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A study of changes in everyday mobility during the Covid-19 pandemic: As perceived by people living in Malmö, Sweden

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ABSTRACT

Sweden's strategy to manage the spread of Covid-19 has not included any form of lockdown, in contrast to the approaches adopted by most other countries. Instead, the strategy has been largely based on strong recommendations for society. Even though Sweden has not had any form of lockdown, the Covid-19 pandemic has during a relatively short period of time brought changes for society, significantly disrupting everyday life. The pandemic poses both challenges and opportunities for sustainable future transport, not least public transport provision, supply and use. The purpose of this study is to investigate how changes for society have translated into changes for mobility as an element of everyday life during the early stages of a pandemic. This study draws on a map-based online survey (public participatory GIS) which was purposefully designed to allow people to contribute with their experiences in order to capture how the current situation has affected several different facets of people's everyday life. Results suggest that effects on mobility, such as the possibility to telework, affect different groups differently and may exacerbate existing differences in terms of gender, geography and mobility. In order to mitigate negative effects, transport policy needs to be tailored in order to take these heterogeneities into account. Both spatio-temporal adjustment and modal adjustment were dominant themes for most activities, although the dominance of these themes varied among the activities. Our findings give an indication of both the short and long-term impacts on everyday mobility in the Swedish context, for groups of inhabitants in the city of Malmö. Through deepening our understanding of the processes at play, we suggest eight possible policy responses that can be carefully tailored, both in the interim and into the future.

1. Introduction

Sweden's strategy to manage the spread of Covid-19 has not included any form of lockdown, in contrast to the approaches adopted by most other countries. Instead, Sweden's strategy has been largely based on strong recommendations for society such as encouraging people who can work from home to do so, and recommending that people minimise their number of social contacts (Weman Josefsson, 2021). Until the summer of 2020, primary schools and day-care centres had not been required to close, neither had shops nor restaurants as long as guidelines were followed. During the spring of 2020, all education at upper secondary schools and institutes of higher education transferred to online learning, and public gatherings were limited to a maximum of 50 people (see The Public Health Agency of Sweden 2020).

Despite this relatively soft approach, people's everyday lives have been affected by the pandemic, with corresponding mobility and travel behaviour in turn affected. Some have highlighted that with this current situation come new opportunities to establish more sustainable transport systems and mobility (e.g. Eby, 2020; Rohr, 2020; Welle and Avelleda, 2020). An important first step in order to implement such changes is to deepen our understanding of changes in underlying travel behaviour (Eby, 2020), not least in relation to trends related to working from home and how corporeal mobility has been replaced by virtual mobility (Rohr, 2020).

The purpose of this study is to improve and deepen the understanding of how changes in society have translated into changes in mobility as an element of everyday life and corresponding travel behaviour. Drawing on a cross-sectional perspective, this study focuses

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specifically on the early stages of the pandemic, a period during which people were still adjusting their everyday lives, coming to terms with the new reality of social distancing, and while there was still a great deal of uncertainty regarding how the virus was spread, its medical and socio-economic consequences, and the duration of the pandemic. This study draws on a map-based online survey which was purposefully designed to capture how the current situation has affected several different facets of people's everyday life. We investigate how inhabitants in an urban context have perceived these changes, in terms of reductions in travel, as well as changes in modes of transport and shifts from corporeal to virtual mobility. This type of methodological approach can be referred to as using Public participatory GIS (hereafter PPGIS) which has been widely used in urban planning. Studies with a particular emphasis on transport-related issues are not as common.

The scope of this study is limited to people aged 16 and above living in Malmö, Sweden. Malmö is part of the Greater Copenhagen region, with a population of 4.3 million inhabitants (Greater Copenhagen 2020). During the course of the ongoing pandemic, Malmö has found itself somewhat caught between two approaches to the crisis. During the initial stages of the pandemic and until summer 2020, Denmark had enforced much tighter restrictions than Sweden, and closed their borders to those who are not citizens, residents or who do not otherwise have a legitimate reason to enter the country (Danish Police 2020). This closure affected commuters, the public transport authorities and corresponding supply of public transport, and could pose several challenges for the future integration of the region.

2. Previous research

2.1. Mobility and Time Geography

Mobility is often defined as actual embodied movements and the potential to realise such movements, derived from the resources of the individual (Cresswell, 2010; Kaufmann, 2002), with other forms of mobility such as virtual mobility complementing this embodied movement (e.g Urry, 2002), implying that mobility is more than physical movement alone. Mobility relates to activities in people's everyday lives, which in turn generates the need for transport (Ellegård and Svedin, 2012). Activities revolve around a few nodal places or points, where the home is considered the most vital (Ellegård and Vilhelmson, 2004). Mobility is not evenly accessed or operationalised (Sheller, 2018; Sheller and Urry, 2006). Access to mobility depends on factors such as gender, class, age and ethnicity (e.g. Sheller, 2018; Cresswell, 2010). Questions of mobility are political and a matter of power relations and hierarchies (Cresswell, 2010).

Time geography allows for the understanding of mobility as an element of everyday life (Hägerstrand, 2009: 114–118). Hägerstrand (1989) stressed that 'actions are always actions in landscapes', emphasising that the context in which actions are found is an important explanatory factor and something which must be understood in order to understand the actions themselves. The individual as an agent continuously assesses and reassesses her/his opportunities and potential activities with respect to the now-line (Ellegård and Svedin, 2012; Neutens et al., 2012). Time is constantly moving and circumstances are constantly changing as the individual negotiates and re-negotiates her/his reality. Hägerstrand's thinking compels the researcher to look beyond this aggregate flow and focus more on the individuals comprising the flow: what about their individual decision-making processes?; what about the resources available to them?; … the constraints limiting them?; … their family constellations?; and so on.

2.2. Virtual mobility and tele-working

Virtual mobility enables access to places and information through digital tools and networks and can widen the possibilities for people to interact and communicate digitally (Christensen and Jansson, 2011). Information and communication technologies (ICT) bring people and objects closer through networked relations (e.g. Kwan, 2007; Urry, 2007; Sheller and Urry, 2006) and offers the possibility to overcome some of the space-time constraints that might restrict people's corporeal mobility (Kwan, 2007).

The relationship between time and space and new technologies has been discussed for decades. A recent study has highlighted how teleworking was considered to make major breakthroughs since the 1970s (Elldér 2020, citing Nilles, 1975 and Toffler, 1980), with teleworkers now encompassing a considerable proportion of the workforce in Sweden, having increased from 10% in 2005 to more than 20% in 2012 (Elldér, 2019; see also Vilhelmson and Thulin, 2016), with this proportion likely to see a dramatic increase for the current time period since the outbreak of Covid-19, and perhaps into the future if this trend becomes more permanent (Elldér, 2020). In terms of effects for individuals' travel behaviour, Elldér (2020) found that those who telework for the entire working day make significantly fewer and shorter trips. They were also more likely to drive than those not teleworking. However, the results from this study also show that part-day teleworkers tend to make more trips, and travel further than those not teleworking.

The aspects of time-space compression and the interchanges between corporeal mobility and virtual mobility are essential to highlight in a world increasingly characterised by new technologies and digitalisation, especially during the ongoing Covid-19 pandemic. Virtual mobility seems to have replaced some corporeal mobility (Castelvecchi, 2020). Meetings and conferences have been held virtually to a greater extent than before, and have replaced some of the social interaction between people as well. From a policy perspective, it is essential to recognise such changes and to gain a deeper understanding of how changes in society translate into changes in people's everyday corporeal and virtual mobility.

2.3. Previous studies engaging PPGIS

PPGIS has not yet been widely engaged as part of studies related to transport and mobility, with only a handful of studies having engaged this tool and having been carried out on these topics to date. Such studies include accessibility to public transport from a user's perspective (Steward, 2017), exploring the neighbourhood, built environment and travel behaviour by using a web-based survey (Haybatollahi et al., 2015); urban and structural effects on travel patterns and greenhouse gas emissions among young adults (Czepkiewicz et al., 2018); exploring the accessibility of recreation environments by using a web-based survey (Laatikainen et al., 2017); accessibility to social services offices, accounting for walkability and access to public transport (Case and Hawthorne, 2013); and combining PPGIS and multimodal travel time analysis for daily mobility research (Salonen et al., 2014).

2.4. Previous findings on the impact of epidemics on everyday mobility

Although pandemics are rare in modern history, some studies of the effects of epidemics on mobility were carried out prior to the outbreak of Covid-19. In a study on the Ebola outbreak in Sierra Leone using cell phone data, Peak et al. (2018) found a drastic decline in mobility during a three-day lockdown. Once restrictions were lifted, travel quickly returned to normal levels. They also observed large spatial heterogeneity of the effects. A study carried out in Poland on the effect of the Covid-19 outbreak on everyday mobility during the early stage of the pandemic observed significant declines in travel times (Borkowski et al., 2021). Traffic data from Santander, Spain revealed how the Covid-19 lockdown meant that mobility decreased by 76 percent, while public transport users dropped by 93 percent, with less substantial effects for the use of the private car (Aloi et al., 2020). A study from the Netherlands found that approximately 80 percent of respondents had reduced their outdoor activities as a result of the Covid-19 'intelligent lockdown', which was explained as a lighter form of lockdown (de Haas

et al., 2020).

Previous studies on epidemics not involving lock-downs include a survey-based study from five countries during the 2009 H1N1 pandemic (SteelFisher et al., 2012) found that, although variation between countries was large, social distancing measures were less common than public protective measures such as handwashing. Measures of social distancing included avoiding crowded places, avoiding long-distance travel and avoiding public transportation. Even though Sweden has not had any form of lockdown, the Covid-19 pandemic has during a relatively short period of time brought changes for society, significantly disrupting everyday life. Data from the largest mobile phone operator in the country revealed a decrease in numbers of trips by almost 50 percent in some Swedish cities during March 2020. In Stockholm and Malmö travel decreased by 28 percent, in comparison to decreases of 42 percent, 37 percent and 34 percent for Oslo, Copenhagen and Helsinki, respectively (Telia, 2020). Another Swedish study indicates a transition from using public transport to travelling by private car, cycling or walking, highlighting that every second respondent is doubtful about returning to public transport after the pandemic (WSP, 2020).

3. Material and methods

The study design employs qualitative data embedded in a quantitative study design. This approach allows for complementarity between the two methodological approaches, supporting a fuller understanding of the research problems in comparison to what would have been the case if only one method had been employed (Creswell and Plano-Clark, 2011:67–71). The more user-friendly development of GIS technology has opened up for map-based methods to collect data from the public. PPGIS often includes a qualitative approach, with several such approaches having been developed over the years (WeiWei and WeiDong, 2015). PPGIS mostly deals with gathering location-bound data based on people's experiences, often allowing participants to plot places in a map combined with adding experiences of the place. Often, the researcher combines the micro-geographies of the participants with other data, to gain a more comprehensive knowledge about the chosen case (Teixeira, 2018).

The programme Maptionnaire was used to develop the online survey for this study. Respondents were free to plot out as many activities/locations as desired. Questions regarding the transport mode used to reach each activity, and the frequency with which the person partakes in the activity, were posed. Respondents had the option to mark out the locations where they work, study, shop for groceries, partake in social activities, hobbies or sports, as well as children's schools, day-care facilities and hobbies and sports. Work and study were only available for those who had marked either alternative as their main occupation, while activities related to children were included only if respondents had earlier in the survey stated that they themselves have children, or if they regularly take care of children. The qualitative strand consisted of embedded open-ended qualitative questions, so that respondents could report more information for any changes to these activities, as well as comment on their own experience. Respondents were also asked to map out locations of any new activities they have begun to partake in since the outbreak of Covid-19.

3.1. The scope of the study

The scope of this study is limited to Malmö City, the third largest city in Sweden, with a population of approximately 344,000 inhabitants (Malmö Municipality, 2020). The city has since the mid-1980s transformed from an industrial city to a knowledge city (Möllerström, 2011). The city has a strong cycling culture, partly due to the compact and flat city structure but also as a result of the highly developed cycling infrastructure in the city (Cykelfrämjandet, 2020). Around one-third of the population in Malmö is born outside of Sweden. Malmö is a key hub linking Sweden with Europe, and comprises part of the Greater Copenhagen region (see Fig. 1), which has a population of 4.3 million (Greater Copenhagen 2020). This polycentric region has during the last number of decades worked towards enhanced integration, with public transport infrastructure functioning as an important means of establishing a cohesive labour market (Wiborg et al., 2019).

3.2. Distribution of the PPGIS online survey

The online survey was distributed through a range of different channels during the period 8–27 May 2020, through established networks (such as pensioners' organisations) and social media, aiming for a wide distribution; geographically, demographically and socio-economically. This was followed by smaller extra market promotions on social media, some of which were targeted towards men. Although we did not initially draw on a representative sample of the population, during the course of data collection it was discovered that men were underrepresented among respondents. We therefore took measures aimed at rectifying this imbalance in responses. These measures were, however, not successful in fully rectifying such imbalances.

Contrary to many other studies and means of data collection which have problems attracting a sufficient number of respondents (Brown et al., 2014; Silvano et al., 2020), this study resulted in 693 valid responses. Fig. 2 presents respondents by age group and the corresponding population shares in five-year intervals within the age range 16–95 living in Malmö Municipality. The younger age groups are underrepresented among respondents, and those aged 66–85 are overrepresented. This differs from previous such studies, in which older age groups were underrepresented (Gottwald et al., 2016).

Fig. 2 also presents a response analysis. Of people who started the survey but did not submit, the average age was slightly lower than for the group who finished the whole survey. Those in their early 30s tended to exit the survey to a greater extent than other age groups, whereas the older age groups showed a greater tendency to finish, except for respondents aged 81–86.

Women were overrepresented among respondents (66%), despite the fact that special advertising was targeted to attract male respondents. Furthermore, 56% of respondents state they have three (or more) years of tertiary education, while the corresponding proportion for Malmö is 42%. This is partly explained by the large share of women, since only 48% of the participating men state that they have this level of education. The overrepresentation of some groups of the population (women, people with higher education and older people) should be kept in mind when interpreting the findings of the survey, as they are not representative for the population as a whole.

3.3. Data analysis

The data analysis thematically follows the shifts in coupling constraints, authority constraints and capability constraints experienced by respondents (Hägerstrand, 1970; Schwanen, 2008). Our findings are further conceptualised in terms of how these changes in constraints mean changes for people's potential path areas with this, in turn, associated with more localised activities and corresponding shrinking action spaces (Hägerstrand, 1970; Lenntorp, 1976; Patterson and Farber, 2015). The spatio-temporal exchanges between telecommuting, distance learning, digital communication and physical interaction are also analysed in our study.

The analysis of our material contained three elements:

1. A descriptive analysis of statistics
2. A geographical analysis of trends
3. A thematic and content analysis of open-ended responses (embedded qualitative strand)

In the descriptive and geographical analyses, data on both individuals as well as for the collection of drop needles indicating places

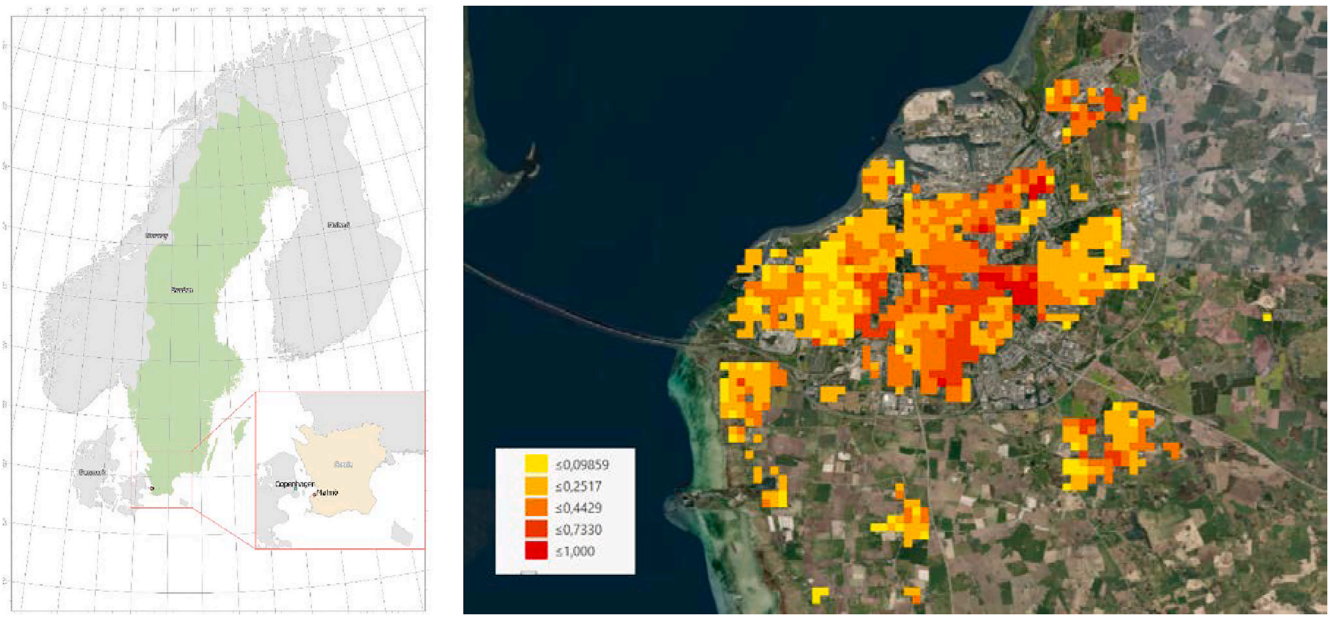

Fig. 1. a, left. Map of Malmö, Sweden. (b), right. Income levels in Malmö (low income individuals as share of total population).

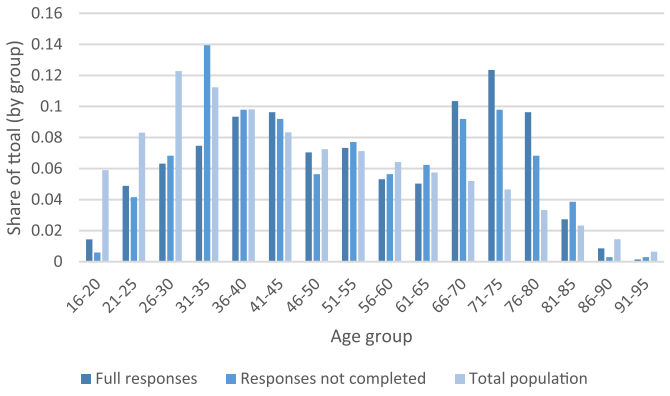

Fig. 2. Response analysis and representation.

used for the different activities were analysed. In total, 3578 drop needles were plotted out by respondents. The geo-locations of the drop needles were analysed descriptively, with information regarding modal choice and share also analysed. We also analysed possibilities to work from home. Individuals' responses were visualised and analysed further using heat maps, detecting if there were geographical associations between residential location and flexibility in work-related travelling and/or possibilities to work from home.

A reflexive methodology was employed in the analysis of the open-ended responses (the qualitative strand of the approach) (see Alvesson and Sköldberg, 2009). This entailed an in-depth thematic analysis and a content analysis (as detailed in Silverman, 2014). The in-depth thematic analysis allowed for predominant themes to emerge, with the detailed decomposition of the empirical material complementing the definition of the predominant themes and allowing for the emergence of sub-themes, in relation to the Time Geography framework. The language used by respondents to explain the changes was analysed, with patterns and fragmentations becoming more apparent as the analysis progressed, and the part-whole anatomy understanding of the problems at hand developing (see Alvesson and Sköldberg, 2009).

4. Results

4.1. Modal share

Table 1 presents an overview of the respondents' reported modal choice before the Covid-19 pandemic. Cycling and public transport constitute about one third of the responses concerning work trips, and car use around one fourth. Most workplaces are concentrated in the city centre, in close proximity to major train stations and local and regional bus lines. For education trips, public transport use is even more pronounced and constitutes more than half of the modal share. The campuses of Malmö University are located in different parts of the city, but are close to major public transport nodes. Public transport is however less prevalent for trips related to grocery shopping and children's activities, for which the car and walking dominate. For dropping children off and picking them up from school and activities, walking and cycling were most prevalent. This is consistent with the fact that many parents enrol their children in schools close to the home.

4.2. Gendered differences

There are notable gendered differences in terms of mobility resources, with men to a higher degree having a driving license and having access to a car, while women to a greater extent have access to monthly public transport cards. This is in line with previous findings reporting

Table 1
Modal choice of respondents for different activities.

Activity	Car	Cycling	Public transport	Walking	N
Work	24.3%	32.3%	32.0%	4.7%	403
Education	1.8%	29.1%	54.5%	3.6%	55
Main occupation (other than work or education)	22.5%	13.9%	17.2%	21.2%	151
Grocery shopping	38.3%	18.1%	3.9%	30.8%	871
Hobbies and sports activities	26.4%	26.1%	8.9%	26.4%	704
Social activities	19.0%	20.2%	19.7%	25.3%	763
Children's school or daycare centre	27.3%	28.3%	5.7%	25.9%	194
Children's hobbies and sports activities	42.0%	23.6%	6.4%	20.4%	157

that women use the car less frequently than men (e.g. Vance and Iovanna, 2007).

Another gendered difference relates to changes in income for the survey respondents (see Table 2). Women report, to a greater extent than men, negative changes in income as a result of the pandemic. Men in turn report increases in income to a larger extent than women. This indicates that the economic consequences from the pandemic may affect men and women in different ways (see Table 3).

4.3. Trips to the workplace and working from home

The results from the content analysis of open-ended responses indicate that changes to work trips were overwhelmingly characterised by a *shift to working from home*, the activity (alongside education) apparently most associated with a shift to virtual as opposed to corporeal mobility (see Cresswell, 2006). From the survey data, there are tangible gendered differences in having the possibility to work from home. Approximately two-thirds of men state they can normally work from home, while more than half of the female respondents state they can never work from home. This gendered difference is in line with previous research on telecommuting (Ory et al., 2004; Sarbu, 2015; Sener and Bhat, 2011).

About half of respondents state that the pandemic has not changed their possibility to work from home. Some respondents, in their open-ended responses, framed working from home as a choice, with others referring to this as being something they have been forced to do. This was often framed as an authority constraint, with the language of being 'forced to' or 'having to' work from home used by several, with some detailing how their workplace is closed, again hinting back to the authority constraint of the workplace not being physically accessible.

The majority did not however specify whether or not working from home is done by choice. Several specified the extent to which they now work from home (as a percentage of their working hours or in a number of days per week). Several also emphasised how they now exclusively work from home. Others reported the exact date they started working from home, or the time frame during which they have been working from home, indicating that this shift has marked a sudden, considerable change where the exact point in time stands out as having significance from the individual's perspective.

Respondents who had completed three or more years at university level, as well as men, were overrepresented among those whose possibility, or obligation, to work from home has changed. Slightly less than half of all respondents stated that the possibility to working from home had increased. Since the possibility to work from home was already more prevalent among men, and has now increased to a greater extent than for women, the effects of the pandemic seem to exacerbate existing gendered differences. Respondents who under normal circumstances have access to monthly public transport cards also reported more limited possibilities to work from home than respondents who do not.

The two heat maps (Fig. 3a and b) indicate the areas in which respondents who are active in the labour market live. Fig. 3a shows the concentrations of respondents who either partly or entirely can work from home under normal circumstances. Fig. 3b depicts concentrations of respondents who do not have the possibility to work from home. People who can work from home are more concentrated in the city centre and along the North-Western, more prosperous parts of the city. There are also some areas in the suburbs of Oxie (in the South-East) where people can work from home. However, also within Oxie, the hotspot marked is a new development with higher real estate prices compared to the rest of Oxie. People who cannot work from home are more geographically dispersed, and are generally spread among less prosperous parts of the city.

Table 2
Changes in reported income as a result of the Covid-19 pandemic.

	Number of responses	Lower income	Increased income
Women	454	16.7%	1.8%
Men	230	11.8%	3.5%
Total	688	15.1%	2.3%

Table 3
Possibility to work from home.

	N	Possibility to work from home (pre-Covid-19 pandemic)			Change in possibility to work from home (during the pandemic)	
		Can work from home	Can work from home partly	Cannot work from home	Change	No change
Women	242	11.6%	35.5%	52.1%	43.8%	55%
Men	104	26%	40.4%	33.6%	46.2%	51%
Total	348	16.1%	36.8%	46.6%	44.3%	53.7%

Fig. 4a indicates the residential locations of those who have experienced a change in their possibility to work from home. Combined with information provided in the open-ended responses, we can conclude that the primary change is an increase in the possibility to work from home. It is interesting to note that areas in which people are experiencing a change are similarly geographically distributed to the areas in which respondents already to a larger extent had the possibility to work from home. In other words, the pandemic seems to heighten existing differences with respect to the possibility to work from home. People who have not experienced any changes tend to live in parts of the city where these possibilities were already more limited.

Drawing on the results of the content analysis for trips to the workplace, *modal adjustment* was another dominant theme, with a 'ranking' sub-theme emerging, whereby modes and combinations of modes were ranked according to their risk, with public transport always listed as the lowest ranking (least preferred) mode. Several emphasised how they now use their own private car, or how a combination of the car and the bike is now used instead of public transport. One mentioned how there is less congestion now, hinting that it is now more enjoyable (or less of a hassle) to drive. Others highlighted how, when they do travel to the workplace, they use other modes.

'I have become more inclined to cycle to work. I had intended to cycle during the summer anyway, but Covid-19 has *become a further argument for avoiding public transport.'* (Man aged 56–60, public transport user for this trip prior to pandemic living in a suburb, limited possibility to work from home).

One mentioned how she now 'has to' walk 30 min each way, in order to avoid using public transport:

> *'Today I have to walk to and from work, which takes 30 minutes each way.'* (Woman aged 46–50, public transport user for this trip prior to pandemic, residential location not given no possibility to work from home)

The bus in particular is emphasised as being avoided altogether, with others expressing how they have limited the use of the bus. Some expressed frustration regarding the difficulty with crossing the border to reach their workplace (in Denmark), highlighting how the adjustment of the public transport service and corresponding border controls mean many more factors to take into consideration, an increased risk, and the level of service not being what it was before:

> *'Fewer trains, longer travel time, crowding, compulsory seat reservation in both directions. Otherwise one risks fines as well as two border controls a day, and Skånetrafiken [the Swedish public transport provider in the region] continues to charge the full fare.'* (Woman aged 26–30, public transport user for this trip, living in the city centre, no possibility to work from home)

Temporal adjustment was another dominant theme, with many emphasising that they have reduced the frequency with which they

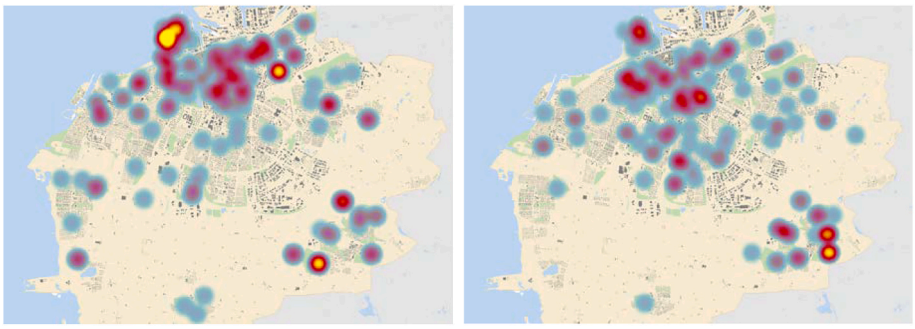

Fig. 3. (a) Concentrations of respondents with the possibility to work from home (before Covid-19). (b) Concentrations of respondents who do not have the possibility to work from home (before Covid-19).

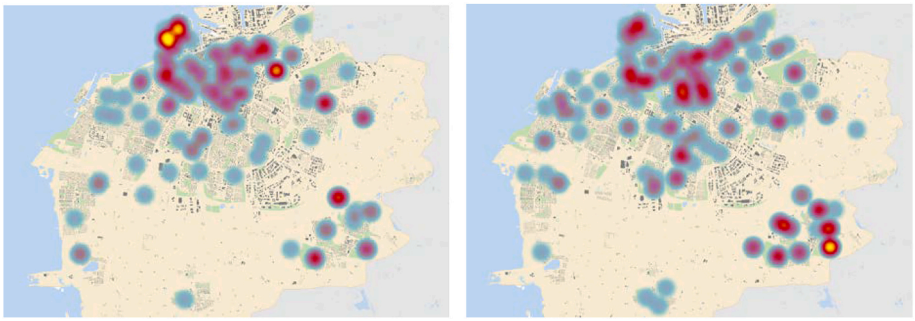

Fig. 4. (a) Residential locations of those who have experienced changes in their possibility to work from home (during Covid-19). (b) Residential locations of those who have not experienced changes in their possibility to work from home (during Covid-19).

travel to work, and others detailing how they travel at different times of the day to avoid crowds, with some outlining how they draw on a combination of strategies. Others highlighted how they have developed strategies to avoid public transport. Strategies comprising both temporal and modal adjustment were also apparent, involving decreasing the frequency with which one travels to the workplace, alongside driving or cycling for the trips to work that actually are realised:

> *'[I] am barely there [at the workplace] and if I do travel to work I take the car more often.'*(Woman aged 31–35, living in a suburb, cyclist for this trip prior to pandemic, possibility to work from home)

There was one mention of working from home as a result of being in a risk group, with few mentions of symptoms – one's own or children's – mentioned as a reason for taking fewer trips to the workplace.

4.4. Changes for other activities

4.4.1. Trips to the place of education

Similar to work trips, trips for education purposes were highly characterised by a shift to digital solutions and virtual as opposed to corporeal mobility. The closure of upper secondary schools and institutes of higher education was most often expressed as an authority constraint by respondents, implying a desire to actually be in the school but the school being out of bounds. Several respondents referred to this in negative terms; not being 'allowed to go to school', with others looking at it as an adjustment in the activity with a shift to studying from home. Some expressed dismay at this shift:

> *'[There's] no onsite teaching – just distance learning. [I] miss discussions and meetings with classmates.'* (Woman aged 46–50, public transport user for this trip prior to pandemic, living in a suburb)

Compared to work trips, this activity was much less characterised by discussions of modes of transport but several still mentioned attempts to avoid public transport.

Others specifically highlighted how they no longer or very rarely travel to Lund (another university city in the polycentric region) for education, hinting to effects for intra-regional travel if this is a more widespread phenomenon.

4.4.2. Grocery shopping trips

The activity of grocery shopping was highly characterised by a theme of spatio-temporal adjustment. This activity was cited as being carried out much less frequently and/or with an adjustment of the time at which this activity is carried out. Respondents detailed strategies such as how they have adjusted their grocery shopping behaviour to buying large amounts more seldom (usually once a week instead of several times a week). In this way, it was reasoned that exposure is limited to just one occasion a week. No impulse buys and only necessary or as one put it 'emergency' purchases are allowed, with another referring to being more 'strict' with respect to purchases.

Several highlighted how they adjust shopping times so that they go when there will be fewer people in the stores, or avoiding stores/supermarkets with large amounts of people. One person mentioned being affected by fewer slots for delivery and as such having to go shopping more frequently. Others mentioned buying groceries close by, or changes to the stores or the number of stores in which a person buys food.

Drawing on social resources was a rather apparent theme within the activity of grocery shopping. Some mentioned avoiding the activity altogether due to recommendations for risk groups. Giving and receiving help with grocery shopping was a predominant theme. Exchanges within the family – buying for parents (in an identified risk group) or parents in such groups being bought for by children/neighbours.

This activity was before the Covid-19 pandemic largely associated with very low levels of public transport use (see Table 1) and is not associated with modal adjustment.

4.4.3. Trips for social activities

Social activities were characterised by a split between autonomous decisions, half-autonomous decisions and the experience of constraints in terms of no longer being 'allowed' to participate in such activities.

Social activities were framed by a combination of accounts of having chosen to stop participating in activities, and having no option to participate because the activities have been cancelled. The former was linked to mentions of not meeting people outside their family in their spare time; 'voluntary quarantine'; avoiding such activities completely; or not meeting friends, while not stating whether this decision is their own or someone else's. The latter was linked to statements related to the activity having stopped, having closed, or having been postponed until further notice, not happening or simply not existing anymore.

Others referred to not being able to participate in such activities (neither because they have chosen nor because the activity is cancelled). This was usually linked to more tangible perceived capability constraints among those aged 70 and above, or being defined as belonging to a risk group, with expressions such as 'total isolation' and 'I am not allowed to' associated with these effects.

Mentions of specific activities being closed, cancelled or not happening included the cinema, card games, concerts, museums, theatres, opera, nightclubs, lawn bowling, after work activities, as well as visits to restaurants and pubs. One respondent mentioned how she and her son no longer meet her friends and described how this lack of social interaction is:

> *'[…] difficult for both me and my son.'* (Woman aged 21–25, public transport user for this trip prior to pandemic, living in the city centre)

Specific activities more related to a conscious decision by the individual to abstain rather than the activity being cancelled or closed (to them) were visits to shopping centres, visits to other people's homes, going to the gym and visits to the city centre.

Temporal adjustment was a dominant theme, mainly characterised by people having reduced the frequency with which activities are carried out.

Evidence of activities shifting to the home or virtual participation instead of corporeal participation was less visible compared to trips for work, education and grocery shopping. Some did, however, refer to being at home more, socialising in a different way, getting take-away food and eating at home instead of at restaurants. An increase in sedentary activities in the home was not so apparent.

Modal adjustment was more apparent for social activities than for grocery shopping but less apparent than for work trips. A theme of ranking emerged again, with the exchange of public transport for modes such as cycling, with the bus again highlighted as a form of transport to be avoided. This was also linked to a reduction in participation in social activities in the effort to reduce the use of public transport.

> *'I have not been there [at the location of the social activity] since the middle of March when I stopped using public transport.'* (Woman aged 71–75, public transport user for this trip prior to pandemic, living in the city centre)

Social activities were somewhat characterised by *a shift to the outdoors*, with many respondents detailing how they now meet friends outdoors, get coffee outdoors, meet in the garden, restrict their social activities to outdoor activities or take walks together with social contacts while maintaining a distance between them.

Experiencing symptoms related to Covid-19 were not so visible in terms of affecting social activities, although some did mention having to reduce their participation with the slightest symptom.

4.4.4. Hobbies and sports activities

Hobbies and sports were less characterised by cancellation and more by the individual's optional, voluntary adjustment of her participation in the activity. While some mentioned the activities being stopped, discontinued or cancelled by the providers, the individuals having themselves chosen to no longer partake in the activity – most often the gym – was more apparent.

A strong expression of avoidance of gyms and forms of indoor exercise was evident. Having stopped exercising altogether was mentioned by a considerable number of respondents:

> *'I have chosen not to exercise because of the recommendations.'* (Woman aged 41–45, car driver for this trip prior to pandemic, living in a suburb)

> *'[I] do not exercise at all anymore. Previously because of the risk of the infection, later mainly because of poorer physical capacity.'* (Woman aged 41–45, pedestrian for this trip prior to pandemic, living in the city centre)

Modal adjustment was also dominant, again linked to ranking of modes, with for some, not taking public transport meaning not being able to participate in the activity. In some cases, it was considered that the activity itself was not necessarily problematic but having to take public transport and it being too far away to walk or cycle meant not being able to participate in the activity.

A tangible shift to the outdoors was apparent for hobbies and sport activities. This was characterised by mentions of indoor training no longer being available and transitions to training outdoors in groups, or an adjustment in terms of training less often when the training is not outdoors.

There were several mentions of partaking in activities in outdoor forested areas more often. While there were some, but rather few, mentions of training at home instead of at a gym.

Hobbies and sport activities were also characterised by temporal adjustment, with several respondents mentioning how they visit such locations less often as a result of the risk for infection, and how they adjust the time frames during which they participate in these activities. Some references were made to restrictions and guidelines with respect to these activities (e.g. the maximum number of people who can gather in one room).

Activities that were specified as being avoided were overwhelmingly related to the gym and indoor exercise classes. While activities such as music, theatre, choir and association meetings were cancelled or on hold. Less apparent than anticipated was the use of digital solutions to see cultural shows.

4.4.5. School and pre-school trips

Symptoms were much more visible as a capability and coupling constraint among trips to and from children's schools and pre-schools. This activity was characterised by parents having to stay at home to mind children with symptoms of a cold, and the stricter rules enforced since the outbreak of Covid-19.

Modal adjustment was a dominant theme for this activity, with many highlighting how they now use more active modes of transport such as walking or cycling, with some mentions of the use of the car. Some discussed modal adjustment as being related to working from home. Others mentioned that their children have now started to travel to school independently:

'I got the golden opportunity to teach the children to cycle to school as we work from home and suddenly have the opportunity to pick them up in the early afternoon which previously was a problem.' (Man aged 41–45, public transport user for this trip prior to pandemic, living in a suburb).

Some mentioned how there have been changes to who drops off and picks up the children as a result of working from home, with one respondent highlighting that the morning routine has changed:

> *'[…] The mornings have become calmer.'* (Woman aged 41–45, cyclist for this trip prior to pandemic, living in the city centre)

Responses from grandparents were characterised by no longer dropping off or picking up grandchildren, and no longer having any

physical contact with grandchildren.

4.4.6. Children's hobbies and sports activities

Children's hobbies and sports were characterised by *cancellation*, a theme which was much more apparent than for the respondents' own hobbies and sports activities. However, some spatio-temporal adjustment was apparent, with some activities having shifted outdoors, and taking place less frequently. Others highlight how they themselves have chosen not to go to the location of the activity, that there are too many people, or that they choose not to partake in the activity even though it has shifted outdoors. Authority constraints were mentioned; how adults are not allowed to join or have to stay on the other side of a fence to where the activity is taking place, whilst maintaining a distance between themselves.

Fig. 5a and b illustrate the locations of children's activities; the former, activities prior to the pandemic, and the latter, the children's activities for which changes have occurred since the beginning of the pandemic. Fig. 5b would suggest that activities lying further from the city centre have been affected.

Modal adjustment was not at all as apparent as with other activities, but as in the case of grocery shopping, this is an activity for which public transport use is low and car is the dominant transport mode. Virtual participation was not as visible as anticipated, with only a small number mentioning that the activity is now provided through online teaching.

4.4.7. New activities

Several respondents mentioned and mapped out new activities in which they have begun to engage since the outbreak of the Covid-19 pandemic. These activities were highly characterised by a *shift to the outdoors*.

Mentions of new activities were characterised by walking for leisure or in forested areas or parks, hiking, trips to the beach, and exercising outdoors instead of indoors. These activities were usually linked to mentions of running, jogging, yoga, and less frequently, tennis and basketball. New or more frequent visits to playgrounds, DIY stores and garden centres were also tangible.

Less visible than expected, although still mentioned, were activities such as meeting friends online, reading books, at-home activities, gardening, exercising at home, studying, spending time with the family, cycling, getting take-away food, and working from (someone else's) home. Spending more time in a holiday home, helping friends and helping people in at-risk groups were also mentioned.

5. Discussion and policy implications

The purpose of this study was to improve and deepen the understanding of how the early stages of a pandemic have translated into changes in mobility as an element of everyday life and corresponding travel behaviour through engaging a Time Geographical perspective. By engaging PPGIS, we investigated how inhabitants in an urban context have perceived these changes, in terms of reductions in travel (e.g. shifts from corporeal to virtual mobility), temporal and modal adjustment. Resources and forms of access to modes of transport were explored, and conceptualised as shifts in coupling constraints, authority constraints and capability constraints. Activities such as work, education, grocery shopping, hobbies, and social activities were explored with respect to the frequency of the activity, the mode of transport used, and any changes to these activities during the ongoing crisis.

Work-related trips were characterised by relatively high public transport use pre Covid-19, and show two important changes. First, a shift to virtual mobility is noted as many were either encouraged or forced to work at home. This shift seems to be more apparent for respondents who already had the opportunity to work from home, indicating a more pronounced divergence between those who can work from home and those who cannot. The shift to virtual mobility thus seems to heighten existing differences (see Cresswell, 2006). Second, modal adjustment in the form of a shift from public transport is also evident. This shift is driven by both choice (choosing not to use public transport) and a lack of choice (claims of no longer having the option to use public transport).

In the future, if such habits hold, they might translate into a significant reduction in travel demand generally, and with perhaps less pronounced peaks. This could present significant challenges as well as opportunities for public transport providers. Policy responses could take the form of smoothing out peaks in tandem with staggered working hours, opening hours for services and organisations, and school hours (see Camén and Lidestam, 2016) (policy response 1, see Table 4).

Moreover, the low ranking of public transport by respondents indicates significant challenges for public transport use. The balance between supply and demand and corresponding pricing and ticketing strategies is likely to play out as a considerable challenge for the provision of public transport. The results of this study highlight the challenges that public transport providers face during the Covid-19 pandemic, which may be a reality during the aftermath also (see Vitrano, 2021). Drastically reduced revenues caused by the reduction of movement may trigger public transport providers to reduce supply with lower capacity into the future. This in turn could make public transport an even less attractive or even impossible option for some. It is still unclear to what extent changes in travel behaviour may hold into the future, but this study indicates changing spatio-temporal patterns that have may have an impact on ticketing policies. Many respondents indicate they work from home at least for part of the working week. This makes traditional monthly cards less attractive. A tangible policy response is to adjust ticketing pricing and policies to meet new travel patterns (policy response 2). Unless such measures are taken, the willingness to use public transport may decrease. By comparison, other

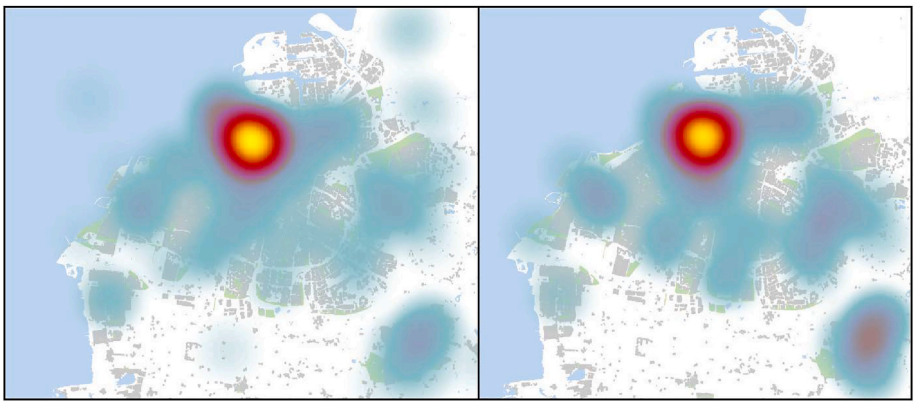

Fig. 5. (a) (left): children activities as reported by respondents. (b) (right): Children activities that have been affected by Covid-19.

Table 4
A summary of policy recommendations for the short and long-term.

Policy response number	Description
Policy response 1	Smoothing out peaks in tandem with staggering working hours, opening hours for services and organisations, and school hours.
Policy response 2	Adjusting ticketing pricing and policies to meet new travel patterns.
Policy response 3	Monitoring public transport-related accessibility needs, taking spatial and gender inequalities into account
Policy response 4	Tightening cooperation and consulation between education providers, municipalities and public transport providers in order to ensure that (1) an increase in car trips does not ensue; and (2) access to education facilities by sustainable modes of transport is secured.
Policy response 5	Ensuring sufficient capacity in pedestrian and cycling infrastructure in the vicinity of supermarkets. This policy response could encompass a particular focus on infrastructure and suitably dimensioned parking for cargo bikes.
Policy response 6	Improving the outdoor environment and adjusting outdoor areas for outdoor meetings.
Policy response 7	Improving accessibility to parks and outdoor areas, with a particular focus on developing the infrastructure for walking and cycling to these places.
Policy response 8	Improving walking and cycling infrastructure to schools and day-care facilities.

transport modes, such as the car, may become more attractive for people who commute irregularly or less frequently. See De Vos (2020) for a further discussion of the challenges faced by public transport.

There are notable gendered differences in terms of mobility resources:a higher proportion of men have a driving license and access to a car, with a higher proportion of women having access to monthly public transport tickets. This is in line with previous findings reporting that women use the car less frequently than men (e.g. Vance and Iovanna, 2007). Approximately two-thirds of men state they can normally work from home, while more than half of the female respondents state they can never work from home. This gendered difference is in line with previous research on telecommuting (Ory et al., 2004; Sarbu, 2015; Sener and Bhat, 2011) and may present significant challenges into the future, if working from home holds as a behaviour beyond the pandemic.

One of our study's main findings is the uneven distribution of the effects in terms of gender, geography and socio-economic aspects. Although one should interpret the results with caution, the overall picture is that women in the study are to a larger extent affected than men, in terms of facing decreases in income and having fewer opportunities to work from home, while also being more dependent on public transport. In terms of the geographic distribution of the possibility to work at home, as well as changes in this possibility, we observed clusters in the more prosperous areas of the city. Those who do not have the possibility to work from home, and have not experienced any changes in this respect, are clustered in areas associated with lower income levels. This suggests that shifts in virtual mobility are unevenly distributed, and that access to public transport remains important, especially for some groups, even during the pandemic. One policy response by transport authorities could include monitoring public transport-related accessibility needs, taking these spatial and gender inequalities into account (policy response 3). This concerns both temporary changes in transport provision and scheduling during the pandemic, but also long-term adjustments if mobility patterns change in the long run.

Trips for education purposes were associated with high public transport use under normal circumstances (pre Covid-19), but since all upper secondary and tertiary education had during the spring of 2020 moved to online education, there was almost an entire shift to virtual mobility. The interchange between public transport provision and use, and any move back to on-campus learning will be telling in terms of travel demand. The location of higher education is likely to exceed walkable or cycle-able distances from students' omes and with smaller proportions within these age groups holding driving licenses, public transport may at present be the only option. Whether this could result in a greater demand for driving licenses, private cars and thus parking remains to be seen. Possible policy responses include tight cooperation and consulation between education providers, municipalities and public transport providers in order to ensure that (1) an increase in car trips does not ensue; and (2) access to education facilities by sustainable modes of transport is secured (policy response 4).

Shifts to online grocery shopping were also present. In future, booking a time for onsitegrocery shopping might be a reality in order to ensure social distancing. Online shopping was mentioned by a few, but it was not as apparent as anticipated, suggesting that the logistics surrounding online shopping had not fully adapted to the circumstances, or that the traditional activity of onsite grocery shopping by customers will persist. A concrete policy response if for municipalities and others responsible for the road, cycling and pedestrian networks to ensure sufficient capacity in pedestrian and cycling infrastructure in the vicinity of supermarkets. This policy response could encompass a particular focus on infrastructure and suitably dimensioned parking for cargo bikes (policy response 5). This could function as a way of counteracting the concerning trend of a shift to car use and bulk buying.

Considering that social activities were somewhat characterised by a shift to the outdoors, transport and city planning implications and policy responses may take the form of improving the outdoor environment and adjusting outdoor areas for outdoor meetings (policy response 6). Worryingly, the reduction in the frequency of participation in these activities was rather tangible. The positive well-being outcomes associated with participation in out-of-home activities (e.g. De Vos et al., 2013; Ettema et al., 2010) are at risk if declines in such participation persist.

New activities were largely characterised by outdoor activities. Transport and land use policy could in future focus on accessibility to parks and outdoor areas, with a particular focus on developing the infrastructure for walking and cycling to these areas (policy response 7). It has been highlighted how several cities worldwide have at least temporarily transformed road infrastructure to accommodate larger volumes of pedestrians and cyclists (Laker, 2020).

The crisis does however also provide opportunities for more sustainable transport. Avoidance of public transport and reductions in travel demand have seen declines in public transport patronage as well as car traffic elsewhere (see discussion De Vos 2020). Long-term changes in teleworking, or virtual mobility, may result in spatio-temporal changes including less frequent trips. Although our study mainly finds modal shifts towards increased car use, there are also reports in shifts to biking and walking. This shift to walking and cycling has been seen elsewhere, with Kick (2020) highlighting how people in Germany are now spending an average of 25 min per day cycling, an increase of 25% from the previous 20 min. Strategies to avoid the use of public transport are credited with such increases. Improving walking and cycling infrastructure is one way for policymakers to encourage these travel modes. Of special interest here is mobility related to schools and day-care facilities (policy response 8). Modal adjustment with respect to dropping off and picking up children could largely be considered positive from a sustainable transport perspective, with the exceptions of adjustment to the use of the car. Indeed, this could be considered an opportunity for sustainable mobility and *independent* sustainable mobility for children. Improving accessibility for cycling and walking could improve traffic safety, health and environment alike.

In the case of Malmö, its position in the Greater Copenhagen region will be a considerable challenge for the future. Indeed, the role of public transport in underpinning the integration of this region is also at stake. Despite Sweden's relatively 'soft' strategy to manage the spread of Covid-19, substantial changes to people's everyday lives are observed, with this study giving an insight into the situation in Malmö, a city which has found itself somewhat caught between two approaches to the crisis. Our findings give an indication of both the short and long-term

impacts on everyday mobility in the Swedish context, for groups of inhabitants in the city of Malmö. Targeted policy responses, such as those outlined above, will be crucial in supporting people in their everyday activities, supporting the life of the city, and ensuring the continued integration of the region into the future.

Author statement

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Declaration of competing interest

None.

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