Less traffic due to home office? Hopes in the wake of the Covid-19 experience

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ABSTRACT

The global coronavirus (COVID-19) pandemic and the implemented measures to limit the spread of the virus are having a great impact on all areas of the everyday life, including travel behavior. A significant part of the working population is teleworking during the pandemic. Given the importance of teleworking as a viable strategy to reduce travel, looking at commuting behavior during the pandemic allows analyzing the potential of teleworking, even though not under real-world, but pandemic conditions. This study focuses, therefore, on analyzing sociodemographic characteristics of teleworkers, commuting behavior during the pandemic, and individual evaluation and satisfaction with teleworking. The analysis is based on a longitudinal representative study for Germany. In addition, pre-pandemic teleworking behavior is analyzed based on the German national household travel survey. The results show a high level of satisfaction with teleworking and a desire to continue working at home in the future. However, positive effects on transport demand are not evident neither before nor during the pandemic. The strategy of reducing transport demand through teleworking only works if policy and planning are managed accordingly.

Keywords: COVID-19, travel behavior, Coronavirus impacts, teleworking, travel patterns change, representative survey

INTRODUCTION

In spring 2020, numerous countries, including Germany, were on lockdown. In view of growing numbers of infections with COVID-19, millions of employees were forced 'overnight' to move their workplace from the office to their home places. As a result, in Germany, 34% of the employees were teleworking (1). Until then, teleworking was rather rare in Germany. A study reports for 2014 that about 8% of employees were teleworking at least sometimes, slightly less than the European average of 10% (2). In view of the constant traffic growth, it was repeatedly referred to teleworking as a transport reducing strategy, almost resembling the euphoria that prevailed in the 1990s, when personal computers and the Internet enabled entirely new forms of teleworking and seemed to promise a solution to growing traffic problems (3, 4). De facto, however, home office options were introduced only on a relatively small scale.

The current situation during the COVID-19 pandemic is novel in two ways: On the one hand, a large number of employees whose jobs would seem suitable for teleworking (in Germany, for example, this applies to about 65% of the jobs, 1) were forced to use this new form of working and this way to gain experiences with it over a longer period of time. On the other hand, more and more employers consider teleworking as an opportunity to organize work in a new way and to reduce the need for office space. Against this background, the discussion about the traffic-reducing effect of home office is experiencing a renaissance, once again associated with high expectations for positive effects although evidence from the past suggests that teleworking indeed changes the mobility patterns of employed persons, but does not lead to a reduction of overall travel demand, especially by car.

The analysis of the progress in teleworking during the COVID-19 pandemic provides evidence-based insights on which deliberations about the potential impact of teleworking on traffic, but also on urban space, in the future can build. Important questions in this context are related to the extent to which people telework during the pandemic, socio-economic characteristics of teleworkers, direct effects on the use of the various modes of transportations resulting from the elimination of commuting trips as well as attitudes of teleworkers regarding the work from home and their expectations about the time after the pandemic. Furthermore, also potential general changes in the use of various modes of transportation among commuters have to be analyzed in order to draw initial tentative conclusions about the impact of teleworking on travel behavior.

This paper aims to provide insights into these questions on the example of Germany. These insights are based on a series of four online surveys that were conducted in a panel design. Based on the national household survey 'Mobility in Germany' from 2017 (5), the situation of telework before the pandemic is also described.

State of the Art

The COVID-19 pandemic has had very similar effects on the form of working around the globe, especially when comparing industrialized countries: wherever the type of working tasks allowed, there was a change from physical presence at the office to home office. On the one hand, this had a strong impact on the everyday mobility of those who were affected, but also a massive impact on business trips. National telework rates in Germany rose from approx. 8% who were teleworking at least sometimes (2) to values between a quarter and half of the employees who telework at least partly; accordingly, the number of commuting trips decreased.

Molloy, Schatzmann (6) report a close connection between telework and the decline in commuting trips for Switzerland. For Germany, telework shares of up to 40% were observed during the first lockdown. Based on this number, a recent study estimates a decrease in person kilometers travelled due to commuting in Germany between 1-2% (4).

Astroza, Tirachini (7) also show a strong increase in teleworking and the associated decline in commuting for Chile. Additionally, they considered also the influence that the type of work has on teleworking. Based on a sample of around 4,400 respondents, they show that 77% of workers from low-income households had to go out to work (blue-collar workers and workers in the service sector), while 80% of workers from high-income households worked from home (mostly white-collar workers).

Borkowski, Jażdżewska-Gutta (8) come to similar results for Poland. A study in Italy is in line with these results and additionally shows spatial differences in the effects of teleworking on mobility (9).

The influence of socio-demographic characteristics on the opportunity to telework is highlighted in a recent Swedish study for Malmö (10). It reveals that women are much less likely to have the opportunity to work from home during the COVID-19 pandemic. This appears to further exacerbate previously existing differences. This reinforcement effect along demographic characteristics seems to generally appear in the Malmö case when comparing the 'teleworking population' before and during the pandemic.

For Greece, a recent study show that more than 60% of the 1,200 people they surveyed worked from home several times a week or daily during the COVID-19 crisis, compared to 26% before the beginning of the crisis (11).

However, the results of the analyses on the impacts of teleworking during the COVID-19 pandemic are only partly comparable to the results of studies on the topic conducted before the pandemic. Several of these 'earlier' studies had shown that working from home has a reducing effect on the number of trips to work, but not on kilometers travelled at the individual or household level. Employees who telework make rather more (albeit shorter) trips for other purposes, such as shopping, running errands and leisure. In addition, a large number of them live at a relatively long distance from their workplace; the less frequent use of the physical place of work is associated with more car use at the expense of alternative use of public transport (12-14). In view of the fundamentally different conditions during the COVID-19 crisis - general request to avoid contact or even a temporary ban on contact outside the household, closure of leisure facilities and in particular restaurants and bars, restriction of shopping opportunities, closure of schools - there are inevitably specific, with the pre-COVID-19 time not comparable, effects on individual travel behavior.

For the assessment of possible developments in the time after the COVID-19 pandemic, it is therefore particularly important to record in a differentiated manner - as the present study does - to what extent the desire and willingness of the employed are to continue to telework. A change of perspective is called for, as telework is initially viewed as a strategy on an individual level - people and households - to make time use and management more flexible, but not as an instrument for reducing everyday traffic (15, 16).

METHODS

The study combines data from a multi-wave survey conducted during the COVID-19 pandemic in Germany and data from the German national household travel survey MiD (5) in order to provide deeper understanding of travel behavior changes and individual attitudes of teleworkers before and during the pandemic. Similar questions as used in the MiD 2017 were used in different parts of the multi-wave survey in order to facilitate comparability of the surveys. In the following, we describe the data collection and data analyses methods used in the multi-wave survey. The methodology used in the German national travel household survey with a sample size of 316,000 respondents and almost a million reported trips is described in (5, 17).

Study design and set up

In order to provide empirical insights into changes in travel behavior during the coronavirus pandemic for Germany, including commuting and teleworking, a longitudinal (partly panel) study was conducted as an online quantitative survey. To date, the study includes four waves that were conducted in April 2020, July 2020, November/December 2020, and April/May 2021.

Samples

The sample of each of the four waves of the quantitative study consists of 1,000 participants and is representative for the German population between 18 and 82 years in terms of having a sufficient share of people in a certain age as well as of certain gender, education level and residential location to represent these segments in the German population. The response rate of people that participated in more than one of

the survey waves varied between the four waves: in the second wave 56.6% of the participants already participated in wave one, in wave three 75.1% participated repeatedly, and in wave 4 88.3%. The participants were recruited using the professional panel provider KANTAR GmbH[1]. People who did not participate in a particular survey wave were replaced with people having similar socio-economic characteristics. The sample was additionally weighted in order to ensure that representative conclusions can be derived. Weighted criteria were the following: gender, age, educational level, spatial type, and federal state as place of residence.

Data analyses

The data from the quantitative study was analyzed performing descriptive and inferential statistical analyses looking into potential changes in travel behavior between the period before the coronavirus spread and during the different pandemic periods (captured through the four waves) as well as into subjective evaluation of teleworking. All statistical analyses were performed using SPSS (18).

RESULTS

The description of the results starts with the situation before the pandemic based on the MiD and continues with the development of telework in the different phases during the pandemic.

Importance of work-related mobility for total transport demand

Work-related trips are responsible for large parts of total transportation. The data of the national survey MiD show that before the pandemic, 16% of all trips were work-related and a further 11% were business-related trips during working hours or business journeys. While both work trips (15.5 km) and business trips (18.4 km) are longer than average (average length of all trips: 12.5 km), their share in passenger kilometers performance is even higher. 38% of all passenger kilometers travelled are work-related.

Home office before Corona

Home office has therefore been regarded for years as a way to reduce overall transportation demand and make transportation more sustainable. Before Corona, however, the home office, as described in the introduction, led a niche existence. This is also shown by the MiD data. Only 13% of the professionals surveyed stated that they worked from home in 2017. At that time, 33% of these individuals worked almost exclusively at home (four or more days), 28% worked two to three days, another 33% worked one day, and 9% worked at home less than one day per week.

Characteristics of teleworkers before Corona

People who telework have very specific characteristics (see Table 1). They are better educated than average. 50% of teleworkers have a college or university degree. In contrast, only 28% of those who do not telework have such a degree. Accordingly, the monthly income of teleworkers is higher than that of non-teleworkers. In addition, teleworkers are more likely to be male and more likely to live in urban areas. In contrast, there are no differences in terms of the amount of professional activity. Full-time employees are just as likely as part-time employees to telework.

[1] https://www.kantardeutschland.de

TABLE 1 Socio-demographic and Mobility Characteristics of teleworkers and non-teleworkers before the pandemic

Extract of Sociodemographic Characteristics						
	Average Number of Teleworking Days/Week	Men	Women	University Degree	Urban Area	Rural Area
non teleworkers (n=25,242; 87%)		55%	45%	28%	62%	38%
teleworkers (n=5,100; 13%)	less than one day per week (9%)	74%	26%	67%	78%	22%
	1 day (30%)	64%	36%	63%	75%	25%
	2-3 days (28%)	58%	42%	52%	67%	33%
	4 days and more (33%)	58%	42%	31%	55%	45%
	total	61%	39%	50%	66%	34%
Mobility Characteristics						
	Average Number of Teleworking Days/Week	Commute Length (km)	Share Commute Trips	Daily Trip Length (km)	Number of Trips	
non teleworkers (n=25,242; 87%)		15	29%	54	3.8	
teleworkers (n=5,100; 13%)	less than one day per week (9%)	27	24%	92	3.5	
	1 day (30%)	27	18%	73	4.1	
	2-3 days (28%)	16	12%	86	4.1	
	4 days and more (33%)	16	11%	52	3.6	
	total	22	15%	72	3.9	

Source: MiD 2017

There are also distinctive differences in mobility. On the one hand, there are differences between teleworkers and non-teleworkers. On the other hand, there are differences depending on the number of working days in the home office.

For teleworkers, the share of work trips is only half as high as for non-teleworkers. However, this does not affect the total number of trips made. In the teleworker group, the number of daily trips is slightly higher (3.9) than in the non-teleworker group (3.8). Still, the reduction in work-related trips does not affect the daily distance traveled. The daily distance turns out to be higher for teleworkers with an average of 72 km than for non-teleworkers with 54 km.

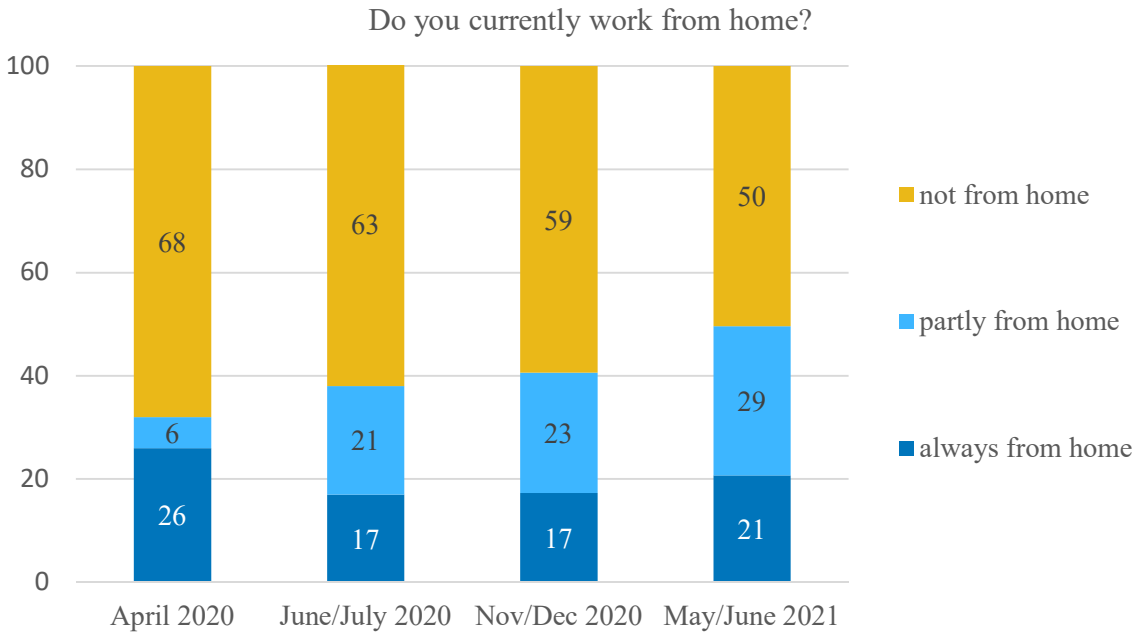
Within the group of teleworkers, people who work one day or less per week at home differ significantly from people who work two or more days at home. The group with a small number of telework days has by far the longest distance to work (27 km). In contrast, individuals with two or more telework days travel only 16 km, which is only slightly more than non-teleworkers. The same correlation is found for daily distance.

Individuals with few and many telecommuting days also differ significantly in terms of their socio-demographics. The typical characteristics of the overall telecommuting group – male, highly educated, and living in an urban area – are particularly pronounced among telecommuters with a small number of home office days. 74% of those with fewer than one home office day per week are men (compared to 61% of the overall group), and 78% live in urban areas (compared to 66% of the overall group).

Before Corona, therefore, the group of teleworkers was small and specific, not homogeneous within itself, and by no means less mobile.

Development of teleworking during Corona

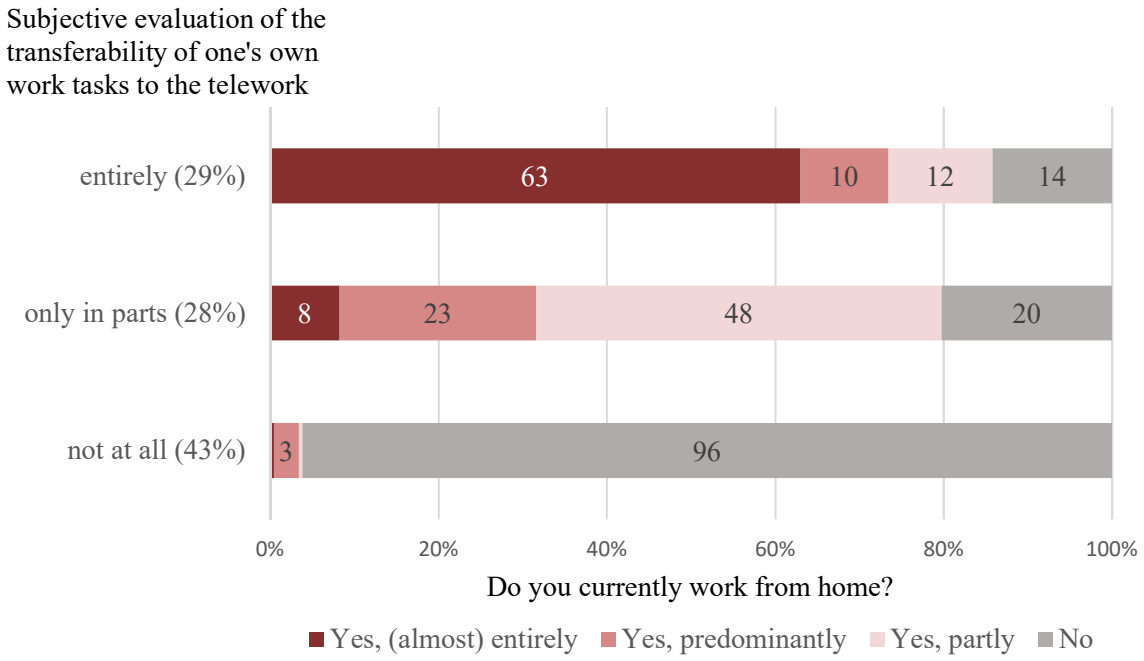
Corona forced people to change their daily routines overnight. During the first lockdown, the number of people teleworking rose abruptly from the 13% according to MiD to 32%. As the pandemic progressed, the overall percentage was increasing steadily (see Figure 1). In the last survey, half of professionals reported working at home. 21% of all professionals worked exclusively, and 29% worked partially at home. Even in phases when contact restrictions were reduced, as in the summer of 2020, the proportion of home office workers did not decline.



1st, 2nd, 3rd and 4th DLR survey regarding mobility during the corona pandemic, people in employment, differentiated by place of residence. Figures in percent.

Figure 1. Development of the proportion of teleworkers during the pandemic.

The potential of teleworking is not yet fully exploited even with the high proportion of 50 percent of all professionals (see Figure 2). 14 percent of those who, according to their subjective assessment, could shift their work to the home office do not telework and another 12 percent only partially telework. Conversely, only a very small proportion (3%) of those whose work cannot be shifted nevertheless work in the home office.



4th DLR survey regarding mobility during the corona pandemic; all participants who are employed.

Figure 2. Proportion of teleworkers depending on the possibility of shifting the professional activity to the home office.

Characteristics of teleworkers

What are the characteristics of teleworkers in the different phases of the pandemic? Do they show the same characteristics as based on the MiD in the pre-Corona period? Does the continuous increase in the proportion of teleworkers lead to a different socio-demographic composition?

The analyses of the characteristics of commuting and teleworking patterns are based on the subsample that includes partly or fully employed people, i.e. the representatives of the working population in Germany. The subsample corresponds to about half of the full sample. Table 2 compares people who telework vs. people who don´t with regard to selected socio-economic characteristics of the respondents. It compares the results from the 1st and the 4th survey wave.

TABLE 2 Socio- economic characteristics of teleworkers and non-teleworker during the pandemic

		1st Survey		4th Survey	
Variable	**Characteristics**	**Non-teleworkers (n=372)**	**Teleworkers at least partly (n=207)**	**Non-teleworkers (n=294)**	**Teleworkers at least partly (n=282)**
Gender	Male	49%	49%	49%	47%
	Female	51%	51%	51%	53%
Age	under 29 years	14%	20%	15%	22%
	30 - 49 years	49%	39%	37%	32%
	50 - 64 years	32%	34%	31%	28%
	65 years and older	5%	6%	17%	18%

Educational level	No degree			1%	
	Secondary gen. school	22%	14%	30%	21%
	Secondary school	38%	29%	27%	25%
	Academic sec. school	18%	20%	17%	21%
	University	13%	34%	16%	24%
	Other education	8%	3%	9%	10%
Employment status	Full-time (35h/week)	70%	72%	76%	79%
	Part-time (18-35h/week)	24%	20%	21%	16%
	Marginal (11-18h/week)	6%	8%	3%	5%
Place of residence - regional type	Urban region	61%	71%	62%	63%
	Rural region	39%	29%	38%	37%
Household income	under 1,500 €/month	15%	13%	13%	5%
	1,500 to less than 3,000 €/month	48%	42%	44%	43%
	3,000 to less than 5,000 €/month	32%	33%	38%	40%
	5.000 €/month and more	5%	13%	6%	11%

Source: 1st and 4th DLR survey regarding mobility during the corona pandemic

A comparison between teleworkers and non-teleworkers in all waves shows differences in the educational level and the income level (higher share of people with university level and with high household income in the sample of teleworkers). When comparing the 1st and 4th surveys, additional differences in the share of people with university educational level and in the place of residence of teleworkers can be seen. In the 4th survey, the share of people with university level is by 10% lower than in the 1st survey; the share of teleworker who live in urban areas, on the other hand, drops by 8% in the 4th survey. Given the higher share of teleworkers in the 4th survey (see Figure 1), the results indicate that expanding teleworking is associated with having teleworkers with more diverse occupations and higher share of teleworkers who live in rural areas. In the other two study waves (the 2nd and the 3rd), we noted that the share of people with university level is in the same range as in the 1st survey, while the share of people living in urban areas among the teleworkers is again around 70% in the 2nd wave, but 84% in the 3rd study wave.

In order to measure statistically the effect of socio-economic characteristics of the respondents on the probability of belonging to the group of teleworkers, we performed four logistic regression analyses (one per study wave). The results suggest significant effects of educational level, age and income level in at least three out of the four models. Having a university level of education lead to higher probability to be a teleworker compared to having low educational level. This effect is in the surveys one, two and three highly significant (1st wave: ß=1.127, Wald=16.841, p=.000; 2nd wave: ß=1.031, SE=.263, Wald=15.333, p=.000; 3rd wave: ß=1.016, Wald=14.277, p=.000) and in the 4th not statistically significant (ß=.375, Wald=3.262, p=.133). Age has a negative effect on the probability to telework. In other words, teleworkers belong rather to the younger age groups. This effect could not be confirmed in the 1st survey, but remains consistent in the 2nd, 3rd, and 4th survey. In the 2nd survey, belonging to an age group between 30 and 64 years old had a statistically significant negative effect on being a teleworker compared to being 29 years old or younger (30-49 years old: ß=-.679, Wald=5.542, p=.019; 50-64 years old: ß=-.763, Wald=5.760, p=.016). In the 3rd and 4th survey, people between 50 and 64 years were statistically significantly less likely to telework compared to younger people (3rd wave: ß=-.637, Wald=4.125, p=.042; 4th wave: ß=-.647, Wald=5.356, p=.021). Income effects can be observed in the 3rd and 4th survey, but not for the first two waves. In the 3rd survey, people from high-income households (>5.000 €/ month) were more likely to be teleworkers than people from low-income households (<1.500 €/month); in the 4th wave, belonging to any income class above 1.500€/month had a statistically significant positive effect on being a teleworker

compared to belonging to a low-income household. A comparison of the statistical power of the models shows a medium power/ effect (f^2 between .12 and .18) of the models for the first three waves and low power for the model for the 4th study wave (f^2 =.06). This underlines the results of the descriptive analyses that suggest that teleworkers in the 4th wave where we observe highest share of teleworkers are more diverse, i.e. sociodemographic characteristics are less determining for the description of the teleworkers group.

Satisfaction with teleworking

The situation before Corona and during the various phases of the pandemic is only of limited use for drawing conclusions about the future share of teleworking. As a first indicator, we consider the satisfaction of individuals with their home office activities. Satisfaction levels are consistently high throughout the pandemic. During the first lockdown, 61% of telecommuters agreed with the statement 'Overall, I am satisfied with how working from home is realized'. This increased to 75% in the summer of 2020, a period with only minor Corona-related restrictions and a remaining high home office rate of 38%. The trend dropped slightly as the pandemic and the duration of teleworking progressed. In the last two surveys, it had leveled off at 65%. Only 10-11 % were explicitly dissatisfied with the situation.

In the last survey wave, in spring 2021, the teleworkers' attitude towards home office was measured using 13 items. Using a cluster analysis (hierarchical clustering, average linkage), two clusters were identified that differ clearly from each other. In line with the high level of satisfaction with home office, there is a large group of home office supporters (92%) and a small group (8%) that evidently rejects home office. Tests with higher number of clusters did not provide better results as only small splinter groups from the large group of home office supporters are grouped into their own clusters.

70% of those in favor of home office can imagine working more at home in the long term (see Figure 3). 69% confirm that they are satisfied with their work at home. They also reported working at home as efficiently as at their usual workplace. In contrast, 90% of those who reject home office are glad when they no longer need to work at home; they reported missing the personal contact with colleagues and/or customers. They find it much more difficult to separate their professional and private lives than the supporters of home office. 90% of home office opponents find home office stressful the longer they practice it.

There is only one aspect on which supporters and opponents of teleworking both agree with: 66% of supporters and 59% of opponents evaluate positively not having to commute to work. The influence of this on the choice of residential location and thus on the length of the commute is shown by the responses to the two items 'In the long term, when I have to work more from home, the length of the commute is no longer important to me' and 'Working from home means that it is no longer so important for me to live near my place of work.' Half of the home office supporter agree with the statement and only 15% disagree.

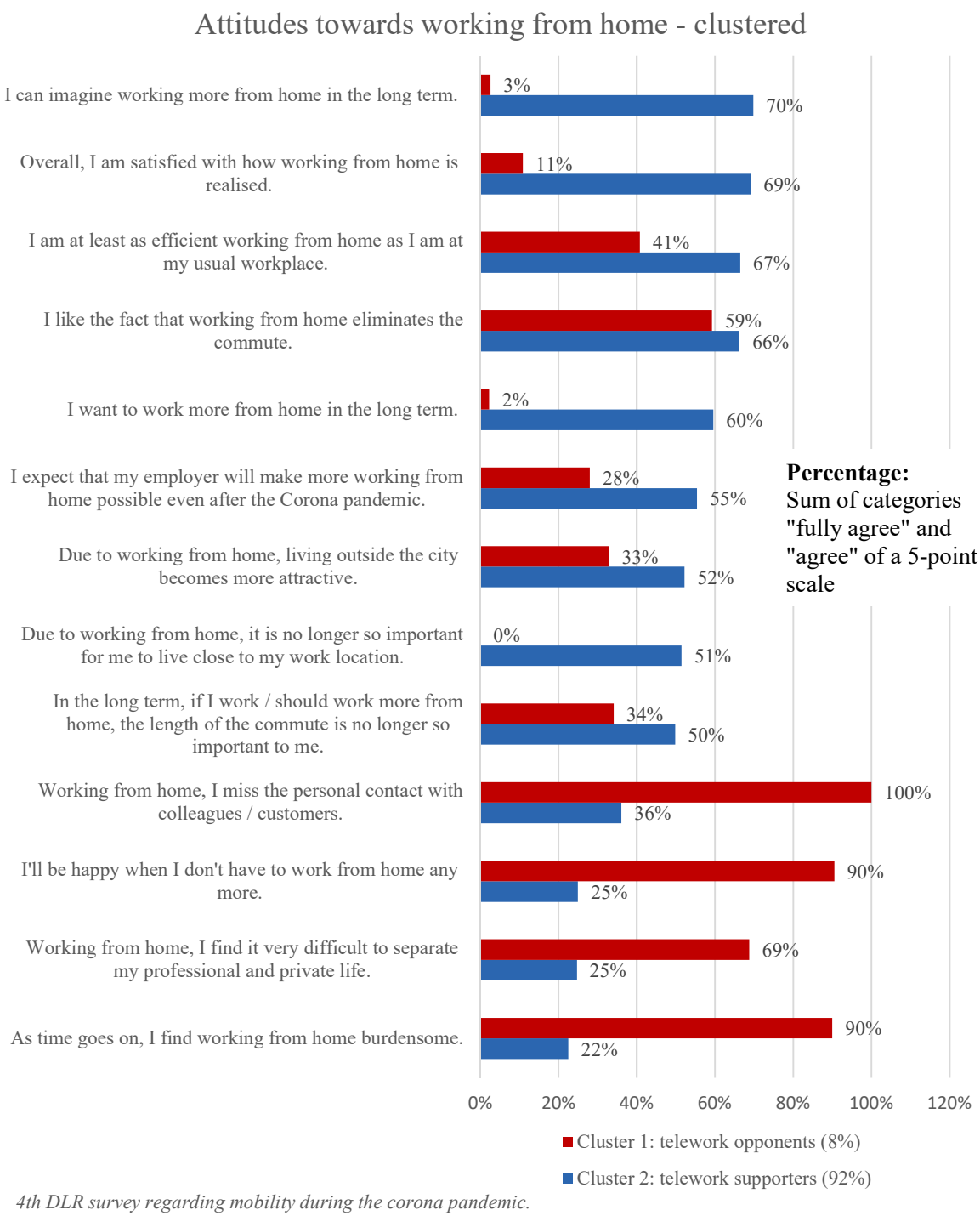


Figure 3. Attitudes of supporters and opponents of telework (results of a cluster analysis).

Mobility during the pandemic

In addition to the question of how many people telework in the long term, the most important question from a transport policy perspective is how a likely higher proportion of teleworkers will affect transport demand in the long term. Will a higher share of teleworkers actually lead to a decrease in trips

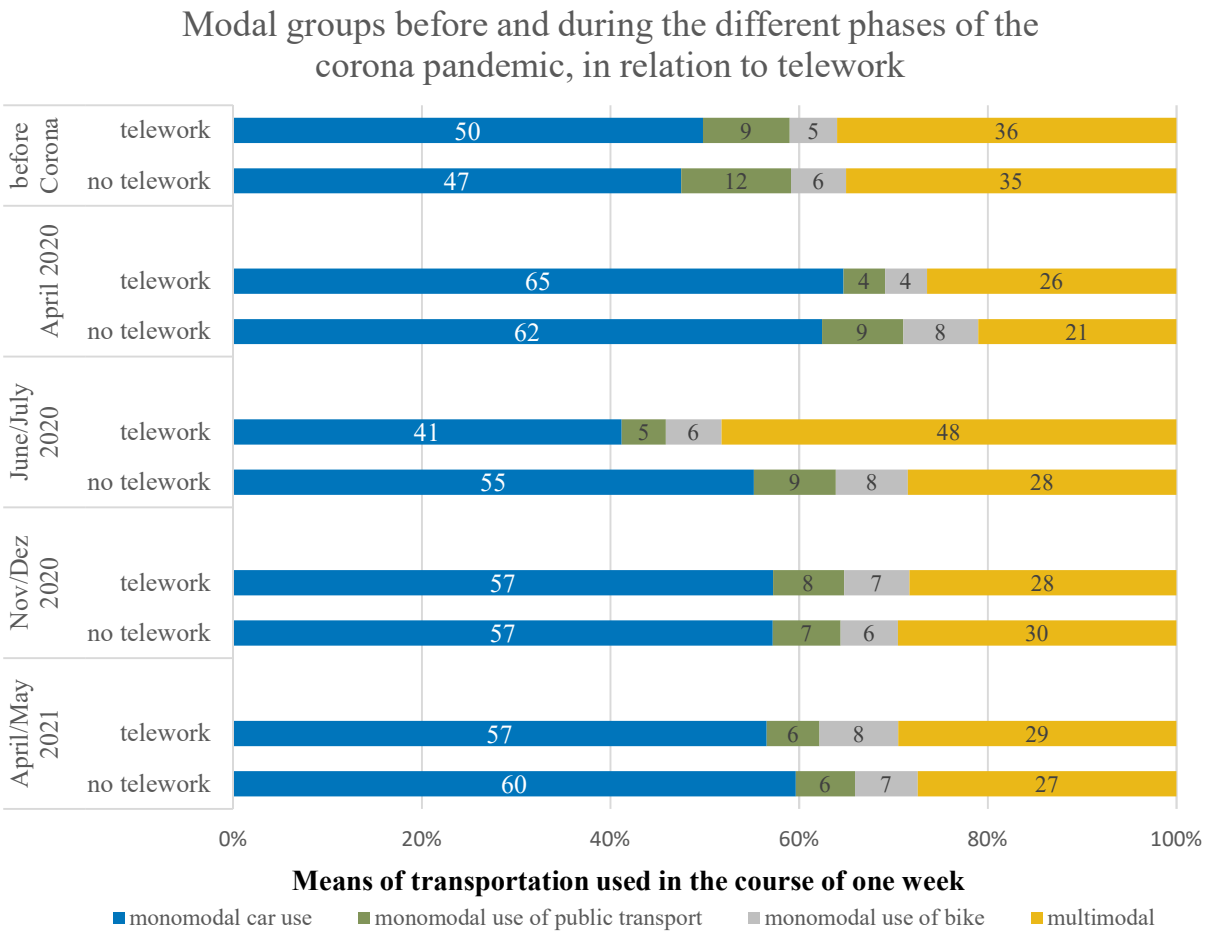
and/or person-kilometers traveled? Based on MiD, this could not be confirmed for the situation prior to Corona. What is the situation during the pandemic?

To measure travel demand, respondents were asked to estimate the number of trips they made for work, leisure, shopping, and other activities over the course of the previous week. Due to the retrospective, it is not possible to determine an exact number of trips, especially since respondents report a trip, for example, to the shopping center or to work, as one trip rather than two, as it would be the case in a trip diary. However, the number is an indicator of group differentiation. With 10 to 11 trips per week, the number of trips made by teleworkers in all surveys was lower than that of non-teleworkers at 14. This is primarily due to a lower number of trips to work.

There are also clear differences in the use of transportation modes. In general, people's mobility behavior is characterized by routines that are reflected in preferences for means of transportation. Before the outbreak of the Corona virus, it was normal everyday life for half of respondents to use only the car of the three means of transport: car, bicycle and public transport. This monomodal use of the car received a significant boost during the pandemic, especially during the first lockdown. In the last two surveys, the proportion of monomodal car users has stabilized at a good 10 percentage points higher than the baseline level of 61% (3rd survey) and 62% (4th survey).

Figure 4 shows the shares of the modal groups differentiated by teleworkers and non-teleworkers for the period before Corona and at the time of the four survey waves which were conducted during the pandemic. Although work trips are stronger influenced by routines than trips for other purposes, especially compared leisure trips, the absence of work trips has little effect on which modal group people belong to. With the exception of the 2nd survey wave in June/July 2020, telecommuters and non-telecommuters similarly distributed in the modal groups at all survey time points.

For both groups, the pandemic led in spring 2020 to a high increase in trips done exclusively by car. Because of the risk of infection, public transportation is associated with a high level of discomfort. For this reason, a large proportion of the respondents tried to avoid using it. As a result, the exclusive use of public transportation and the use of multiple modes of transportation in everyday life have decreased significantly. In the last survey, in spring 2021, exclusive (monomodal) car use has stabilized at a higher level in both groups. Among non-teleworkers, the proportion of these modal groups has shifted more than among teleworkers.



4th DLR survey regarding mobility during the corona pandemic.

Figure 4. Distribution of modal groups in relation to telework before and during the pandemic.

Usage of various modes of transportation on the trip to work

For the 'pre-Corona' period, the modal split for trips to work is based on respondents' estimates of mode share. Since the majority of the respondents have a clear primary mode of transportation, they most often reported only this one particular mode of transportation. For the period during the pandemic, information about the number of trips that the respondents made to work in the past week and about the used modes of transportation is available in the 2nd, 3rd, and the 4th survey.

Before the COVID-19 pandemic, teleworkers walked and used public transportation to get to work more often than non-teleworkers (see Figure 5). The proportion of trips made by car was accordingly relatively low. Only 45% of teleworkers traveled to work by car as drivers, compared to 57% of non-teleworkers. This difference results mostly from the high proportion of highly educated individuals among teleworkers who are generally more likely to use environmentally friendly modes of transportation. During the pandemic, the same picture emerges. Due to the general increase in the importance of the car (see above), the modal split for car on commuter trips has increased by 8%, starting, however, from different base values in the two groups.

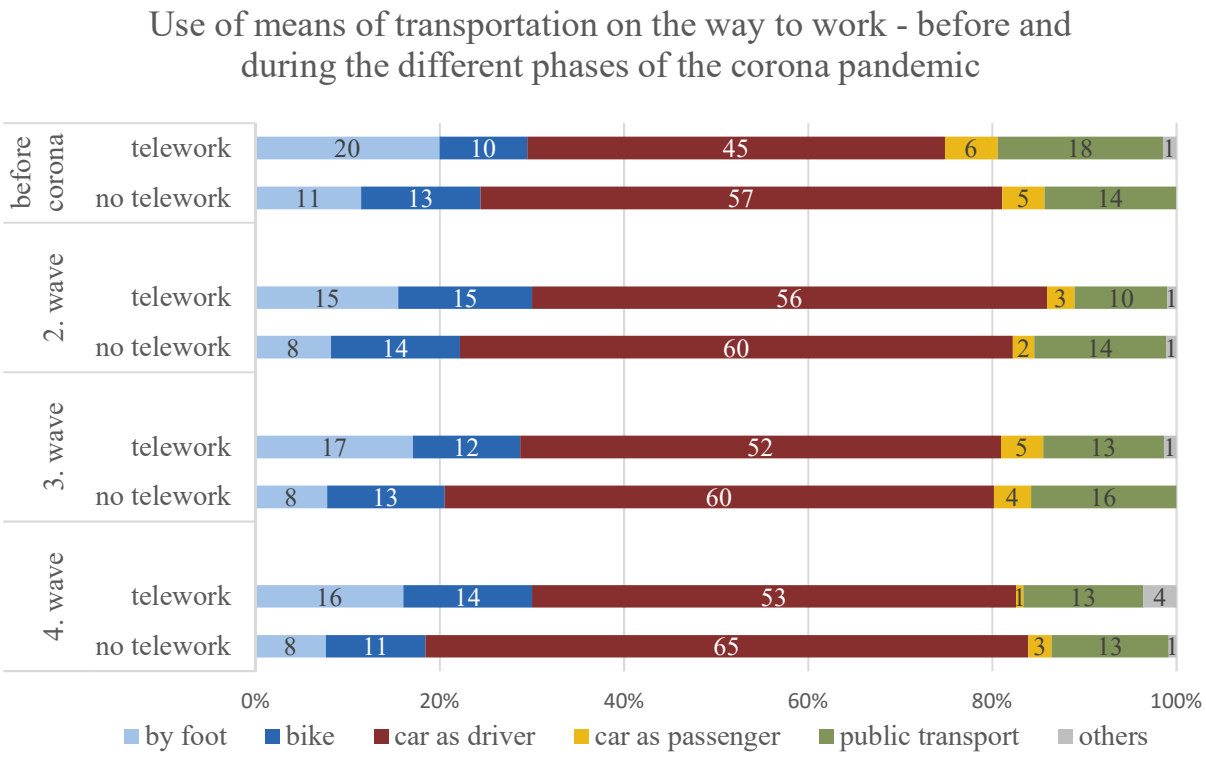


Figure 5. Use of means of transportation to work before and during the pandemic.

DISCUSSION

This paper describes the development of teleworking in Germany during the COVID-19 pandemic considering also the pre-pandemic situation reflected in the German national household survey MiD.

Regarding the time before Corona, our analyses show that 13% of the working population are teleworking; almost two third of them are teleworking at least on two days per week. The sociodemographic characteristics of teleworkers is very similar to those of teleworkers worldwide: they are predominantly men and highly educated, and are more likely to live in urban areas.

Before the pandemic, teleworkers' commute was on average 7 km longer than that of non-teleworkers. This difference is almost exclusively due to teleworkers who work only one day or less in the home office. This group is characterized not only by long distances to work, but also by very high daily distances. Apparently, teleworking is for this group a way to save occasionally their commuting trip. In contrast to this, this motive for teleworking cannot be observed for the other types of teleworkers.

Simultaneously, even though teleworkers don´t have a trip to work (or have less such trips), they are not less mobile than non-teleworkers; they even have rather higher daily kilometers traveled. A reduction in travel demand due to teleworking options can be, therefore, only observed with regard to trips to work.

Regarding the sociodemographic characteristics of teleworkers, we observe a notable diversification during the COVID-19 pandemic compared to the status in 2017. In particular we see an expansion of teleworking to all age groups, especially also to the over 50 years old persons, as well as an increase in the share of teleworkers with low or middle level of formal education. Furthermore, the share of teleworkers with middle household income increased. We assume that this is a result of the expansion of teleworking during the pandemic.

The high satisfaction of teleworkers with the implementation of the work in a home office is remarkable. This goes along with the high willingness to work at least partly in a home office after the pandemic. Accordingly, teleworkers evaluate their work as being suitable to be done in a home office. Simultaneously, some of the teleworkers reported also disadvantages of working from home, including not having a direct contact with colleagues as well as difficulties to separate working from private time.

The differences in the travel behavior between teleworkers and non-teleworkers remain surprisingly stable before and during the pandemic. However, both groups use the car more often than before at the expanse of public transport. Further conclusions about differences between teleworkers and non-teleworkers with regard to number of trips or daily kilometers travelled cannot be made due to the general restriction of leisure or other out-of-home-activities during the pandemic. It is, however, important to mention that the prospect of being able to work from home expands the options for residential choice: half of the respondents agree with the statement that work in a home office makes living outside the city more attractive and the distance to be covered between home and work is less important.

CONCLUSIONS

The aim of the study was to describe and analyze the impact of the COVID-19 pandemic on the activity 'work' resulting from the change from working on a certain work place to working at home that many employees faced. The focus lied on the extent to which employees in Germany work in a home office and sociodemographic characteristic of teleworkers. Additionally, attitudes of teleworkers with regard to working at home as well as their future expectations related to this were addressed. Wherever possible, teleworkers were compared with non-teleworkers and changes over time were considered.

Overall, the results of the analyses suggest that there was a breakthrough of the home office due to the COVID-19 pandemic after many years in which teleworking gain only slowly relevance in spite of technical possibilities due to digitalization trends. This is supported also by the high share of teleworkers who are satisfied with the work in a home office and their willingness to continue working from home after the pandemic. Future studies have to focus particularly on the further development of this trend and its effect on travel behavior of the working population and the households in which they live in order to enable reliable predictions on the topic.

Furthermore, research questions which are indirectly related to travel behavior and transportation arise. They include aspects on development of land use: on the one hand, the impact of teleworking on location of urban center areas and demand for office spaces and on the other, the demand for working space in private houses for a home office. Lastly, we can expect also societal impacts of teleworking, including division of labor within single families as well as impacts on career chances – both topics with high relevance also for mobility of individuals.

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AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design, analysis and interpretation of results: C. Nobis, V. Kolarova, S. Nägele; draft manuscript preparation: C. Nobis, V. Kolarova, B. Lenz. All authors reviewed the results and approved the final version of the manuscript.

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