Observed impacts of the Covid-19 first wave on travel behaviour in Switzerland based on a large GPS panel

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ABSTRACT

In Switzerland, strict measures as a response to the Covid-19 pandemic were imposed on March 16, 2020, before being gradually relaxed from May 11 onwards. We report the impact of these measures on mobility behaviour based on a GPS tracking panel of 1439 Swiss residents. The participants were also exposed to online questionnaires. The impact of both the lockdown and the relaxation of the measures up until the middle of August 2020 are presented. Reductions of around 60% in the average daily distance were observed, with decreases of over 90% for public transport. Cycling increased in mode share drastically. Behavioural shifts can even be observed in response to the announcement of the measures and relaxation, a week before they came in to place. Long-term implications for policy are discussed, in particular the increased preference for cycling as a result of the pandemic.

1. Introduction

The sudden onset of the Covid-19 pandemic in early 2020 dramatically altered the rhythms of daily life around the world. Within the space of a few weeks, borders were closed, lockdowns imposed and local economies brought to a stand-still in the attempt to contain the spread of the virus. Schools were closed, and children had their first experience of remote learning. After decades of unfulfilled predictions of the move towards teleworking, firms were forced to make the shift almost overnight. Those under lockdown orders were generally only allowed outside for shopping and small amounts of exercise. As a consequence, mobility behaviour became unrecognisable.

Understanding the impact these restrictions have had on mobility has been challenging, given the pace of the change. New policies were being implemented constantly; classic survey methods would not have kept pace with the dynamic changes to people's travel patterns. In this paper we present both the method and descriptive results from an app-based mobility survey panel of over 1500 people which was recruited as the pandemic took hold in Switzerland in mid-March. Uniquely, this panel was recruited from a previous mobility survey undertaken in

autumn 2019. Thus, a baseline behaviour for each participant in the study is available against which their mobility behaviour under these extra-ordinary circumstances can be understood.

The paper is structured as followed. First a timeline of the pandemic as it developed in Switzerland is presented, including the various restrictions and relaxations which occurred. The period up to the end of July is covered in this paper. A brief overview of GPS-based mobility studies in the literature is presented, as well as other available sources of Covid-19 mobility data. In the methods and data section, the recruitment and app are presented. The results section presents some of the key insights from the mobility tracking. In the discussion the implications of these findings for transport policy in the near future are discussed.

1.1. Covid-19 timeline in Switzerland

The first confirmed case of Covid-19 was registered in Switzerland on February 25, 2020. The onset followed that in Northern Italy, which was one of the earliest hotspots outside China. The situation deteriorated quickly and by March 9, over 100 people had been infected. At the time of writing, July 31, 2020, 791,725 people have been tested in

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Switzerland, over 35,000 people have been infected with the virus and more than 1700 have died, which translates to infection and death rates per 100,000 inhabitants of 38 and 2.4, respectively.

On March 16, the Federal Council declared an extraordinary situation, which gives it widespread competencies that allowed it to order the introduction of uniform measures in all cantons. Non-essential businesses were closed, along with schools, recreational facilities and public parks. Only food stores, post offices and healthcare institutions were not affected. Furthermore, checks on the borders to Germany, Austria, France and Italy were introduced. Entry to Switzerland from its four large neighbours was only possible for Swiss citizens, persons holding a residence permit for Switzerland and those who have to enter Switzerland for work-related reasons. Employers were urged to reorganise the working hours of their employees to avoid rush hour travel. Wherever possible, home-office was to be implemented. To minimise the risk of infection, the Federal Office of Public Health (FOPH) recommended avoiding the use of public transport wherever possible. People who had symptoms of respiratory disease and people over 65 years of age were told to not use public transport. National and regional passenger transport services were maintained to support the functioning of the economy and society. International passenger transport was maintained to countries with open borders.

The number of confirmed Covid-19 cases in Switzerland increased rapidly. On March 20, more than 4800 infections and 43 fatalities were reported. The canton of Ticino on the border to Northern Italy was hit especially hard by the corona virus. The Federal Council decided to step up measures and forbid gatherings of more than 5 people in public places, and an inter-personal distance of 2 m was mandated for groups with fewer than 5 people. However, unlike in neighboring countries as for example in Austria, Belgium, France, Italy, Luxembourg and Spain, people were allowed to leave the house during the lockdown. Public transport continued operation, though at reduced frequency. The peak rate of daily infections and Covid19-related deaths was in late March and early April. The statistics were subject to weekly fluctuations and showed fewer cases towards the end of the week. On April 5, Switzerland reported a total 158,000 Covid-19 tests, 15% (21,100) of which were positive, and 559 deaths, one of the highest incident rates in Europe. After that, infections started to decrease as a consequence of the containing measures. Despite the fact that the measures put in place to combat the virus were being followed well by the public and were having the desired effect, the Federal Council extended the measures until April 26.

On April 27, hospitals were able to resume all medical procedures, including non-urgent procedures, and a first group of businesses was allowed to re-open (garden centers, florists, hairdressing salons and cosmetic studios). The Federal Council's strategy to emerge from the lockdown was structured into three phases, with transitions depending on the number of new infections, hospital admissions and deaths as well as hospital occupancy rates. In a first phase from April 27 to May 11, measures were eased on businesses where a low level of direct contact is possible, where precautionary measures can easily be put in place, and where there will be no significant movements of people. As opposed to other countries, there was no general obligation for healthy people to wear a mask. Keeping a safe distance and washing hands was seen as the most effective protective measures. Still, sick people were advised to stay home in isolation.

On May 11, Switzerland moved to phase 2 by further easing measures as the spread of the corona virus had continued to slow. Even though rules on hygiene and social distancing still applied, most types of businesses opened again, including restaurants, along with mandatory school for students up to grade 9. Museums and libraries were allowed to re-open and sports activities in small groups of up to 5 people were permitted as well. In parallel, restrictions on entering Switzerland were relaxed and scheduled public transport services increased significantly. Furthermore, the Federal Council decided to introduce contact tracing for new infections with Covid-19.

Entering phase 3 of the emergency plan on June 6, all events of up to 300 persons and spontaneous gatherings for up to 30 people were allowed again. High schools and universities were able to resume, all leisure and entertainment businesses plus tourist attractions re-opened. Switzerland reported a cumulative total of 30,988 infections, 1663 Covid-related deaths and only 16 new cases. The number of new infections, hospitalisations and deaths continued to fall despite measures being eased, and stabilised at a low level. The extended powers of the federal government expired on June 19.

From June 22 onwards, the start of the fourth phase, most of the measures put in place were lifted and only the ban on large-scale events remains in place until at least the end of August. Interestingly, the Federal council reduced the minimum distance that should be kept between two people from 2 m to 1.5 m and strongly recommended to wear a face mask when using public transport if it is not possible to maintain the necessary distance. It also lifted the recommendation to work from home, leaving the decision to the employer, which is required to protect the health of staff by putting in place appropriate measures. In contrast to the first wave, the prime responsibility in the event of a renewed increase in Covid-19 cases now rests with the 26 cantons in Switzerland.

In response to an increase in new daily infections in mid-June and increased ridership on public transport, the Federal Council made wearing masks compulsory on public transport throughout Switzerland starting from July 6. Since mid-June, the number of new corona virus cases has been rising in Switzerland as infected persons have entered the country from countries both within and outside the Schengen area. Consequently, travellers entering Switzerland from certain regions must quarantine for ten days upon their return.

1.2. Tracking studies in the literature

The use of GPS tracking in mobility studies is becoming an integral data collection method in transportation. Where traditionally, such surveys required participants to carry a GPS logging device which had to be returned at the end of the study for the data to be collected, more recent methods allow users to install an app on their smartphone, which uses the GPS receiver and other location services on the phone to detect the location. These apps run in the background, and depending on the phone model, have a minimal effect on battery life, something which used to be extremely detrimental to such studies. For example, in the original MOBIS study sample on which this study is based, only 12.5% of participants who started tracking were lost over the 8 week study duration (Molloy et al., 2020).

In recent years there have been an increasing number of studies which have used either a separate GPS device (Nielsen, 2004; Wargelin, Stopher et al., 2012; Livingston, 2011), or a smartphone app (Allström et al., 2017; Greene et al., 2012; Safi et al., 2015; Stopher et al., 2018; Nahmias-Biran et al., 2018). This data is then usually segmented into trips (or sometimes lower level segments) and activities, on which the mode and trip purpose are imputed. The usefulness of this method is indicated by multiple sources that identify trip under-reporting in traditional paper-based travel diaries (Janzen et al., 2018; Wolf et al., 2003; Stopher et al., 2007).

1.3. Other Covid-19 mobility data sources

The rapid onset of the Covid-19 pandemic meant that there was little opportunity to set up new tracking studies to measure changes in mobility. However, there were a number of data sources which were already available. The most prominent were those from Apple (2020) and Covid-19 Community Mobility Reports (Google, 2020). The Apple reports monitor the number of search requests by transport mode (driving, walking, public transport) as an indicator for mobility. The Google reports use records of visits to land use types (i.e. parks), based on anonymised data collected from google apps and mobile devices. Both these reports present only overall aggregate numbers and do not

include analysis of socio-demographic differences. For the baseline, the Apple reports take January 13, 2020, and Google uses the period January 3 – February 6, 2020. Another available resource for Switzerland is produced by Intervista AG, in collaboration with the Zurich Statistics Bureau (Intervista AG, 2020). The Intervista sample consists of 2561 persons (daily average) and is broadly representative, with socio-demographic attributes for the participants. Data is also available since the start of 2020.

1.4. The impacts of pandemics on mobility behaviour

It has been widely acknowledged that transportation is a key driver in the spread of infectious diseases (Baroyan and Rvachev, 1967; Herrera-Valdez et al., 2011). The important role of mobility in a pandemic has been demonstrated for historical pandemics such as the Spanish flu in 1918 (Trilla et al., 2008; Ammon, 2002). For a comprehensive overview of studies exploring the link between transport and infectious diseases, see Muley et al. (2020). However, the impact of measures to overcome pandemics also have an impact on mobility. In the much of the recently published transport literature on the Covid-19 pandemic, the focus has been drawing conclusions on the impact of restrictions on the spread of the disease, with little focus on the specific impacts on the restrictions on mobility itself within the population. In the following paragraphs a few studies which do focus on mobility are highlighted.

In the current pandemic, mobile data has played a key role in understanding the changes in both regional and global mobility during the pandemic. Many countries are now using mobile data to understand the effectiveness of measures, including Austria, Belgium, Chile, China, Germany, France, Italy, Japan, Spain, United Kingdom and the United States (Oliver et al., 2020; Yabe et al., 2020). In particular, Heiler et al. (2020) used real-time anonymised mobile phone data to understand the changes in mobility behaviour as a result of the introduced measures in Austria during the first wave. They saw a doubling of the number of persons with a radius of gyration (activity space) of less than 500 m, and increased segmentation of the community structure.

In the USA, Badr et al. (2020) found a strong correlation between reduced mobility behaviour and decreased Covid-19 case growth rates. Furthermore, they show evidence that behavioural changes were already observable days to weeks before movement restriction policies were implemented, indicating that it was not just the introduced policy measures that restricted mobility, but the desire of persons to avoid the pandemic.

All these data sets use data collected from mobile phone providers, which are less effective at capturing mobility changes at local urban scales. Socio-demographic differences (e.g. across age, gender and household-size) can also not be explored with this data. This is important for understanding how the mobility of different groups was affected by the pandemic.

Other work has used travel surveys to explore the impact of the Covid-19 pandemic on mobility. Beck and Hensher (2020) performed a household survey of 1457 respondents. The main conclusions of this paper focus on telework (working-from-home) and suggest that there could be significant implications for localised transport networks. The shift towards more flexible working conditions may also lead to a spreading of peak-hours.

Huang et al. (2020) used location data from Baidu in China to examine the impacts on mobility and activity patterns as a result of the pandemic. They suggest that the government should promote cycling as means of transport and the construction of bike lanes.

2. Methods and data

2.1. Recruitment

Starting in September 2019, a sample of 5375 persons living in Switzerland were recruited to a mobility pricing field experiment called

MOBIS (MObility Behaviour in Switzerland). The study required the participants to use an app (available for both Android and iPhone) which used the phones location services to track their location, and identify trip stages and activities. They were tracked for 8 weeks to investigate their response to a conceptual mobility pricing scheme. 3680 persons completed the 8 weeks, with the last person finishing in January. They did not have to uninstall the app afterwards, and could continue using it. At the start of March 2020, around 300 people were still using the app. The tracking panel for the MOBIS-Covid19 study was recruited from those 3680 participants who completed the MOBIS study. Of these participants, around 1600 volunteered to reactivate the tracking app, Catch-my-Day, developed by Motion-Tag. Table 1 presents the distribution of the sample by different socio-demographics, showing that the MOBIS-Covid19 sample is broadly representative. Our sample is slightly more educated and more likely to be employed - but this is primarily since those over 65 years of age were not invited to the original MOBIS study. Participants were only eligible to participate in the MOBIS study if they used a car at least 2 days a week. This also skewed our sample towards car drivers, compared to the Swiss population.

Weekly reports have been produced online in three languages (English, German and French) since the start of the MOBIS-Covid19 study, to which both participants and the public have access. Participants also have access to a custom dashboard of their own mobility behaviour during the crisis, as long as they continue tracking. This was designed as

Table 1
Comparison of MOBIS-Covid19 (MOBIS) sample with the last national travel diary Mikrozensus (MZ) 2015.

		N		%	
Variable	Value	MOBIS	MZ	MOBIS	MZ
	No	13	2587	0.8	6.2
	Yes	1480	31,824	90.4	75.8
Access to car	Sometimes	144	7584	8.8	18.1
	Under 18	–	7546	–	13.2
	(18,25]	259	5126	16.9	9.0
	(25,35]	272	8117	17.7	14.2
	(35,45]	314	8789	20.4	15.4
	(45,55]	359	9560	23.4	16.7
	(55,65]	333	7384	21.7	12.9
Age	66+	–	10,568	–	18.5
	German	1191	39,023	72.8	68.4
	French	446	14,450	27.2	25.3
Correspondence language	Italian	–	3617	–	6.3
	Mandatory	96	9954	5.9	19.3
	Secondary	758	25,594	46.3	49.5
Education	Higher Ed.	783	16,124	47.8	31.2
Gender	Female	828	28,928	50.6	50.7
	Male	809	28,162	49.4	49.3
	1	209	19,439	12.8	34.0
	2	546	20,222	33.4	35.4
	3	331	7400	20.2	13.0
	4	417	7133	25.5	12.5
Hosehold size	5 or more	134	2897	8.2	5.1
	4000 CHF or less	92	10,139	5.6	17.8
	4001–8000 CHF	470	18,728	28.7	32.8
	8001–12,000 CHF	495	9945	30.3	17.4
	12,001–16,000 CHF	267	3878	16.3	6.8
	More than 16,000 CHF	168	2593	10.3	4.5
Income	Prefer not to say	143	11,807	8.7	20.7
	Employed	1196	27,521	73.1	48.2
	Self-employed	111	4133	6.8	7.2
	Apprentice	10	1488	0.6	2.6
	Unemployed	59	1423	3.6	2.5
	Student	83	2114	5.1	3.7
	Other	110	9421	6.7	16.5
Main employment	Retired	68	10,990	4.2	19.3
	Swiss	1517	43,347	92.7	75.9
Nationality	Other	120	13,743	7.3	24.1

a form of non-monetary incentive to encourage continued participation.

2.2. App based tracking

The Catch-my-Day app works similarly to other tracking apps. It runs in the background, collecting location data from the phone, with the participant's consent. The tracking can be turned on and off at any time. The data is transferred to the server when the phone is connected to a WiFi network, where the location points are processed to detect the transport stages, activity locations, mode of travel and where possible, trip purpose. The trip purpose detection is based on the activity type nominated by the participant for other activities at the same location. The detection algorithms are based on Openstreetmap data (Open-StreetMap contributors, 2017) and available public transport schedules. Users are able to validate the imputations made by the algorithms and make corrections.

Since not all activities have an assigned purpose in the data collected from the app, we impute the missing activity purposes for the rest of the data using a random forest approach, using the reported activity purposes as the ground-truth dataset.

2.3. Online surveys

The tracked data was supplemented by online surveys, which the participants were invited to participate in by email. Initially, socio-demographic information about participants was collected in the original MOBIS study. Participants were also asked in May to complete another 2 surveys, one during the lockdown, and one after, asking about their working conditions and experience during the lockdown.

2.4. Sample weighting

As mentioned in above, our sample is skewed towards car-users in urban areas, due to the sample composition of the original MOBIS study. To make some correction for this, the MOBIS-Covid sample is weighted against the original 22,000 participants which filled out the introductory survey in the MOBIS Study. This allowed a weighting of the MOBIS-Covid results by age, gender, income, education, mobility tool ownership and accessibility. Weights were calculated for each person-week in both the MOBIS and MOBIS-Covid study periods, against the sample present in that week. This accounts for the changing sample composition over the weeks of the study. The weights are both reasonable and stable across the study period, with the weights in the range 0.5–3.

3. Results

Across all segments of the population, a downward trend in the average travelled Kilometers per day was observed before the lockdown measures were put in place on March 16. This indicates that the Swiss population preempted the preventative measures, and were proactively taking steps to protect themselves from the virus by reducing their mobility. This is also a consequence of the clear messaging from the Swiss federal government, which mostly gave forewarning of at least a week before measures were implemented.

Mobility behaviour was most suppressed in the first week of the lockdown, however, the average daily distance and the number of trips per day immediately started increasing, demonstrating the challenge of sustaining a suppressed mobility demand over a long period through non-policed lockdown measures.

3.1. Impact of home-office and kurzarbeit (short-work)

During lockdown, 20% of participants reported being on kurzarbeit (Short-work). kurzarbeit is an industrial-relations policy that exists predominately in German speaking countries, where a employee in the scheme has their hours reduced by between 20 and 95% due to extreme economic circumstances. They are then paid the majority of their usual wage, with the difference between hours worked and hours paid covered by government finances.

Surprisingly, being on kurzarbeit had little effect on the number of trips per day during the lockdown, compared to those on normal conditions. The amount of home-office (telework) a participant was performing is much more influential (see Fig. 2 and Fig. 3). After the lockdown was lifted, the difference between the groups has reduced as more of those who were allowed home-office have returned to the workplace. However, differences still persist, clearly indicating that home-office is effective for suppressing travel demand.

3.2. The cycling boom

Significant changes in modal split were observed, particularly towards cycling, where a large increase in the average daily distance travelled was observed (see Fig. 1). The change in average daily distance is, on some weeks, greater than 100%, which is well beyond what the seasonal causes would imply. The magnitude of the variations fluctuates throughout the weeks, depending on the weather, which was excellent during the lockdown period, but variable afterwards.

A large increase of the number of cycling trips per day was also observed, as can be seen in the temporal patterns by time-of-day and type of day in Fig. 4. The red curve shows the average number of cycling trips started for each hour of the day during the 2019 baseline period, with black and grey lines being the Lockdown, post-lockdown respectively. The blue line indicates the hourly number of trips since masks were required on public transport.

These temporal patterns indicate that cycling was primarily used as a leisure tool. First, the increase primarily occurred on weekends, indicating a leisure objective. Second, although an increase in the number of trips was also observed during the week, much of this occurred over midday, hinting that these trips were not conducted for commuting purpose. Indeed, considering that a large number of commuting and station-access/egress trips did not take place during the lockdown, this suggests that the use of cycling for other purposes has increased.

In Fig. 5, the increase in mode share for different trip purposes is presented. The mode share compared to the baseline period has increased for all trip purposes. The influence of the weather is visible across all purposes. The increases were largest during the lockdown, but the trend has stabilised since then, at around a 75% increase over the baseline period.

3.3. Socio-demographic variations during and after the lockdown

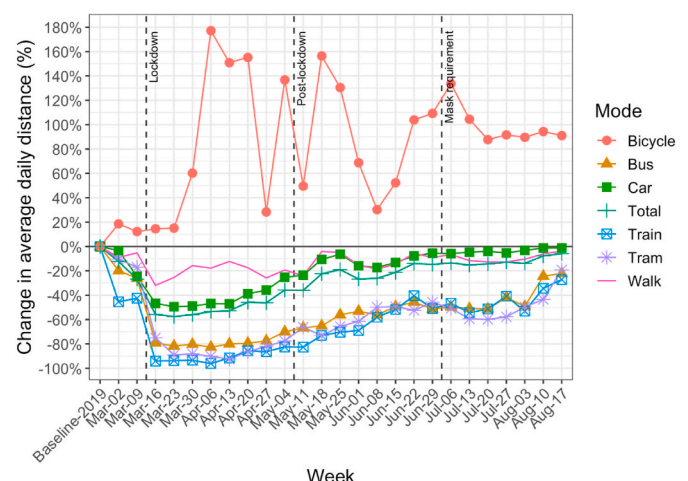As indicated by the analysis of working conditions, particularly

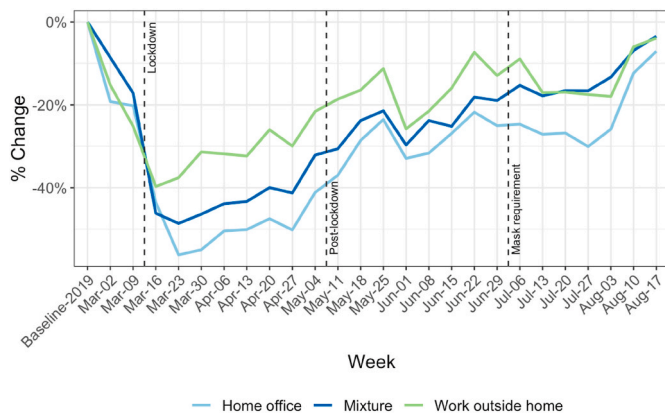**Fig. 1.** Weekly change in average daily Km travelled.

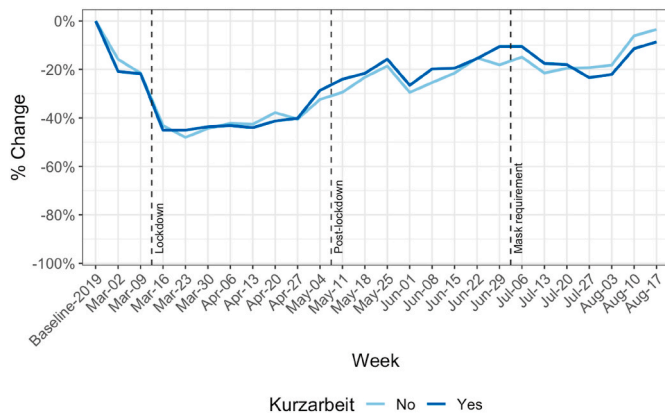**Fig. 2.** Trips/day by home-office arrangement.
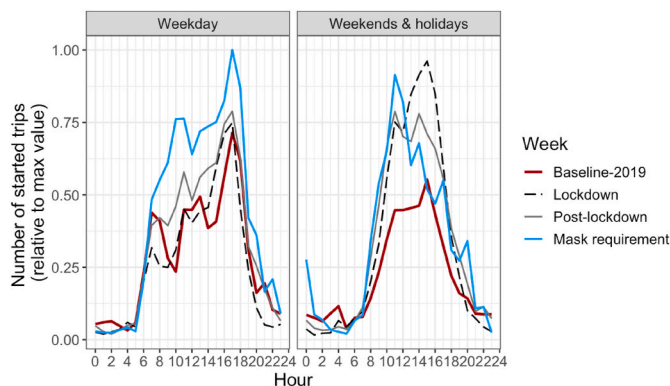

Fig. 3. Trips/day by kurzarbeit status.

Fig. 4. Hourly bicycle trip counts.

Fig. 5. Increase in bicycle mode share by trip purpose.

Fig. 6. Change in kilometers travelled by education level.

The relaxation of the lockdown measures were met with a continued increase in travelled distance. All socio-demographic groups saw a spike in the average daily distance as the lockdown measures were lifted, to varying degrees, before a return to a trend similar to that observed during the lockdown.

The various adaptions to the lockdown measures by different household sizes is also insightful, as seen in Fig. 7. Again, the total average weekly kilometers dropped by approximately 60%, with the reduction in travel correlated with household size throughout the

home-office capability, certain segments of the working population were able to reduce their travel more than others. Fig. 6 shows the reduction in the average daily travelled kilometers by education level, as compared to the reference period in September/October 2019. Those with a tertiary education (i.e. from a university or technical college) had a larger decrease in daily kilometers than the less educated. Towards the end of the lockdown and post-lockdown, this difference became more pronounced. Those with the mandatory education level experienced a rapid increase in their daily kilometers. This coincides with the return to work for those in service industries, where professional degrees are not required. Travel per day for this segment has plateaued in the post-lockdown period, indicating that a new daily pattern for this cohort has been reached.
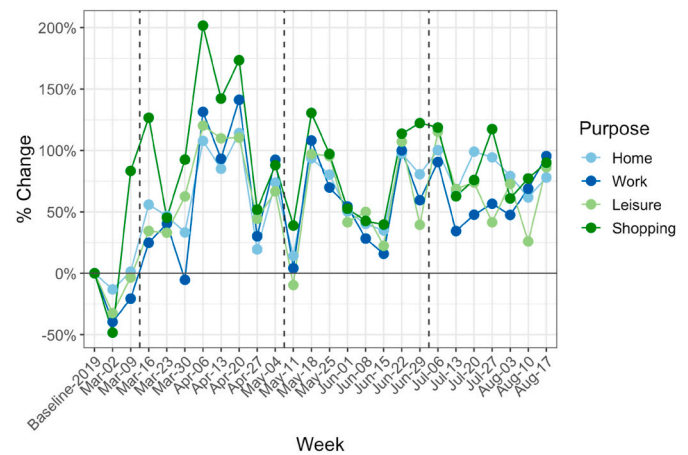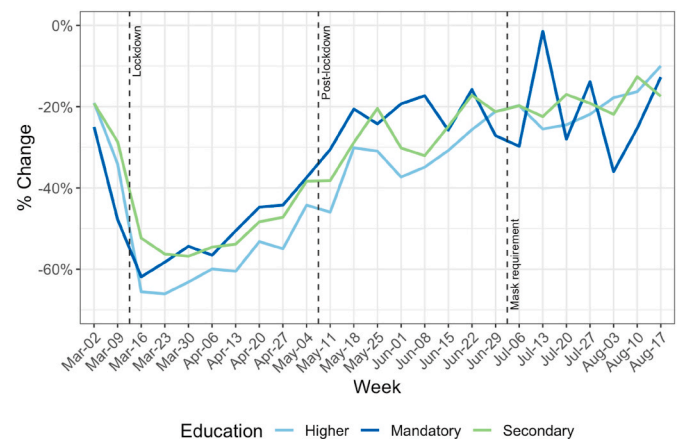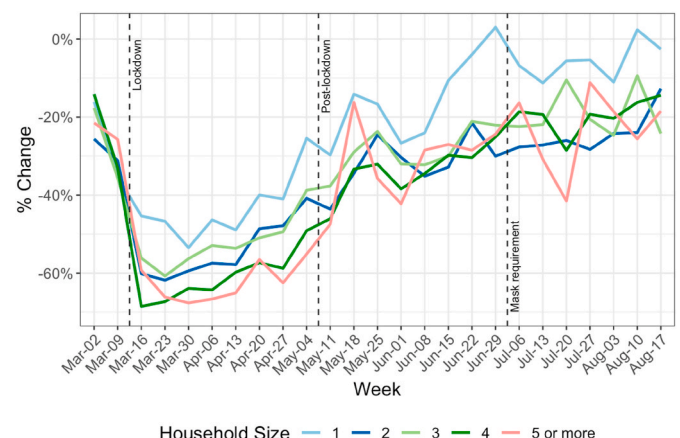

Fig. 7. Change in kilometers travelled by household size.

lockdown period. On one had, larger households had more travel constraints (e.g. taking care of the children who now have to stay at home). Furthermore, those in smaller households, particularly single person households had the smallest reduction in daily travel. It is important to note that no household had more than one person participating in the study, hence we cannot say how tasks such as shopping were redistributed among the household members to reduce public exposure. It can also be reasonably inferred that those in larger households had a larger incentive to reduce their daily travel. If one household member were to contract the virus, it would have spread to the whole household. This ties to the idea of social pressure, with larger households resulting in a level of normative behaviour within the household community.

The relaxation of the lockdown measures not only impacted travelled distance, but also had an effect on the average number of trips per day and the activity space. Indeed, at the beginning of the lockdown, the number of daily trips plummeted by nearly half and remained low during the entirety of the lockdown, whereas they have essentially returned to pre-Covid numbers during the post-lockdown period (see Fig. 8). The evolution, however, was quite gradual. The effect of the relaxation is much more evident on the activity spaces, as can be seen in Fig. 9. The lockdown caused a reduction in the activity space to around $50 km^2$, which only slowly increased during the lockdown - indicating that while people were travelling more, they were doing so within their local neighbourhood. Immediately after the lockdown was lifted, the area of the weekend and holiday activity spaces increased. A short downward trend over 3 weeks followed, before the activity space started growing again. This post-lockdown downward trend was also observed on weekdays, which one would not expect to be compatible with the rhythms of the 5-day work week. The size of the activity spaces are now similar to what they were pre-Covid, both during the week and on weekends.

3.4. Change in road speeds

The general reduction in travel observed during the lockdown period also included a significant reduction in car travel. With less vehicles on the roads, congestion levels dropped during the lockdown, and average travel speeds across different trip-distance classes correspondingly increased.

Fig. 10 shows the effect of the Covid-19 crisis on median car travel speeds during the week, i.e. excluding weekends and holidays. The black line indicates the baseline travel speeds from the baseline period in 2019. Car trips of over 500 km, which correspond to driving across Switzerland, or with an average speed of over 180 km/h were considered unrealistic and removed from the analysis.

During the lockdown period from March 16 to May 11, an increase by up to 15 km/h in the peak-hour speeds was observed, indicating a
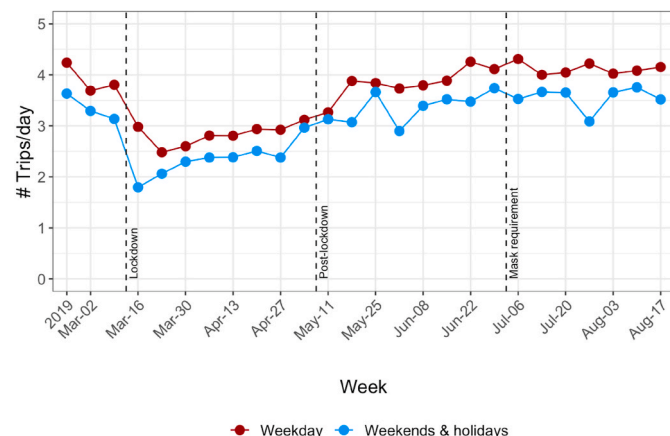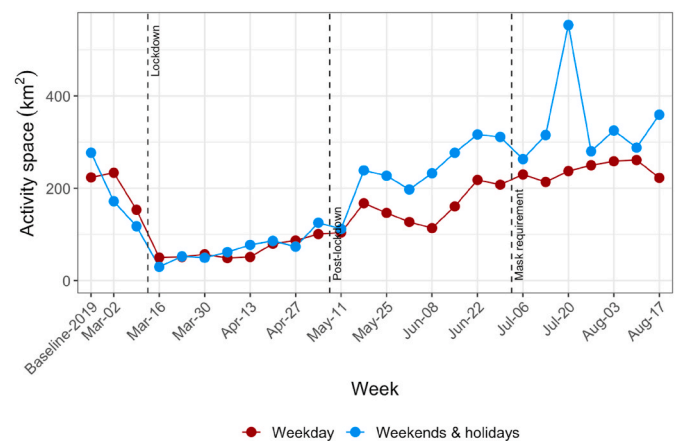
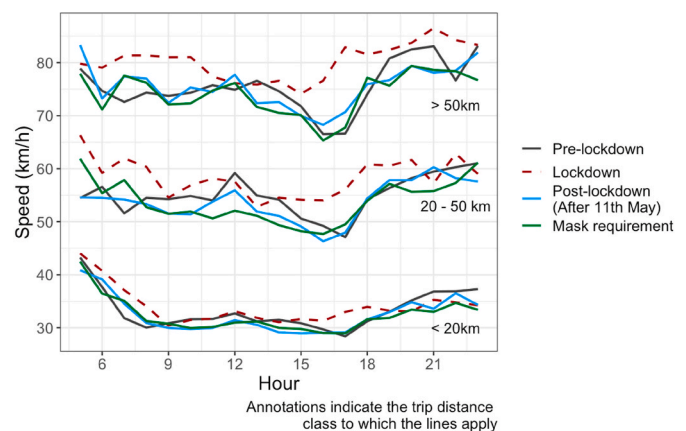**Fig. 9.** Activity space (95% CI Ellipse).

Fig. 10. Road travel speeds.

decrease in overall congestion. Reductions in congestion were observed during both morning and evening peaks. However, no reduction was observed in the middle of day. Since the relaxation of the lockdown measures on May 11, peak-hour speeds have returned to almost pre-Covid-19 values, a sign that congestion is returning to usual levels in peak periods. This is consistent with the fact that public transport use is still suppressed, while car mileage is roughly back to the baseline (see Fig. 1). Post-lockdown, non-peak travel speeds during the day are now lower than they were during the baseline period, particularly for the 20–50 km trip-distance class. Viewed in combination with Fig. 11, which shows the hourly counts for car trip departures in the two weeks post-lockdown, it is evident that more car trips are being generated
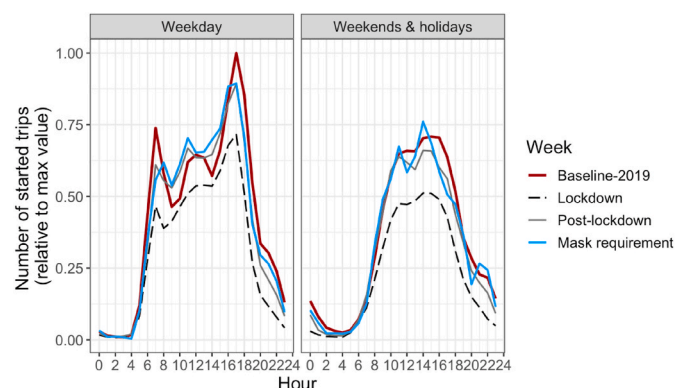
Fig. 8. Average number of daily trips.

Fig. 11. Car travel hourly counts.

during the middle of the day than during the baseline period. This is a natural consequence of the reduction in public transport usage, and has concerning implications for the coming months if public transport demand remains suppressed.

3.5. Transport mode share shifts

The Covid-19 crisis also had had a clear impact on mode shares. While the overall distance travelled has recovered since the lockdown and is now only 15% below pre-Covid values, public transport has been most affected. The daily distance travelled on public transport modes is still 50% below the reference values, 8 weeks after the lockdown ended. In contrast, the daily car distance is now essentially back to pre-Covid levels. The biggest winner has been cycling, which has seen an increase in travelled distance throughout the crisis. However, it is also necessary to look at the transport modal shifts that occurred.

The change in mode shares over the course of the Covid-19 crisis for different types of public transport subscriptions - GA (National), Halbtax (50% discount) and other - can be visualized with the help of ternary diagrams. Fig. 12 plots the shifts in mode shares by distance. The modes are grouped into the following categories:

- Motorized individual transport (car, motorbike, taxi, Uber)
- Public transport (bus, tram, ferry, metro, train)
- Non-motorized transport (walk, bike)

During the lockdown, a higher share of kilometers were performed using motorized individual and non-motorized modes as compared to the reference period. After the lockdown, the share of public transport has increased and the share of non-motorized modes has decreased slightly. The share of motorized individual modes it still greater than during the reference period. The modal shifts were much larger for those with a full national subscription. Those with other types of subscription - which are usually for a particular zone or connection - have not returned to public transport in the same way that national ticket holders have.

4. Discussion

The reductions in mobility have been drastic. The average daily kilometers travelled fell by 60% and 95% for car and train modes respectively (see Fig. 1). Car travel has recovered slowly, back to the Autumn values within 2 weeks of the lockdown measures being relaxed.

However, public transport ridership at the same point was still low, at 20% of pre-Covid levels, despite the importance of public transport as a commuting mode in Switzerland. This is likely a result of many people still working from home. Indeed, further results show that the morning and evening peeks are only slowly returning - and this return is dominated by car travel.

The fall in the number of new corona cases in Switzerland since the introduction of the measures (Federal Office of Public Health, 2020) shows that restricting social interaction is a key requirement in dealing with the pandemic. The home-office requirement aimed to reduce the possibility for disease transmission both in the workplace and on public transport. Indeed, the daily number of public transport trips has fallen by around 90%.

An important question is to what extend home-office will be encouraged post-pandemic, and the implications for transport policy. A reduction in peak-hour travel may reduce crowding and thus postpone or negate the need for further infrastructure investment and dynamic demand measures, such as mobility pricing.

Furthermore, it remains to be seen if some of the behavioural shifts observed during this period will become permanent. These shifts have been both positive and negative.

The increase in car usage during the day, with midday off-peak travelled kilometers now slightly above the 2019 baseline (see Fig. 11), suggests that people are driving more to avoid public transport. It remains to be seen if this observed trend continues in the coming months. If and when workers eventually return to the workplace, this shift from public transport to car usage would lead to additional congestion and be financially challenging for the public transport operators. The obligatory wearing of masks was introduced on the July 6, in order to reduce transmission on public transport. This will also be important for encouraging a return to public transport. Passengers may see public transport as safe enough when masks are required. The alternative would have been other measures to increase public transport capacity to allow social distancing, such as increasing the train length or providing more services. These policy measures haven't been implemented, with mask wearing deemed to be sufficient. Furthermore, the cost burden is shifted to the passengers, who need to provide their own mask. If disposable masks are used, this effectively increases the per trip cost of travel, which may further suppress public transport demand in the coming months. Tirachini and Cats (2020) suggest that there is a possible risk that if the public transportation is seen as unsafe during the pandemic due to crowding and a lack of social distancing measures,
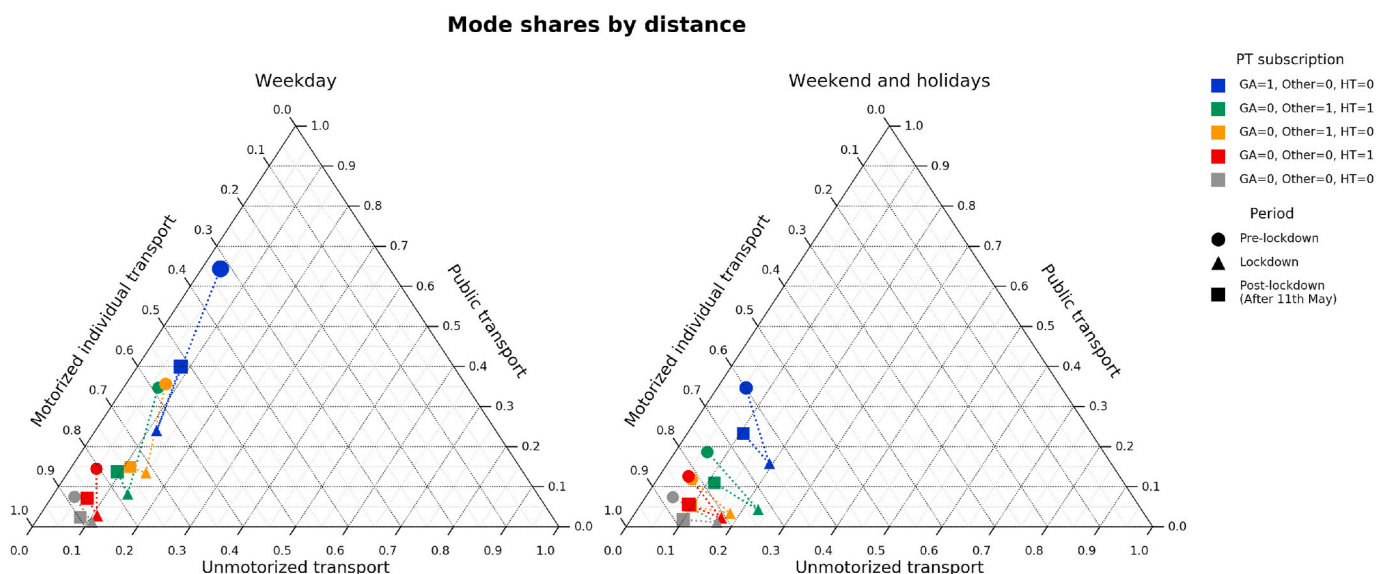
Mode shares by distance

Fig. 12. Mode shares by distance during the Covid-19 crisis.

formed negative perceptions of public transportation will become more prevalent and could persist after the pandemic, resulting in the formation of new undesirable habits.

Home-office will continue to play a role. Globally, many companies are continuing to allow or even encourage home-office working (The most well publicised examples being the big tech companies). This is also the case in Switzerland. In the post-lock period, we have already seen how congestion has increased in certain times of the day.

The Cycling boom observed since March also raises policy challenges for Switzerland. Other research has highlighted the negative effect of car traffic on willingness to cycle (Kaplan et al., 2019), The lack of car traffic during the lockdown undoubtedly made cycling more attractive. Sales of cycles increases dramatically, not just in Switzerland (Matthias Heim, 2020), but worldwide (Roger Harrabin, 2020). Sustaining the observed increase in cycling would be associated with health benefits (De Hartog, Boogaard, Nijland and Hoek, 2010), but also with an increase in accidents. The Covid-19 pandemic has shown a willingness in the population to take up cycling, and policy measures have already been mooted or implemented in other jurisdictions to further encourage this trend (Keohane and Abboud, 2020). In the countries there have been moves to introduce new temporary and permanent cycling infrastructure as a result of the pandemic. One of the key justifications is to simultaneously reduce demand for public transport and try persuade public transport users to shift to active modes rather than use the car, which would increase congestion. Such a policy has been suggested for Zurich, the largest city in Switzerland, and the initiative was approved in the last elections in September 2020. This is a good step towards making these changes permanent.

In Handy, Van Wee and Kroesen (2014), the key research needs for promoting cycling are discussed. In particular, they note that even in pro-cycling cities, strong evidence around cycling behaviour is important for effectively directly resources. To this aim, the wealth of data collected in the MOBIS-Covid19 study will prove invaluable in highlighting areas which are underserved by cycling infrastructure. Lanzendorf and Busch-Geertsema (2014) identify the importance of local government policy in increasing the cycling mode share. They also note that in the case studies presented, the governments took advantage of favourable general conditions. With this in mind, governments should take advantage of the observed cycling uptake as an opportunity to further develop their cycling strategies.

5. Conclusion

The application of app-based tracking, combined with online surveys of participants allowed the study of the changes in mobility patterns caused by the Covid-19 pandemic. The study sample is broadly representative, with a slight over representation of car owners. Important variations in travel reduction were observed across different socio-demographic groups, which are obscured in other data sources. Finally, the implications for transport policy in Switzerland are widespread, especially if further increases in congestion are to be avoided, and the observed uptake of cycling to be made habitual.

Interest

No interests to declare.

Acknowledgement

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