Landscape and Urban Planning 214 (2021) 104175

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Back to nature: Norwegians sustain increased recreational use of urban green space months after the COVID-19 outbreak

Zander S. Venter *, David N. Barton, Vegard Gundersen, Helene Figari, Megan S. Nowell

Norwegian Institute for Nature Research - NINA, Sognsveien 68, 0855 Oslo, Norway

HIGHLIGHTS

- Increases in recreational activity during COVID-19 pandemic in Oslo, Norway.
- Increases sustained up to 6 months post-lockdown.
- Largest increases were in protected areas and cultural landscapes.
- Teenager demographic exhibited greatest relative increase.

ARTICLE INFO

Keywords:
Coronavirus
Mobility
Ecosystem service
Aesthetic value
STRAVA
Open space
Environmental green justice

ABSTRACT

In Oslo, as elsewhere, the COVID-19 outbreak and the following lockdown measures during spring 2020 led to increased use of urban green infrastructure. Whether this has led to more durable changes in recreation patterns remains an open question. We used mobile tracking data from 53,000 STRAVA users to explore the longevity of increases in recreational activity. We compared 2020 activity levels relative to a weather benchmark (i.e. baseline), defined as the activity one would have expected given the time of year and prevailing weather conditions. Recreational activity increased by 240% during the five weeks of comprehensive lockdown and were maintained until the summer vacation period in June/July when they dropped to baseline levels. Yet, during August they increased again to 89% above baseline. Although activity increased across all city land use zones, after lockdown there was a shift away from residential and commercial zones toward city green spaces including forests and protected areas. Cultural landscapes and protected areas received disproportionately high activity levels relative to the length of recreational trails available within them. Recreationists in the teenager demographic (13–19) exhibited a four-fold increase in their share of the STRAVA user-base at the start of lockdown. The COVID-19 pandemic and its disruptions to the *status quo* has had lasting effects over the short-term on the way Norwegian citizens recreate. Our findings reinforce the value of urban nature and open spaces for societal pandemic preparedness, particularly youths, during and after times of crisis.

1. Introduction

There has been higher demand for recreational space in a number of cities throughout the world during the COVID-19 outbreak (Day, 2020; Kleinschroth & Kowarik, 2020; Samuelsson et al., 2020; Venter et al., 2020; Weed, 2020). In Oslo, Norway, as life returned to a semblance of normality during the summer of 2020, it was unknown whether the changes in recreational activity initiated during lockdowns would be sustained. There has been limited research on whether recreation patterns are short term responses to restrictions of the pandemic (Bereitschaft & Scheller, 2020) or likely to persist due to changes in personal risk perception, social norms and habituation to new environments. Research on the permanence of changes in outdoor recreation patterns has therefore been called for (Honey-Rosés et al., 2020). In cities with crowdsourced data on human mobility, such as the social network training app STRAVA, there is potential to explore outdoor recreation patterns and their permanence with high temporal and spatial resolution.

There is consensus in the scientific literature that regular participation in physical activity is beneficial for both physical and mental health (Penedo & Dahn, 2005). At the same time, research shows that activity and experiences in the natural environment can improve long-term

* Corresponding author.
E-mail address: zander.venter@nina.no (Z.S. Venter).

https://doi.org/10.1016/j.landurbplan.2021.104175
Received 16 December 2020; Received in revised form 16 April 2021; Accepted 14 June 2021
Available online 29 June 2021

health outcomes (Slater et al., 2020; Twohig-Bennett & Jones, 2018). It is not surprising, then, that outdoor recreational activity and time spent in nature has been recommended as an antidote to the negative psychological impacts of the COVID-19 pandemic and quarantine measures (Brooks et al., 2020; Slater et al., 2020; McCunn, 2020; Pouso et al., 2021). Urban and *peri*-urban green spaces - defined as street trees, parks, and natural areas within and outside the city border (Konijnendijk et al., 2005) - have been proposed as critical infrastructure in urban planning (Derks et al., 2020; Kleinschroth & Kowarik, 2020; Soga et al., 2021). Use and perception of urban green spaces during the pandemic is also important from a public health perspective because of observed lower physical activity and mental health levels in general across a number of populations and countries since the COVID-19 outbreak (Slater et al., 2020; Torales et al., 2020; Xie et al., 2020; Stockwell et al., 2021; Wilke et al., 2021). This research agenda requires looking at the conjunction of urban green space characteristics (e.g. availability, quantity, quality), government pandemic restrictions, and population mobility and social distancing behaviour in outdoor spaces over time. Furthermore, there is an urgent need for research that informs the integration of public health and urban planning (e.g. Honey-Rosés et al., 2020).

Global comparative studies (Ritchie et al., 2020; Day, 2020; Geng et al., 2020; Johnson et al., 2021) that use Google Community Mobility reports to quantify mobility to parks are aggregated to provincial or national level. Their ability to differentiate city and neighbourhood level use of urban outdoor spaces under pandemic regulations is therefore limited. A majority of studies have been based on questionnaire responses rather than observed behaviour (Bereitschaft & Scheller, 2020), with limited spatial and temporal resolution to observe preferences for varying characteristics of urban open space. Nevertheless, combining aggregated mobility data, infection case rates at council level, green space patchiness and availability in the UK, Johnson et al. (2021) found that reduction in mobility is the strongest predictor of infection rates; but if mobility is necessary, outdoor park use is safer than indoor aggregated activities, especially during an exponential phase of transmission. This implies that urban green space may allow for low-risk social activities (Day, 2020), and de-densification has been identified as part of increasing urban resilience in the face of future pandemics (Bereitschaft & Scheller, 2020).

Recommendations for keeping parks and green space accessible for mental and physical health reasons during the course of the pandemic consider longer term effects (Slater et al., 2020). Longer durations of self-quarantine can lead to poorer mental health, post-traumatic stress symptoms and other negative psychological impacts (Bavel et al., 2020; Brooks et al., 2020; Hossain et al., 2020). Urban green spaces are particularly important for children and youth; for play, socialization and physical recreation (Skår et al., 2016). Younger demographics prefer inner city living and research on the effects of the pandemic on recreational and residential preferences of this demographic is of particular interest (Bereitschaft & Scheller, 2020). Research is underway on specific mental and physical impacts of pandemic restrictions on youth (Silva Junior et al., 2020), given indications of additional risk of negative psychological effects among adolescents (O'Reilly et al., 2020). A significant influence of the living environment on the decrease of physical activity levels was observed in e.g. Croatia, with a larger decrease in physical activity for urban adolescents than in rural areas (Zenic et al., 2020). Studies focusing on urban green spaces have tended to observe total increases in use (Day, 2020; Fisher & Grima, 2020; Venter et al., 2020), and findings have been limited with regards to the demographic composition of users (Stockwell et al., 2021).

In this paper, we extend upon the findings that people seek urban green spaces during crises due to a combination of positive preferences for natural areas that promote well-being and public health, a possibility to use green shelters to escape from denser crowds at home and in the city, and an increased habituation and socializing in the population to use green spaces during the crisis. We demonstrate how mobile app tracking data is an additional tool for health authorities and urban planners, offering high spatial–temporal resolution data to explore short term fluctuations and longer term behavioural changes in urban green space use. Specifically, we use STRAVA data from the capital city of Norway, Oslo, to test the hypothesis that the COVID-19 lockdown event had effects on recreational activity patterns that lasted beyond the duration of initial lockdown measures. Here, initial lockdown is defined as 12 March to 20 April, covering the first wave of COVID-19 spread (Venter et al., 2020). Specifically, we aim to address the following research questions:

- Was the relative increase in recreational activity observed during March 2020 sustained over the succeeding six months?
- How were changes in recreational activity and its intensity distributed across land use/cover zones?
- How did recreational activity change across different age demographics in an urban population?

2. Methods

2.1. The Norwegian context

Engaging in outdoor physical activity is widely embraced across various Norwegian social strata (Breivik, 2013; Rybråten et al., 2019). An important reason for this is the principle of common access ("allemannsretten" in Norwegian) that grants anyone the individual right to freely roam on private and public land, and to engage in a range of recreational activities. We may consider "allemannsretten" to be an intrinsic component of Norwegian culture. In March 2020 the Norwegian authorities issued lockdown regulations which led to the closing of gyms and other sports facilities. To compensate for this, the citizens presumably needed to engage in alternative forms of indoor or outdoor physical activity. It was therefore not surprising that Venter et al., (2020) found a three-fold increase in outdoor recreational activity in the weeks following initial lockdown in Oslo, Norway. Since the publication of these findings, there has been successive lifting of lockdown measures with life somewhat returning to normal. Whether the unprecedented increases in outdoor use of urban nature has been sustained beyond the period of formal lockdown measures remains unknown.

Norway has been among the countries in Europe least affected by the coronavirus when looking at the number of infected and dead in relation to the total population (https://ourworldindata.org/covid-cases). Some of this can perhaps be attributed to the overall low population density (Ursin et al., 2020). The country has nevertheless undergone large urbanization processes, and today more than 80% of the population lives in cities and towns (Statistics Norway, 2019). The population density in Oslo is comparable with other European cities and therefore makes for an interesting case study of how a typical urban population responds to relatively relaxed lockdown measures.

Norway has large tracts of natural areas, and together with Finland are the countries in Europe with the most *peri*-urban forested areas (Konijnendijk et al., 2005). This was probably one of the reasons why it was not necessary to prevent access to green infrastructures, as was done in most other European countries during the initial COVID-19 lockdown period (Geng et al., 2020). Instead of viewing green areas as potential sources of infection (Shoari et al., 2020), they were perceived as opportunities for shelter and recreation in environments where social distancing is possible.

An aspect of the recreational activity response to lockdown that was not explored by Venter et al. (2020) was that of age demographics. This is of particular interest because the 13–19 and 20–29 demographic had the highest COVID-19 infection rates during the second infection wave in Norway (Norwegian Institute of Public Health, 2020). It is therefore possible that one may find a disproportionate response in their recreational activity as well, and that space to recreate is particularly important to youth in Oslo. School and kindergarten closures could be expected to have a distinct response from adults in the child caring demographic. The average age of parents at childbirth in Norway is 32.8 and 35.2 years for mothers and fathers respectively (Statistics Norway, 2019). An effect in adults in their 30 s to early 50 s could also last after schools and kindergartens reopened in late spring due to continued recommendations to work from home, combined with stricter stay-at-home rules keeping parents at home with symptomatic children.

2.2. Study area

Located in South-Eastern Norway on the Oslo Fjord (59′55 N, 10′45E), Oslo municipality includes a population of 693 491 which accounts for approximately 13% of the entire population of Norway (Statistics Norway, 2019). Using land use zone data obtained from the City Environment Agency and Statistics Norway (2019), we find that the municipal land area is dominated by boreal conifer forest, mainly spruce (*Picea abies*) ("Marka" in Norwegian) (63%, Fig. 1). The build-up area (commercial and residential) constitutes 19% of the land area, however it is interwoven by a network of city parks and green areas making up 9% of the municipality.

Along the urban-wilderness continuum in Oslo there exists a range of opportunities for recreation (Gundersen et al., 2015). The recreational spectrum consists of 1400 km of forest roads and 2100 km of marked trails. The new Marka Act (2009) established that the forest surrounding Oslo (altogether 1700 km^2) should be managed primarily for recreation. While forestry is permitted, development of further recreational infrastructure is strictly regulated and housing development prohibited, as it has been for at least a century (Mjaaland & Andresen, 1986). In this context, the Oslo case is very interesting and an unusual example of a city that still has a very large proportion of nature in its surroundings.

2.3. STRAVA data

STRAVA is a mobile application used to monitor personal sports activity. STRAVA data is a form of crowdsourced GPS tracking data that has been used to quantify recreational use of green areas (e.g. Heikinheimo et al., 2020; Venter et al., 2020), however the bulk of studies using STRAVA data have focused on cycling activity in relation to transportation research questions (Lee & Sener, 2020). The STRAVA application tracks the GPS location of the user over the course of an outdoor activity resulting in a detailed record of spatio-temporal movement pattern. For each activity, the application records metadata including the age of the user (in brackets of 13–19, 20–34, 35–54, 55–64, and greater than 65), the type of activity (pedestrian or cycling) and the purpose of the activity (commuting for work or leisure). These data are manually entered into the app by the user, however the range of options (e.g. age bracket) is defined by STRAVA. STRAVA then uses an

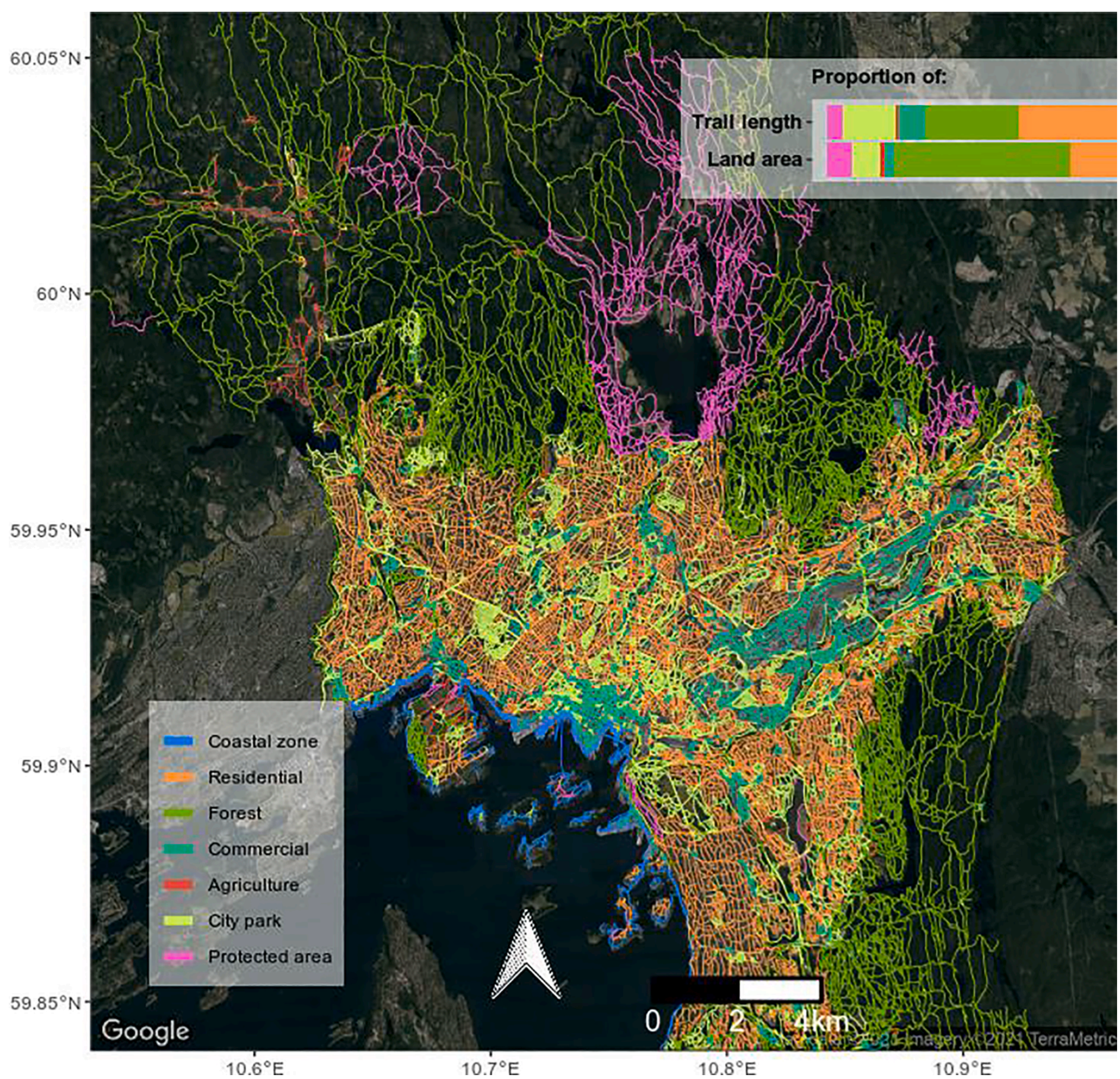

Fig. 1. Distribution of available STRAVA trails in Oslo municipality. Trail segments are coloured by the land use/cover type they fall within. A proportional summary of the total trail length and land area coverage within each land use/cover type is depicted in the inset bar graph.

automated procedure to align the raw GPS tracks with the closest recreational or transport line geometry defined by the OpenStreetMap base layer. There is a substantial STRAVA usership in Oslo which accounts for approximately 8% of the population and the users record more than half a million unique activities each year on trail segments that amount to 7000 km in length (Fig. 1). Based on a commercial contract with STRAVA, we obtained geospatial STRAVA data from Jan 2019 to Aug 2020 for Oslo municipality. The data is anonymized and aggregated over time and space to maintain user privacy. We therefore had access to daily activity counts aggregated to street/trail segments defined by an OpenStreetMap base layer. Given the aims and scope of this paper, we filtered the data for activities flagged as leisure only.

2.4. Statistical analyses

Aspects of STRAVA data that make temporal analysis challenging include (1) the year-on-year gradual increase in STRAVA usership, and (2) the fact that STRAVA is only a sample of the entire population. To overcome these we adopted the methodology outlined in (Venter et al., 2020). We first detrended the time series relative to the long-term annual average to remove the effect of STRAVA usership increases and so that intra-annual activity levels are comparable between years (see Fig. S1 for illustration). We then cross-validated the STRAVA data using two established automatic counters located at strategic points in the municipality (locations not disclosed to maintain STRAVA user anonymity requirements). These were EcoCounter products with two-way pyroelectric sensors that have been installed and managed since 2015 for high counter accuracy following standard procedures (Andersen et al., 2014). We intersected the location of the established counters with the corresponding STRAVA trail segments and performed a linear regression of monthly, weekly and daily counter totals on STRAVA activity counts (Fig. S2). The cross-validation revealed correlation R^2 values of 0.8, 0.67 and 0.14 for monthly, weekly and daily time series, respectively.

Given the empirical evidence for a correlation between STRAVA activity counts and those measured by fixed-point counter stations, we could assume the STRAVA time series is representative of the total Oslo population. This is primarily true for estimating the volume of users on the urban end of the spectrum including the most used roads and paths in the area (Gundersen et al., 2015), while for areas that are more remote, STRAVA users will probably be less representative. In the more remote areas, the users are often motivated by harvest and wilderness experiences (e.g. fishing, picking berries, feeling of being away, solitude) rather than exercise resulting in less recorded activities in STRAVA (Gundersen et al., 2015). We therefore calculated relative changes in activity counts over time aggregated to spatial units including the entire municipality and land cover/use zones (Fig. 1). We intersected STRAVA trail geometries with land use polygons and assigned each trail segment to a land use based on majority overlap. When aggregating to larger spatial units, we calculated daily recreational activity (A) as

$$A_j = \sum_{1}^{N} (t_s * l_s)$$

where j is the given spatial aggregation unit, N is the number of trail segments within that unit, t is the daily trip number, and l the path distance (in kilometers) of each individual trail segment (s).

We also calculated the recreational activity intensity (AI) for given spatial units. This was defined as the ratio of cumulative activity relative to the total length of available trail segments (D) within the given spatial aggregation unit j:

$$AI_j = \frac{A_j}{D_j}$$

In order to explore the effect of COVID-19 lockdown regulations on the population's recreational activity, we needed to control for the confounding effect of weather – a strong determinant of recreational activity (Smith, 1993). This is based on the rationale that simply comparing 2020 time series with those in previous years is not sufficient because anomalous weather in 2020 (or during the previous years) may have led to anomalous recreational activity which confounds the effect of COVID-19 lockdowns. To control for the weather effect we employed the same methodology as Venter et al. (2020) which involves calibrating a multiple regression model which predicts expected recreation levels given the prevailing weather and time of year. We collected daily meteorological data (temperature, rainfall amount, hours of sunshine, wind speed and snow depth) from five weather stations in the study area that are maintained by the Norwegian Meteorological Institute. In particular, controlling for hours of sunshine is important as daylight length increases by 13 h between winter and summer in Oslo. A generalized linear regression model was built with pre-lockdown (1 January 2017 to 12 March 2020) daily STRAVA activity levels as the response data and daily meteorological variables, and day-of-week and week-of-year as the explanatory data. The model was used to predict what the recreational activity was expected to have been during 2020 post-lockdown days, hereafter referred to as the "weather benchmark". We calculated the percentage deviations between observed activity and the weather benchmark levels. Observed recreational activity levels that were higher or lower than the 95% prediction confidence intervals generated from the regression model were considered as significant deviations from the weather benchmark.

3. Results

3.1. Overall trends in recreational activity

During the initial lockdown dates (12 March to 20 April), recreational activity increased by 240% relative to the weather benchmark (+228% pedestrian, +252% cycling; Fig. 2, Fig. S3). Following the opening of kindergartens and schools up until the summer vacation (20 June), activity levels were maintained at 160% above the weather benchmark (+188% pedestrian, +132% cycling; Fig. 2). During the six weeks of summer vacation (20 June to 31 July), recreational activity dropped close to baseline levels with many days containing non-significant increases/decreases relative to the weather benchmark. However, during the month of August, activity levels rose again to 89% above the weather benchmark (83% pedestrian, 94% cycling; Fig. 2). The direction and relative magnitude of these trends were mirrored for both pedestrian (walking, running and hiking) and cycling activities.

3.2. Trends across land use zones

The temporal pattern of activity change was mirrored across land use/cover zones in the city (Fig. 3). The forest and protected area zones show the sharpest increases in activity post-lockdown in March 2020. City parks experienced greater increases in pedestrian relative to cycling activity during the first few months of lockdown (Fig. 3). In contrast, cycling activity increased with greater magnitude relative to pedestrian activity in agricultural landscapes.

Directly after the lockdown commenced on 12 March, the proportional distribution of recreational activity across land use zones shifted (Fig. 4). Forests, which contained a 9% share of the activity pre-lockdown, increased to a 23% share post-lockdown. Similarly, protected areas shifted from a 0.6% to 1.5% share of recreational activity following lockdown. The two land use zones which showed the greatest declines in their share of activity were the residential and commercial. The magnitude and direction of these changes were similar for pedestrian and cycling activities.

Apart from exhibiting varying trends in recreational activity, the land use zones also revealed varying levels of use intensity. Averaging over January to August 2020, we find that agricultural landscapes and protected areas experience disproportionately high activity levels relative to the length of recreational trails available within them (Fig. 5). For

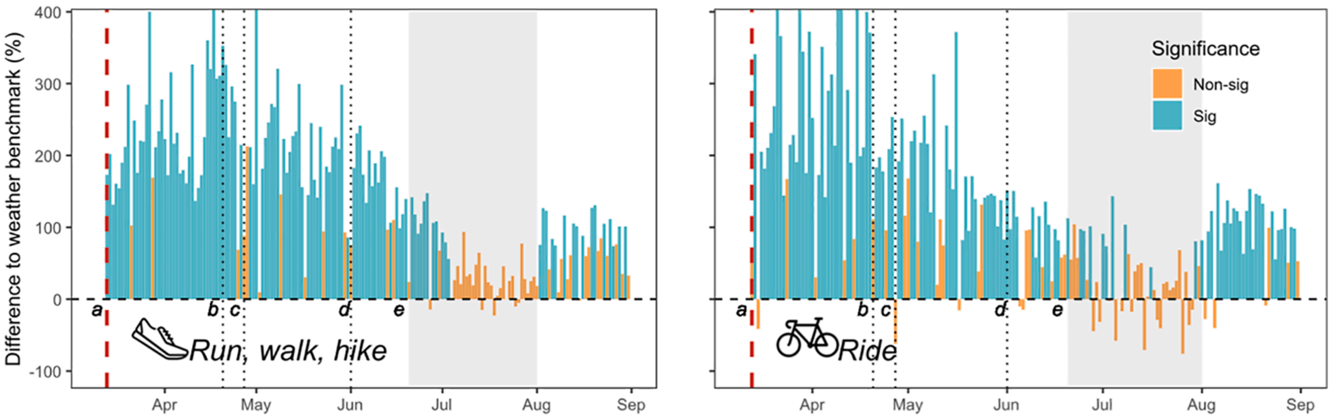

Fig. 2. Daily deviations in total recreational activity (across all trail segments) from the weather benchmark levels during 2020. Weather benchmark is defined as the activity level expected given the prevailing weather and time of year and is set at 0 on the Y-axis. Bars are coloured based on their statistical significance ($p < 0.05$). Vertical dashed lines indicate important COVID-19 regulation announcements for Oslo municipality: (a) comprehensive lockdown announcement, (b) first partial lifting of measures including opening of kindergartens, (c) second partial lifting of measures including opening of 1–4 grade schools, (d) final lifting of measures including opening of bars and other entertainment facilities, (e) shaded areas indicates start and end of summer vacation for Norwegian schools.

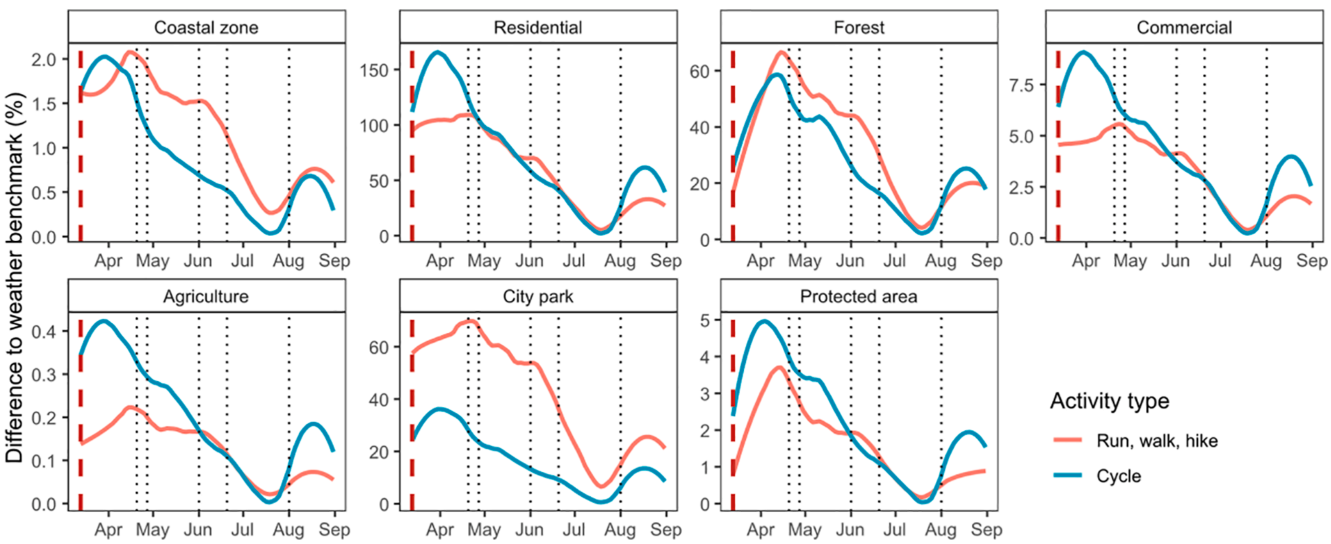

Fig. 3. Daily deviations in total recreational activity from the weather benchmark levels during 2020 for each land use/cover zone. Loess regression lines are fitted for pedestrian and cycling activity separately. Please refer to Fig. 1 for the description of dashed vertical lines. Y-axes are different for each land use class in order to highlight changes over time and differences between activity types. Please refer to Fig. 4 for an indication of relative distribution of activity across land use classes.

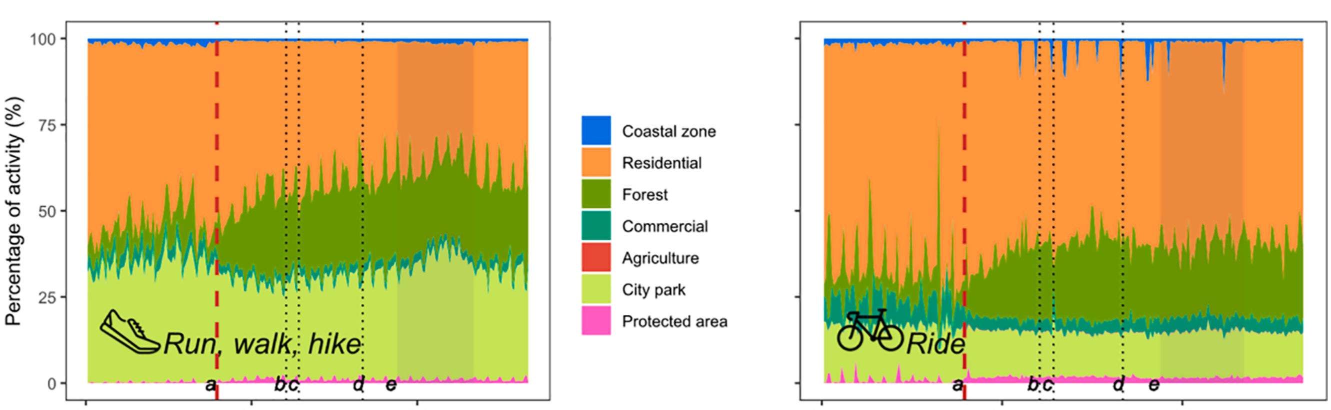

Fig. 4. Daily proportional distribution of recreational activity across land use/cover zones in Oslo. Stacked vertical bars are coloured by land cover zone and sum to 100%. Please refer to Fig. 1 for description of dashed vertical lines.

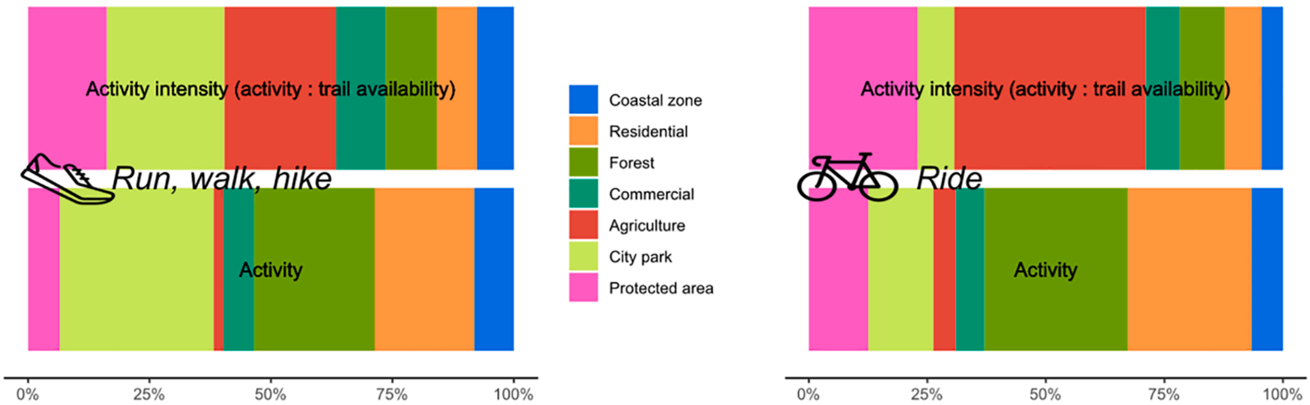

Fig. 5. Proportion of total recreational activity and activity intensity per land use/cover category in Oslo during 2020. Activity intensity is defined as the cumulative length of activity (in kilometres; km) relative to the total length of recreational trails available within the given land use zone.

instance, although protected areas facilitate 10% of the Oslo's total recreational activity, when you account for the trail availability, their usage doubles to 20% (Fig. 5). Similarly, while agricultural landscapes facilitate 4% of the total activity, their land usage intensity comprises 32% of the total for the municipality.

3.3. Trends across age demographics

We found large shifts in the proportional age distribution of STRAVA users coincident with the start of lockdown in March 2020 (Fig. 6). Specifically, teenagers (age 13 to 19) showed sharp increases in their share of the recreational activities during March. The opposite trend was evident for older age groups between 35 and 64. There was also evidence for a disproportionate increase in cycling activity amongst 20–34 year olds, however this trend was less evident for pedestrian activity (Fig. 6). Teenagers and the elderly exhibited a larger increase in use of forest areas relative to other age groups (Fig. S4).

4. Discussion

During the first stages of the COVID-19 lockdown, on average, we observed a three-fold increase in recreational use of outdoor spaces in and around Oslo across all resident groups. This response, also found in (Venter et al., 2020), was observed in other European countries, although to a lesser extent compared to Norway. In Bonn, Germany, the number of visitors to urban forests doubled during March 2020 (Derks et al., 2020). In the UK, researchers found evidence of a large-scale substitution of leisure time towards recreation in available greenspace (Day, 2020). The unique contribution of our study is that we have been able to track recreational response during and after the flattening of the COVID-19 infection curve with high spatial and temporal resolution. During August 2020, six months after the March lockdown and four months after lockdown restrictions were eased, we find that recreational activity remains 89% above baseline levels. This provides some empirical evidence to support the hypothesis raised by some (Honey-Roses et al., 2020) that the COVID-19 crisis may fundamentally change our relationship with public space. Indeed, Oslo's inhabitants, as reflected by calibrated STRAVA, data appear to have increased their time spent outdoors in green spaces within and outside of the city.

4.1. The role of domestic substitute recreation sites

Previous research has not discussed the role of domestic substitute sites for recreation (i.e. sites within one's home country, yet outside of one's residential municipality) during the mobility restrictions. Recreational activity in Oslo during the summer vacation weeks (mid-June to mid-July) was not significantly different to the baseline levels. During these weeks, schools close and many families typically travel abroad. Due to the global pandemic travel restrictions, one might have expected Oslo citizens to remain at home and further increase their use of the city's green space, but this was not the case. We posit that instead, Oslo residents travelled within Norway to locations like Lofoten which are typically hotspots for foreign tourists that have become attractive vacation destinations for Norwegians due to the pandemics. Indeed, in the period between July and September, Statistics Norway recorded an increase from 2.6 million domestic holidays in 2019 to 5.8 million in 2020 (Statistics Norway, 2020b). Another important element is that almost half a million Norwegians own second-homes (Statistics Norway,

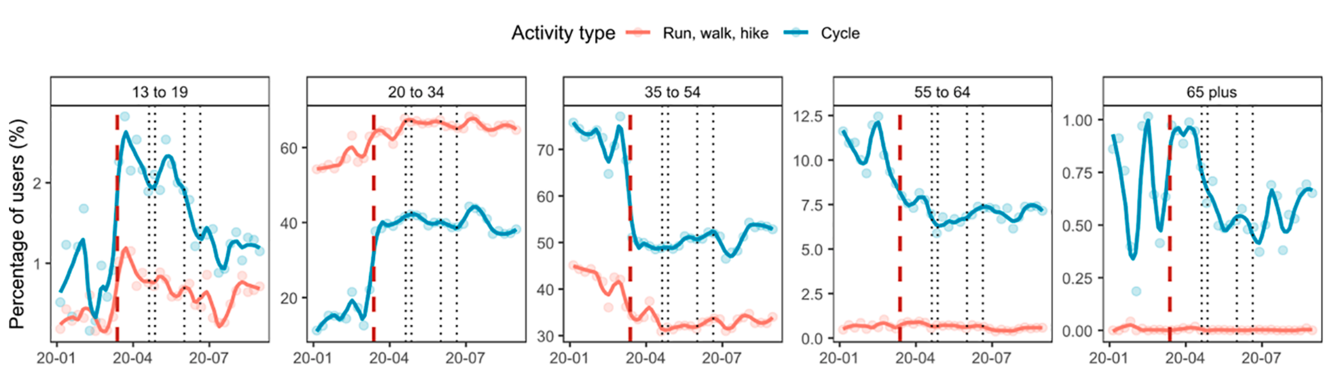

Fig. 6. Weekly proportional distribution of recreational activity across user age classes in Oslo during 2020. Two month moving averages are plotted with solid lines. The vertical dashed line indicates the date on which COVID-19 lockdown measures were introduced. Please refer to Fig. 1 for the description of dashed vertical lines.

2020a) outside the municipality they reside in – often located on the coast or in the mountains. For the period between the lockdown 12 March and 20 April, Norwegians were not allowed to visit their second-homes to prevent overloading rural health care systems. Since a large part of the population usually recreate at second-homes during Easter, this may have further contributed to the increased recreational activity within Oslo municipality in this period. However, during the summer vacation, Norwegians were allowed to visit their second homes and this reduced the recreational activity levels to baseline in Oslo.

4.2. Land use zone differences

During lockdown dates, Venter et al. (2020) observed a gradient of pedestrian activity increasing with paths containing greater surrounding vegetation greenness and tree cover. Vegetation in city streets was not analysed in the present study. Nevertheless, based on current findings most of the association between mobility increases and greenview (surrounding greenery) was in the forest and protected area land use classes. Venter et al., (2020) also found that recreational activity increases were greatest in areas with lower path density (number of recreation paths per unit area) consistent with the greater use of forest areas found in the present study (Figs. 4 and 5). This strengthens the view that parks and *peri*-urban forests function as "green refuges" and provides a disaster preparedness service to Oslo and should be considered "critical infrastructure" (Rung et al., 2011; Derks et al., 2020; Soga et al., 2021). The role of urban green spaces should be evaluated as part of municipal disaster preparedness planning as a means of stress management for the population (Oslo Municipality, 2017)

Protected areas in the *peri*-urban forests support much higher recreational activity relative to the path availability within them (Fig. 5). This suggests that these areas are prioritized and selected for by recreationists and underline the importance of maintaining protected *peri*-urban forest both as refuges and for their cultural and aesthetic value. Oslo municipality owns a large part of the *peri*-urban forests. In recent times, its forest administration has replaced clear cutting methods with a mixed-age and single-tree management regime to imitate natural forest dynamics (Gundersen et al., 2015). Natural forests include forest structures (elements, spatial patterns, processes) that are highly appreciated by the general public (Mjaaland & Andresen, 1986). We hypothesize that high intensive use of protected natural forests and traditional cultural landscapes not only reflect the need for space to keep the social distance, but also reflect a need for refuge in times of crisis.

4.3. Age demographic differences

We observe differences in the age demographic response to lockdown measures as well as the duration of behavioural patterns after lock-down measures were eased (Fig. 6). There was a large increase in outdoor activity in the teenage and young adult demographics immediately afterlockdown, particularly for cycling activity. This effect evened out in the teenage group as restrictions were lifted and schools reopened, while it remained high in the 20–29 group. Conversely, there was a large negative shift in the 35–54 age group in March which has lasted until August. Moving into a second COVID-19 infection wave (ca. October 2020 and onward) in the Northern hemisphere winter months, the age demographic response is important for understanding different responses and targeting measures. The 13–19 and 20–29 demographic has the highest infection incidence in the second wave in Norway (Norwegian Institute of Public Health, 2020). In retrospect, the increase in recreational use by teenagers during March may have mitigated the transmission of the virus, whereas during the second infection wave, with schools remaining open, there has been a spike in teenage transmission of the virus. This hypothesis is important given that urban young adults exhibited high COVID-19 transmission rates and high general susceptibility to physical and mental stress. It will require cohort epidemiological data to test comprehensively. The observed effect in teenage STRAVA users covers at most 2.5% of total STRAVA users, and may not be representative of the teenage demographic in Oslo.

Nevertheless, the increased adoption of outdoor recreation by Oslo's youth is encouraging given that there is mounting evidence that electronic entertainment and screen time has had negative impacts on teenagers' willingness to spend time outdoors (Larson et al., 2019). We hypothesize that behavioural changes in teenagers' engagement with urban nature may have longer-term effects such as where they choose to live. In the USA, older citizens tend to reside on urban peripheries closer to nature (Bereitschaft & Scheller, 2020). If remote working and work-life flexibility drastically increase after the CODIV-19 dust settles (Kylili et al., 2020), a global "back to nature" trend may emerge, with more youth choosing to live on the edge of cities. However, work-life flexibility may play out differently for adults with children. STRAVA users in the 35–54 year group experienced a large negative shift in outdoor activity which lasted beyond the initial mobility restrictions in March. Further research is needed in this demographic to identify temporary and permanent causes (school and employment practices).

4.4. Implications for urban planning

In the aftermath of the rapid spread of the coronavirus during the spring of 2020, policymakers and researchers are asking themselves how the urban environments should be organized in order to cope with potential future pandemics. Quarantining, lockdown and social distancing have been crucial measures in this regard, and will undoubtedly be an integral part of forthcoming preparedness plans in countries and cities all over the world. However, recent research findings suggest that quarantine measures can have negative impacts in terms of social isolation, decline in physical health and increased psychological stress and symptomatology (Brooks et al., 2020; Torales et al., 2020; Xie et al., 2020). Therefore, it is important to develop alternative pandemic mitigation measures that facilitate social distancing whilst maintaining physical and mental health effects (Slater et al., 2020). In this context, urban nature represents a refuge and a source of resilience – a place for well-being, physical exercise and alternative ways of socializing (D'Alessandro et al., 2020; Kleinschroth & Kowarik, 2020; Lai et al., 2020; McCunn, 2020). In the case of Oslo, the urgent need for an increased focus on the role of greenspace in the current situation has been demonstrated in practice (see also Venter et al., 2020; Bavel et al., 2020; Brooks et al., 2020; Hossain et al., 2020). Blessed with relatively easy access to urban forests, the city's STRAVA users have made evident the value of nature in a time of crisis by intensifying their use of it, even up to 6 months past the initial lockdown restrictions.

Yet, while the corona pandemic seems to have increased outdoor activities in Norway and elsewhere, there are still many unanswered questions: Why, for example, were teenagers and the elderly the most intensive users of the forests surrounding Oslo (Fig. S4)? We might speculate that one thing they had in common was time and opportunity. During the spring 2020, the media reported on several occasions that wild camping in hammocks had become a trend among teenagers and that the forests around Oslo were filled up with young people. However, we know little about their motivations. Did the forests provide a welcoming refuge from 'crowded' homes or an opportunity to stay in groups without being observed (Murillo-Llorente & Perez-Bermejo, 2020)? Conversely, we observe a negative and lasting impact in the middle aged demographic most likely to have children. Was the reduction in outdoor activity due to more work from home, which could increase flexibility for near-home recreation, but also be reduced by increased working hours and child home-care, due to changing school and employment practices? These and similar questions can only be answered by the means of surveys or qualitative methods.

Another important topic of inquiry relates to the social profiles of the registered STRAVA-users. While we did observe a prolonged post-lockdown increase in outdoor activities among Oslo's young adult population, and conversely a lasting reduction in the middle aged, the socio-economic pattern of these trends remain unknown. Previous research on the effect of social class and ethnicity on hiking activities has demonstrated that fewer descendants from non-western immigrants and working-class youngsters are active hikers as compared to ethnic Norwegian middle-class adolescents (Bjerke & Krange, 2011). These patterns resonate with broader sociocultural differences in the population with regard to physical activities in general and outdoor recreation in particular (Breivik, 2013). Thus, before rushing to conclusions about the effect of the COVID-19 on outdoor activities, there is a need for more nuanced studies on the interplay between variables such as age, gender (e.g. Fig. S5), income, education, employment, family structure, living conditions and ethnic background. If, for instance, the effect of increased outdoor recreation mostly concerns those with high education and income, the observed change cannot be characterized as socially sustainable, but rather points to increased inequalities.

We note that use of residential routes increased more in percent terms than *peri*-urban forests or parks did. As long as we do not possess more detailed data on the city dwellers who have profited from Oslo's abundance of surrounding forests during the pandemic, it would be imprudent to deduce that urban planners should prioritize 'wilder' and more peripheral urban nature over greenspaces which are more integrated in the urban landscape, such as street trees, city parks and 'pocket parks' (Baur & Tynon, 2010). In line with previous research which indicates that, on the contrary, proximity and immediate access to urban nature are the strongest drivers of outdoor activity while accounting for socio-cultural differences (Akpinar, 2016; Schetke et al., 2016; Shanahan et al., 2014), this study also shows a positive shift for pedestrian exercise in city parks. Beyond confirming the importance of city parks, the results do, however, also provide new perspectives on the enhanced role of fringe forests as a potential space for recreation and retreat in the future.

One clear effect of the pandemic measures has been the directing of nature based recreation towards more local sites (Randler et al., 2020). A supposed durable effect of the COVID-19 crisis combined with an environmentally motivated decrease in long distance traveling will presumably lead to a growing pressure on local nature sites in urban and suburban areas. In an environmental management perspective, and as suggested by Weed (2020), it might be wise to view the current increase in local mobility reflected in the STRAVA data as sustainable modes of travel which are likely to sustain post-lockdown. Indeed, during the pandemic many large cities around the world including Boston, London, Vancouver, Brussels, New York, Paris, and Barcelona have begun reconstructing streets to facilitate more cyclists and pedestrians over longer distances (Honey-Roses et al., 2020). Our results provide empirical evidence to support such policy decisions, assuming they were to be implemented in Oslo. Urban managers should thus seek a balance between the development of integrated urban nature and the preservation of more 'natural' and biodiverse *peri*-urban landscapes, such as Oslo's fringe forests.

4.5. Study limitations and future opportunities

Crowdsourced mobility data from applications like STRAVA have limitations in terms of under-representation of the general population, spatial and temporal activity patterns, and bias towards and away from certain groups (Lee & Sener, 2020; Muñoz et al., 2019). In a review of the literature, focusing on STRAVA cycling data, Lee & Sener (2020) found that, in general, STRAVA does correlate well with observed cyclist counts, however the correlation varies depending on the size of the temporal or spatial window of aggregation. Here, we attempt to correct for the year-on-year increase in STRAVA usership and rely on established cross-correlations with fixed-point counter stations in Oslo. Like Lee & Sener (2020) we find that the representativity of STRAVA data degrades at higher resolutions of temporal aggregation (Fig. S2). Therefore, while one can be relatively confident in drawing conclusions over the entire city at the monthly scale, one needs to be more cautious when interpreting daily variations in activity. Future work should aim to collect a calibration sample of counter stations that are stratified spatially according to trail use intensity. Counter stations should ideally distinguish pedestrian from cycling activities so that the STRAVA data can be corrected for these biases.

STRAVA data is also known to represent a population sample that is biased toward white and higher-income demographics (Roy et al., 2019). STRAVA's user base is also more likely to be male (in general, more than three-fourths) and a certain age group between 25 and 44 (roughly half), (Lee & Sener, 2020). In our analysis we did not have reference demographic data to correct for these biases in the STRAVA data. This is why our conclusions are only drawn from the temporal variation in age demographic activity, and not from the absolute age distributions at any one point in time. Nevertheless, our results should be interpreted given these biases in mind. Further research into the socio-demographic aspects of recreational activity using STRAVA data needs to be complemented with a questionnaire survey at strategic recreational trail points. This survey data can then be used to cross-calibrate the STRAVA data and correct for socio-demographic biases.

A further limitation is that the STRAVA data are not open-access and have to be purchased from STRAVA Metro (https://metro.strava.com/), which inhibits the reproducibility of our work. Nevertheless, with the recent trends in open source geospatial data and science (Mobasheri et al., 2020), such data may become freely available in the future in a similar fashion to how Google made their mobility data available through Community Mobility Reports.

Despite the limitations, mobility data is an important tool for policy makers and researchers to develop evidence-based strategies for urban planning and disaster risk reduction (Slater et al., 2020). Further research is needed on whether STRAVA data can complement COVID-19 mobility reports produced by Emergency Preparedness Agency of Oslo Municipality (Oslo Municipality, 2020) and used for assessing the need for and effect of lock-down measures. Exercise mobility in open spaces is associated with lower infection risk. However, exercise mobility behaviour reflected by STRAVA data may or may not be connected with other infection exposure behaviour which varies by age groups. Linking STRAVA data to health outcomes requires knowledge of, for example, whether younger STRAVA users are representative of infection rates in their age group in general. There may be indications that whereas physical exercise reacted to mobility restrictions directly in the first wave of infections, in the "Second Wave" new physical mobility behaviour may be emerging. Early response patterns in STRAVA data after analysis was completed for this paper indicate that STRAVA mobility by age group is proportional to infection rates over time, i.e. there is H1: a response to reported infection rates, rather than restriction data, and H2: the response is specific to age group. If this is the case STRAVA data may indeed provide a complementary indicator to the dashboard of indicators for covid-19 mobility response used for disaster preparedness in Oslo Municipality.

5. Conclusion

Despite an easing of lockdown measures in Norway during May to August 2020, we observed that recreational activity in Oslo was sustained at elevated levels relative to a weather-corrected benchmark. Our results show increased activity within city green spaces, residential areas and the urban periphery, however, forests and cultural landscapes were preferred by recreationists. There was also a notable increase in the activity intensity within protected areas demonstrating the importance of accessible natural forests as green refuges. This study also explored how the lockdown measures and the subsequent easing of restrictions has influenced different age demographics. Young people exhibited the sharpest increase in recreational activities during lockdown, further illustrating the importance of recreational opportunities for disaster preparedness in urban planning. We conclude that recreational activity in urban green spaces, and the urban infrastructure that support it (i.e.

cycling and walking paths) has been, and continues to be an important coping mechanism during a global pandemic. Our study also demonstrates the usefulness of crowd sourced mobility data from apps like STRAVA for high temporal and spatial resolution monitoring of recreational preferences during pandemics.

CRediT authorship contribution statement

Zander S. Venter: Conceptualization, Formal analysis, Methodology, Writing - original draft. **David N. Barton:** Conceptualization, Writing - review & editing. **Vegard Gundersen:** Conceptualization, Project administration, Funding acquisition, Writing - review & editing. **Helene Figari:** Conceptualization, Writing - review & editing. **Megan S. Nowell:** Conceptualization, Writing - review & editing.

Acknowledgements

We thank the three anonymous reviewers for their constructive comments on our manuscript. The research was carried out with support from the Norwegian Research Council (grant number 160022/F40).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2021.104175.

References

Akpinar, A. (2016). How is quality of urban green spaces associated with physical activity and health? *Urban Forestry & Urban Greening, 16*, 76–83. https://doi.org/10.1016/j.ufug.2016.01.011.

Andersen, O., Gundersen, V., Wold, L. C., & Stange, E. (2014). Monitoring visitors to natural areas in wintertime: Issues in counter accuracy. *Journal of sustainable tourism, 22*(4), 550–560. https://doi.org/10.1080/09669582.2013.839693.

Baur, J. W. R., & Tynon, J. F. (2010). Small-Scale Urban Nature Parks: Why Should We Care? *Leisure Sciences, 32*(2), 195–200. https://doi.org/10.1080/01490400903547245.

Bavel, J. J. V., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., … Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour, 4*(5), 460–471. https://doi.org/10.1038/s41562-020-0884-z.

Bereitschaft, B., & Scheller, D. (2020). How Might the COVID-19 Pandemic Affect 21st Century Urban Design, Planning, and Development? *Urban Science, 4*(4), 56. https://doi.org/10.3390/urbansci4040056.

Bjerke, T., & Krange, O. (2011). A walk in the woods: The effects of ethnicity, social class, and gender among urban Norwegian adolescents. *Nordic Journal of Social Research, 2*. https://doi.org/10.7577/njsr.2056.

Breivik, G. (2013). *Jakten på et bedre liv: Fysisk aktivitet i den norske befolkning 1985–2011*. Universitetsforlaget AS.

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *The Lancet, 395*(10227), 912–920. https://doi.org/10.1016/S0140-6736(20)30460-8.

D'Alessandro, D., Gola, M., Appolloni, L., Dettori, M., Fara, G. M., Rebecchi, A., Settimo, G., & Capolongo, S. (2020). COVID-19 and Living space challenge. Well-being and Public Health recommendations for a healthy, safe, and sustainable housing. Acta Bio Medica Atenei Parmensis, 91(9-S), 61–75. https://doi.org/10.23750/abm.v91i9-S.10115.

Day, B. H. (2020). The Value of Greenspace Under Pandemic Lockdown. *Environmental and Resource Economics, 76*(4), 1161–1185. https://doi.org/10.1007/s10640-020-00489-y.

Derks, J., Giessen, L., & Winkel, G. (2020). COVID-19-induced visitor boom reveals the importance of forests as critical infrastructure. *Forest Policy and Economics, 118*, 102253. https://doi.org/10.1016/j.forpol.2020.102253.

Fisher, B., & Grima, N. (2020). The importance of urban natural areas and urban ecosystem services during the COVID-19 pandemic. SocArXiv. https://doi.org/10.31235/osf.io/sd3h6.

Geng, D., Innes, J., Wu, W., & Wang, G. (2020). Impacts of COVID-19 pandemic on urban park visitation: A global analysis. *Journal of Forestry Research, 32*(2), 553–567. https://doi.org/10.1007/s11676-020-01249-wG.

Gundersen, V., Tangeland, T., & Kaltenborn, B. P. (2015). Planning for recreation along the opportunity spectrum: The case of Oslo, Norway. *Urban Forestry & Urban Greening, 14*(2), 210–217. https://doi.org/10.1016/j.ufug.2015.01.006.

Heikinheimo, V., Tenkanen, H., Bergroth, C., Järv, O., Hiippala, T., & Toivonen, T. (2020). Understanding the use of urban green spaces from user-generated geographic information. *Landscape and Urban Planning, 201*, 103845. https://doi.org/10.1016/j.landurbplan.2020.103845.

Honey-Rosés, J., Anguelovski, I., Chireh, V. K., Daher, C., Konijnendijk van den Bosch, C., Litt, J. S., Mawani, V., McCall, M. K., Orellana, A., Oscilowicz, E., Sánchez, U., Senbel, M., Tan, X., Villagomez, E., Zapata, O., & Nieuwenhuijsen, M. J. (2020). The impact of COVID-19 on public space: An early review of the emerging questions – design, perceptions and inequities. *Cities & Health, 1–17*. https://doi.org/10.1080/23748834.2020.1780074.

Hossain, M. M., Sultana, A., & Purohit, N. (2020). Mental health outcomes of quarantine and isolation for infection prevention: A systematic umbrella review of the global evidence. *Epidemiology and Health, 42*, Article e2020038. https://doi.org/10.4178/epih.e2020038.

Johnson, T. F., Hordley, L. A., Greenwell, M. P., & Evans, L. C. (2021). Effect of park use and landscape structure on COVID-19 transmission rates. *MedRxiv*. https://doi.org/10.1101/2020.10.20.20215731.

Kleinschroth, F., & Kowarik, I. (2020). COVID-19 crisis demonstrates the urgent need for urban greenspaces. *Frontiers in Ecology and the Environment, 18*(6), 318–319. https://doi.org/10.1002/fee.2230.

Konijnendijk, C. C., Nilsson, K., Randrup, T. B., & Schipperijn, J. (Eds.). (2005). Urban forests and trees: a reference book. Springer Science & Business Media.

Kylili, A., Afxentiou, N., Georgiou, L., Panteli, C., Morsink-Georgalli, P.-Z., Panayidou, A., Papouis, C., & Fokaides, P. A. (2020). The role of Remote Working in smart cities: Lessons learnt from COVID-19 pandemic. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1–16. https://doi.org/10.1080/15567036.2020.1831108.

Lai, K. Y., Webster, C., Kumari, S., & Sarkar, C. (2020). The nature of cities and the Covid-19 pandemic. *Current Opinion in Environmental Sustainability, 46*, 27–31. https://doi.org/10.1016/j.cosust.2020.08.008.

Larson, L. R., Szczytko, R., Bowers, E. P., Stephens, L. E., Stevenson, K. T., & Floyd, M. F. (2019). Outdoor time, screen time, and connection to nature: troubling trends among rural youth? *Environment and Behavior, 51*(8), 966–991. https://doi.org/10.1177/0013916518806686.

Lee, K., & Sener, I. N. (2020). Strava Metro data for bicycle monitoring: A literature review. *Transport Reviews, 41*(1), 27–47. https://doi.org/10.1080/01441647.2020.1798558.

McCunn, L. J. (2020). The importance of nature to city living during the COVID-19 pandemic: Considerations and goals from environmental psychology. *Cities & Health, 1–4*. https://doi.org/10.1080/23748834.2020.1795385.

Mjaaland, B., & Andresen, J. W. (1986). Amenity and Service Functions of Oslo's Municipal Forest. *Arboricultural Journal, 10*(2), 101–111. https://doi.org/10.1080/03071375.1986.9746741.

Mobasheri, A., Mitasova, H., Neteler, M., Singleton, A., Ledoux, H., & Brovelli, M. A. (2020). Highlighting recent trends in open source geospatial science and software. *Transactions in GIS, 24*(5), 1141–1146. https://doi.org/10.1111/tgis.v24.510.1111/tgis.12703.

Murillo-Llorente, M. T., & Perez-Bermejo, M. (2020). COVID-19: Social Irresponsibility of Teenagers Towards the Second Wave in Spain. Journal of Epidemiology, 30(10), 483. https://doi.org/10.2188/jea.JE20200360.

Muñoz, L., Hausner, V. H., & Monz, C. A. (2019). Advantages and limitations of using mobile apps for protected area monitoring and management. *Society & Natural Resources, 32*(4), 473–488. https://doi.org/10.1080/08941920.2018.1544680.

Norwegian Institute of Public Health. (2020). Daily report and statistics about coronavirus and COVID-19. https://www.fhi.no/en/id/infectious-diseases/coronavirus/daily-reports/daily-reports-COVID19/#by-sex-and-age.

O'Reilly, A., Tibbs, M., Booth, A., Doyle, E., McKeague, B., & Moore, J. (2020). A rapid review investigating the potential impact of a pandemic on the mental health of young people aged 12–25 years. *Irish Journal of Psychological Medicine, 1–16*. https://doi.org/10.1017/ipm.2020.106.

Oslo Municipality. (2017). Kommunalt risikobilde 2017. (In Norwegian).

Oslo Municipality. (2020). Rapport mobilitetsbilde Oslo kommune. https://www.oslo.kommune.no/getfile.php/13371717-1591944828/Tjenester%20og%20tilbud/Koronavirus/Koronastatistikk/BER_Rapport_Mobilitet_050620x.pdf (In Norwegian).

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry, 18*(2), 189–193.

Pouso, S., Borja, Á., Fleming, L. E., Gómez-Baggethun, E., White, M. P., & Uyarra, M. C. (2021). Contact with blue-green spaces during the COVID-19 pandemic lockdown beneficial for mental health. *Science of The Total Environment, 756*, 143984. https://doi.org/10.1016/j.scitotenv.2020.143984.

Randler, C., Tryjanowski, P., Jokimäki, J., Kaisanlahti-Jokimäki, M.-L., & Staller, N. (2020). SARS-CoV2 (COVID-19) Pandemic Lockdown Influences Nature-Based Recreational Activity: The Case of Birders. *International Journal of Environmental Research and Public Health, 17*(19), 7310. https://doi.org/10.3390/ijerph17197310.

Roy, A., Nelson, T. A., Fotheringham, A. S., & Winters, M. (2019). Correcting bias in crowdsourced data to map bicycle ridership of all bicyclists. *Urban Science, 3*(2), 62. https://doi.org/10.3390/urbansci3020062.

Rung, A. L., Broyles, S. T., Mowen, A. J., Gustat, J., & Sothern, M. S. (2011). Escaping to and being active in neighbourhood parks: Park use in a post-disaster setting. *Disasters, 35*(2), 383–403. https://doi.org/10.1111/j.1467-7717.2010.01217.x.

Rybråten, S., Skår, M., & Nordh, H. (2019). The phenomenon of walking: Diverse and dynamic. *Landscape Research, 44*(1), 62–74. https://doi.org/10.1080/01426397.2017.1400527.

Samuelsson, K., Barthel, S., Colding, J., Macassa, G., & Giusti, M. (2020). Urban nature as a source of resilience during social distancing amidst the coronavirus pandemic. *Preprint https://*. https://doi.org/10.31219/osf.io/3wx5a.

Schetke, S., Qureshi, S., Lautenbach, S., & Kabisch, N. (2016). What determines the use of urban green spaces in highly urbanized areas? – Examples from two fast growing

Asian cities. *Urban Forestry & Urban Greening, 16*, 150–159. https://doi.org/10.1016/j.ufug.2016.02.009.

Shanahan, D. F., Lin, B. B., Gaston, K. J., Bush, R., & Fuller, R. A. (2014). Socio-economic inequalities in access to nature on public and private lands: A case study from Brisbane, Australia. *Landscape and Urban Planning, 130*, 14–23. https://doi.org/10.1016/j.landurbplan.2014.06.005.

Shoari, N., Ezzati, M., Baumgartner, J., Malacarne, D., Fecht, D., & Ramagopalan, S. V. (2020). Accessibility and allocation of public parks and gardens in England and Wales: A COVID-19 social distancing perspective. *PLOS ONE, 15*(10), e0241102. https://doi.org/10.1371/journal.pone.0241102.

Silva Junior, F. J. G. da, Sales, J. C. e S., Monteiro, C. F. de S., Costa, A. P. C., Campos, L. R. B., Miranda, P. I. G., Monteiro, T. A. de S., Lima, R. A. G., & Lopes-Junior, L. C. (2020). Impact of COVID-19 pandemic on mental health of young people and adults: A systematic review protocol of observational studies. BMJ Open, 10(7), e039426. https://doi.org/10.1136/bmjopen-2020-039426.

Skår, M., Gundersen, V., & O'Brien, L. (2016). How to engage children with nature: Why not just let them play? *Children's Geographies, 14*(5), 527–540. https://doi.org/10.1080/14733285.2015.1136734.

Slater, S. J., Christiana, R. W., & Gustat, J. (2020). Recommendations for Keeping Parks and Green Space Accessible for Mental and Physical Health During COVID-19 and Other Pandemics. *Preventing Chronic Disease, 17*, E59. https://doi.org/10.5888/pcd17.200204.

Smith, K. (1993). The influence of weather and climate on recreation and tourism. *Weather, 48*(12), 398–404. https://doi.org/10.1002/j.1477-8696.1993.tb05828.x.

Soga, M., Evans, M. J., Tsuchiya, K., & Fukano, Y. (2021). A room with a green view: The importance of nearby nature for mental health during the COVID-19 pandemic. *Ecological Applications, 31*(2), Article e2248. https://doi.org/10.1002/eap.2248.

Statistics Norway. (2019). Population statistics: Annually, estimated figures. Statistikkbanken. https://www.ssb.no/en/befolkning/statistikker/folkemengde/aar-berekna (In Norwegian).

Statistics Norway. (2020a). Bygningsmassen. https://www.ssb.no/bygningsmasse (In Norwegian).

Statistics Norway. (2020b). Domestic travel increased sharply in the third quarter. https://www.ssb.no/transport-og-reiseliv/artikler-og-publikasjoner/innenlandsreiser-okte-kraftig-i-3.kvartal (In Norwegian).

Stockwell, S., Trott, M., Tully, M., Shin, J., Barnett, Y., Butler, L., McDermott, D., Schuch, F., & Smith, L. (2021). Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: A systematic review. *BMJ Open Sport & Exercise Medicine, 7*(1), e000960. https://doi.org/10.1136/bmjsem-2020-000960.

Torales, J., O'Higgins, M., Castaldelli-Maia, J. M., & Ventriglio, A. (2020). The outbreak of COVID-19 coronavirus and its impact on global mental health. *International Journal of Social Psychiatry, 66*(4), 317–320. https://doi.org/10.1177/0020764020915212.

Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental Research, 166*, 628–637. https://doi.org/10.1016/j.envres.2018.06.030.

Ursin, G., Skjesol, I., & Tritter, J. (2020). The COVID-19 pandemic in Norway: The dominance of social implications in framing the policy response. *Health Policy and Technology, 9*(4), 663–672. https://doi.org/10.1016/j.hlpt.2020.08.004.

Venter, Z. S., Barton, D. N., Gundersen, V., Figari, H., & Nowell, M. (2020). Urban nature in a time of crisis: Recreational use of green space increases during the COVID-19 outbreak in Oslo, Norway. *Environmental Research Letters, 15*(10), Article 104075. https://doi.org/10.1088/1748-9326/abb396.

Weed, M. (2020). The role of the interface of sport and tourism in the response to the COVID-19 pandemic. *Journal of Sport & Tourism, 24*(2), 79–92. https://doi.org/10.1080/14775085.2020.1794351.

Wilke, J., Mohr, L., Tenforde, A. S., Edouard, P., Fossati, C., González-Gross, M., … Hollander, K. (2021). A Pandemic within the Pandemic? Physical Activity Levels Substantially Decreased in Countries Affected by COVID-19. *International Journal of Environmental Research and Public Health, 18*(5), 2235. https://doi.org/10.3390/ijerph1805223510.37473/dac/10.3390/ijerph18052235.

Xie, J., Luo, S., Furuya, K., & Sun, D. (2020). Urban Parks as Green Buffers During the COVID-19 Pandemic. *Sustainability, 12*(17), 6751. https://doi.org/10.3390/su12176751.

Zenic, N., Taiar, R., Gilic, B., Blazevic, M., Maric, D., Pojskic, H., & Sekulic, D. (2020). Levels and Changes of Physical Activity in Adolescents during the COVID-19 Pandemic: Contextualizing Urban vs. Rural Living Environment. *Applied Sciences, 10*(11), 3997. https://doi.org/10.3390/app10113997.