**Additional controls. (1): household size; variations in the number of weekly purchases in supermarkets and shops and from producers. (2): as (1) plus regional fixed effects.**

- **p-value ≤ 0.01.**
- **0.01 < p-value ≤ 0.05.**
- **0.05 < p-value ≤ 0.1.**
### Table 6
Transportation means for purchasing fresh food. Odds ratio after ordered logit regressions on share differences in normalised frequencies. Standard errors in parentheses.

|                  | Feet | Car | Public transportation | Bike |                  | Feet | Car | Public transportation | Bike |
|------------------|------|-----|-----------------------|------|------------------|------|-----|-----------------------|------|
| **Feet Car Public** transportation Bike |
| **Worse economic conditions** |
| Specification 1 | 1.022 (0.0696) ** | 1.243 (0.104)** | 0.380 (0.109)** | 0.247 (0.0135)** |
| Specification 2 | 1.170 (0.127) ** | 1.095 (0.146) ** | 0.833 (0.313) ** | 0.406 (0.0277)** |
| Better economic conditions |
| Specification 3 | 1.193 (0.158)** | 1.122 (0.0757)** | 1.237 (0.265)** | 0.315 (0.0277)** |
| Specification 4 | 1.354 (0.146)** | 0.994 (0.0319)** | 1.129 (0.129) ** | 0.288 (0.0313)** |
| Increased consumption of food |
| Specification 1 | 1.059 (0.0847)** | 0.850 (0.0904)** | 1.893 (0.224)** | 1.921 (0.186)** |
| Specification 2 | 1.175 (0.0896)** | 0.766 (0.134) ** | 9.569 (0.828) ** | 4.510 (0.326)** |
| Decreased consumption of food |
| Specification 1 | 1.165 (0.194)** | 1.062 (0.0828)** | 1.758 (1.355)** | 3.547 (0.254)** |
| Specification 2 | 1.306 (0.0826)** | 0.954 (0.0923) ** | 1.481 (1.273) ** | 3.029 (0.258)** |
| Better ec. cond decreased consumption |
| Specification 3 | n.a. n.a. n.a. n.a. |
| Specification 4 | 0.141 (0.228)** | 7.387 (3.095)** | 6.353 (6.883)** | 7.525 (3.275)** |
| Worse ec. cond increased consumption |
| Specification 3 | n.a. n.a. n.a. n.a. |
| Specification 4 | 0.765 (0.0895)** | 1.299 (0.520) ** | 0.0898 (0.0308)** | 0.263 (0.0278)** |
| Not used to eat outside home |
| Specification 1 | 0.943 (0.0750)** | 0.819 (0.0841)** | 4.825 (2.318)** | 8.379 (0.490)** |
| Specification 2 | 0.920 (0.0784)** | 0.832 (0.0879) ** | 4.762 (2.304) ** | 8.524 (0.446)** |
| Observations |
| Specification 3 | 2742 2742 2742 2742 |
| Specification 4 | 2742 2742 2742 2742 |
| Pseudo R-squared |
| Specification 3 | 0.020 (0.0896)** | 0.037 (0.0938) ** | 0.085 (0.00906)** | 0.108 (0.00566)** |
| Specification 4 | 0.033 (0.138)* | 0.0589 (0.0569)** | 0.081 (0.0938)** | 0.110 (0.00546)** |
| Additional controls |
| Specification 3 | NO NO NO NO |
| Specification 4 | NO NO NO NO |
| Size of the settlement of the interviewer (reference category more than 100,000) |
| Specification 3 | NO NO NO NO |
| Specification 4 | NO NO NO NO |
| Size of the settlement of the interviewee (reference category more than 100,000) |
| Specification 3 | NO NO NO NO |
| Specification 4 | NO NO NO NO |

Additional controls. (1): household size; variations in the number of weekly purchases in supermarkets and shops and from producers. (2): as (1) plus regional fixed effects.
consumption reach the stores relatively more frequently using their own cars and bikes than on foot compared to the pre-lockdown period. Meanwhile, households with increased food consumption and worse economic situation use bikes less frequently, consistent with the hypothesis presented in the previous section. Finally, households who ate outside less frequently before the lockdown decreased (increased) the use of foot (public transportation and bikes). Overall, the results regarding public transportation usage suggest that people considered this rather safe from contagion; otherwise, the use of such promiscuous means would have decreased. Alternatively, given the strict controls on people’s movements implemented by the Italian police, people were deemed less likely to be controlled while using public means than their own cars.

4.2. Transportation means and long-lasting food purchases: normalised variations

Table 5 presents similar estimates for long-lasting food purchases. Households with worsened economic conditions opted to walk (use car sharing) to food stores more (less) that before the lockdown. Meanwhile, improved economic conditions relatively increased public transportation, bikes, and car sharing usage, while there were no statistically significant changes in walking and using their own cars. Both increasing and decreasing purchases of long-lasting food products correlate negatively with changes in the frequency of transportation means usage. Therefore, the values in the table are consistent with a general strategy of reducing the number of purchases, perhaps by increasing the average quantity.

The interaction term between improved economic conditions and decreased food consumption shows that, in this case, households used public transportation and bikes more frequently. The other interaction term features a somewhat opposite behaviour with a relative increase in car usage (both owned and shared), perhaps witnessing large single purchases of long-lasting goods. While the use of expensive means such as private cars may appear paradoxical, large quantities of goods together with a consequent reduction in the number of purchases may render car usage as convenient. Finally, those households, where eating outside home was infrequent before the lockdown, used their own car and bike more often. In large towns and city suburbs, people walked less frequently to purchase long-lasting goods, while they preferred to use public transport, car sharing, and bikes more often than before the lockdown.

Overall, the results presented in Tables 4 and 5 suggest that the lockdown induced some behavioural changes in terms of the use of transportation means to purchase food. Unexpectedly, in many cases, people increased public transportation usage, despite the possibility of being infected. Comparing Tables 4 and 5 also reveals that bikes are preferred in the case of purchases of fresh than long-lasting goods; moreover, their usage for people living in centres with 50,000 inhabitants or less, where distances may be shorter than in larger settlements. Private car usage decreased, particularly in large towns and city suburbs, for purchasing both fresh and long-lasting food. During the lockdown, public authorities recommended shops in the proximate neighbourhoods and enforced severe police control.

4.3. Transportation means and food purchasing: relative normalised changes

Tables 6 and 7 report the estimations for the same specifications as the previous two tables; for the dependent variable, they use the variation in the relative use of transportation means computed using the second normalisation described in the previous section. The values in the tables confirm the previous results. People walk (use cars) more (less) in small-medium towns. Reduced car usage is also compensated by more frequent public transportation (although this concerns very few people in towns with less than 50,000 inhabitants) and bike usage.

For readability, the main results are presented graphically in the following figures. These summarise the results of the fourth specification presented in each of the previous four tables and are derived from the odds ratios, transforming the latter in relative changes. That is, the figures reported in tables are equal to the odds ratios reported in the tables minus one. Therefore, the signs represented in the figures coincide with the sign of the variation in the use of each transportation mean determined by each considered variable (Figs. 3–6).

5. Discussion and conclusion

This research contributes to the literature by comparing the habits regarding the use of specific transportation modes for food purchasing prior and during the COVID-19 lockdown. We do not find a clear and generalized change in households’ mobility habits; the differences depend on whether fresh or long-lasting food is concerned, the improvement/deterioration of households’ economic conditions, and consumption increases/decreases.

The results partially support the first hypothesis as public transport usage increased, while bike usage and walking increased in purchasing both fresh and long-lasting food. Public transportation usage relatively increased (decreased) for households whose economic conditions improved (worsened). Notably, as the dependent variables are differences between normalised frequencies, this result does not imply an absolute increase in this transportation mode’s usage. Rather, the usage increased relative to the other means in a post-pre comparison. However, households experiencing worse economic conditions increased the relative use of owned and shared cars, while decreasing that of public transport, feet, and bikes, especially for purchasing long-lasting foods. This result may suggest that these families increased the average quantities bought per purchase: transporting large quantities, and thus, heavy weights is easier in cars without necessarily increasing expenditure. Indeed, a decrease in both the number of purchases and the price of gasoline during the lockdown may have rendered cars more convenient than public transport.

Regarding the second hypothesis, the results suggest that, in general, car sharing is considered quite safe, in line with Teixeira and Lopes (2020). However, public transportation usage changed differently depending on whether purchases of fresh or long-lasting food are considered and the changes in households’ economic situation. Consequently, the results did not confirm the initial hypothesis.

Regarding the third hypothesis, for fresh food, increased food consumption by households experiencing worsened economic conditions is associated with a greater bike usage. Meanwhile, for long-lasting food, car usage increased; this may be explained by a large single purchase. The descriptive statistics highlight that the frequency of use of different transportation modes has generally decreased, in line with the literature (Cranfield, 2020) and the Italian government’s requirements. A large drop in the average use of car sharing and public transportation is visible, although econometric analyses suggest that households whose economic conditions improved increased their relative use of these

\[\text{While the odds ratios relative to these last two means are statistically different from 1 in specifications 1 and 2, the values in specifications 3 and 4 are more reliable as the regressions control for more factors which may affect the choice between different transportation means.}\]
|                | Transportation means for purchasing long-lasting food. Odds ratio after ordered logit regressions on share differences in normalised frequencies. Standard errors in parentheses. |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | **Feet** | **Car** | **Public transportation** | **Car sharing** | **Bike** | **Feet** | **Car** | **Public transportation** | **Car sharing** | **Bike** |
| Specification 1 |          |          |                          |                |          |          |          |                          |                |          |
| Worse economic conditions | 1.073 (0.143) | 1.078 (0.115) | 0.596 (0.140)** | 0.457 (0.0371)** | 0.933 (0.0722)** | Specification 2 |          |          |                          |                |          |
| Increased consumption of food | 0.697 (0.0320)** | 1.129 (0.0740)** | 0.977 (0.0575)** | 3.102 (0.120)** | 0.530 (0.00845)** |          |          |                          |                |          |
| Decreased consumption of food | 0.582 (0.154)** | 0.707 (0.0335)** | 0.278 (0.0877)** | 0.937 (0.0778)** | 0.179 (0.0174)** |          |          |                          |                |          |
| Better ec. cond * decreased consumption | n.a. (n.a.) | n.a. (n.a.) | n.a. (n.a.) | n.a. (n.a.) | n.a. (n.a.) |          |          |                          |                |          |
| Worse ec. cond * increased consumption | 1.017 (0.0598) | 0.865 (0.0891) | 1.517 (0.257)** | 0.853 (0.0617)** | 0.833 (0.0853)* |          |          |                          |                |          |
| Not used to eat outside home | n.a. (n.a.) | n.a. (n.a.) | n.a. (n.a.) | n.a. (n.a.) | n.a. (n.a.) |          |          |                          |                |          |
| Specification 3 |          |          |                          |                |          |          |          |                          |                |          |
| Worse economic conditions | 1.204 (0.137)** | 0.891 (0.162)** | 0.813 (0.202) | 0.310 (0.0169)** | 0.943 (0.0469) |          |          |                          |                |          |
| Increased consumption of food | 0.731 (0.0685)** | 1.014 (0.0703)** | 1.128 (0.0974)** | 2.003 (0.0734)** | 0.556 (0.0485)** |          |          |                          |                |          |
| Decreased consumption of food | 0.495 (0.155)** | 0.815 (0.115)** | 0.298 (0.109)** | 2.580 (0.319)** | 0.192 (0.0119)** |          |          |                          |                |          |
| Better ec. cond * decreased consumption | 0.545 (0.317) | 0.755 (0.320)** | 2.349 (0.735)** | 0.757 (0.305)** | 2.061 (0.384)** |          |          |                          |                |          |
| Worse ec. cond * increased consumption | 0.687 (0.100)** | 1.553 (0.284)** | 0.817 (0.201) | 3.465 (0.536)** | 1.283 (0.165)** |          |          |                          |                |          |
| Not used to eat outside home | 1.039 (0.0520) | 0.869 (0.0840)** | 1.321 (0.0545)** | 0.569 (0.0619)** | 0.727 (0.0731)** |          |          |                          |                |          |
| Size of the settlement of the interviewee (reference category more than 100,000) |          |          |                          |                |          |          |          |                          |                |          |
| < 25,000 | 0.512 (0.0380) | 1.975 (0.124)** | 9.138 (2.431)** | 6.296 (0.482)** | 2.554 (0.299)** |          |          |                          |                |          |
| 25,000 - 50,000 | 0.462 (0.0489) | 2.015 (0.115)** | 12.12 (2.943)** | 5.746 (0.835)** | 1.709 (0.236)** |          |          |                          |                |          |
| 50,000 - 100,000 | 0.632 (0.112)** | 2.369 (0.397)** | 15.76 (15.76)** | 3.922 (0.659)** | 10.45 (1.420)** |          |          |                          |                |          |
| City suburbs | 0.549 (0.0762) | 1.492 (0.159)** | 6.036 (0.728)** | 3.922 (0.420)** | 1.770 (0.100)** |          |          |                          |                |          |
| Observations | 2742 | 2742 | 2742 | 2742 | 2742 |          |          |                          |                |          |
| Additional controls | 0.024 | 0.025 | 0.203 | 0.207 | 0.135 |          |          |                          |                |          |

**Additional controls. (1): household size; variations in the number of weekly purchases in supermarkets and shops and from producers. (2): as (1) plus regional fixed effects.**

*** p-value < 0.01.

** 0.01 < p-value < 0.05.

* 0.05 < p-value ≤ 0.1.
modes. These two results are not at odds: the economic situation improved (worsened) for 9.96% (44.33%) of the interviewed families. This may also suggest that fewer people use public transportation, rendering it relatively safe due to fewer passengers.

The analyses are in line with the literature (Aloi et al., 2020; Hardt & Bogenberger, 2019) on increased personal transportation usage only for feet and bikes. Instead, no clear and robust increase in private car usage occurs. The economic disparities accentuated by the COVID-19 pandemic and the related lockdown affected the use of different transportation means, with undoubtable repercussions on the sustainability of mobility, especially in urban areas, as reported by Bonaccorsi et al. (2020). However, in some cases, mobility has shifted toward greener transportation modes. These results should be interpreted in a framework in which online purchases increased. Approximately 230 (139)
sampled households reported a higher number of online purchases of long-lasting (fresh) foods. Most increases are concentrated in towns with more than 100,000 inhabitants. This phenomenon may depend on the location of supermarkets and hypermarkets in large towns. These are generally located in the peripheries and are more difficult to reach during the lockdown, especially by people living in the town centres who may have preferred to shop online. Households’ proximity to food stores and supermarkets is, instead, more likely in small towns, where a smaller share of households reported a higher number of online food purchases. Notably, the economic distress caused by the pandemic is likely transitory, although the time needed for recovery is unpredictable and depends on the further evolution of the pandemic itself. Therefore, the results presented here may be transitory as well, particularly if they depend only on income shocks, instead of structural changes in people’s behaviour. The future will answer this query; nevertheless, policymakers interested in environmental protection should also consider the possibility of long-lasting effects of the behavioural changes depicted here.

The chosen sample may represent a limit that influences our results: families where at least one member is a university student are hardly representative of the population. Moreover, their behaviour is inferred from the responses given by the interviewees, who are likely not to be the main person in charge of food purchases in the family. However, these families also allow us to capture the peculiarities of different social strata. Our results can be considered a starting point for future research, contributing to extending the scant literature on households’ transportation habits during the pandemic. Furthermore, Torino is not necessarily representative of other Italian cities. Nevertheless, its size and the fact that university students represent approximately 10% of the population render it similar to many other European cities, which may share the same issues regarding mobility and the impact of COVID-19 related restrictions.

The research also suggests some practical implications. Both policymakers and automotive players should reflect on how mobility has changed and potentially will be after this crisis, with significant consequences on mobility, especially in the urban context. The post-COVID era challenge can be oriented to rethinking the transport system and urban infrastructures to ensure a safe and more sustainable urban environment, while being supported by new technologies. This result is particularly important in terms of policy: as the data show, better economic conditions are associated with increased public transport usage. This may depend on the particular area studied here. The European Commission (2015) notes that Torino’s public transportation system is the third most accessible in the EU. Strengthening public transportation networks may be a sustainable response not only to the current environmental challenges, but also to shocks such as the COVID-19 pandemic. Research that follows-up and monitors these issues will be an important contribution, especially now that countries are facing a second wave of COVID-19.
