



# Mixed method assessment of built environment and policy responses to the COVID-19 pandemic by United States municipalities focusing on walking and bicycling actions

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## ABSTRACT

**Introduction:** In 2020, the COVID-19 pandemic prompted community officials to initiate local level environmental and policy changes to slow the spread of infection and provide more opportunities for outdoor recreation. Changes in both regards could positively or negatively impact walking and bicycling. Using a mixed methods approach, the purpose of this United States-based study was to systematically describe municipal response to the pandemic at the community level through environmental and policy changes that may have impacted walking and bicycling.

**Methods:** Websites of all United States' municipalities with a residential population of at least 100,000 ( $n = 314$ ) were searched to identify environmental and policy changes that might impact walking/bicycling as a result of the pandemic. When actions were identified, we systematically abstracted information from the websites. To provide more contextual information, we interviewed representatives from 12 municipalities about changes made at the municipal level as a result of the pandemic that could impact walking and bicycling. Interviews were recorded, transcribed, and coded for themes.

**Results:** For the 314 municipalities, we identified 353 actions resulting from the COVID-19 pandemic that may impact walking and bicycling. Approximately double the number of actions were identified in large-size municipalities (234 actions in 157 municipalities with population  $\geq 165,000$ ) compared to mid-size municipalities (119 actions among 157 municipalities with population 100,000 to 164,999). Generally, fewer actions that might suppress walking and bicycling ( $n = 59$ ) were identified in comparison to actions that would likely facilitate walking and bicycling ( $n = 294$ ). In-depth interviews provided further context and insight into these results.

**Conclusion:** This mixed-method assessment provides an overview of the environmental and policy changes which may impact walking and bicycling that municipalities implemented in 2020 due to the pandemic. A next step in this line of inquiry is to quantify the impact of these changes on population levels of walking and bicycling and related health and safety outcomes.

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## 1. Introduction

A novel coronavirus was confirmed on January 7, 2020 and the virus quickly spread around the world. The World Health Organization named the illness caused by the virus COVID-19 and declared a pandemic on March 11, 2020 (World Health Organization, 2020). In response to the pandemic, local and state officials tried to limit person-to-person exposure, often through limiting geographic mobility. In the United States (US), stay-at-home orders began in mid-March 2020 (Moreland et al., 2020). By April 7, 2020 at least 316 million people in the US, across 42 states, the District of Columbia, and Puerto Rico were affected by these orders (Mervosh et al., 2020). The stay-at-home orders lasted until states began lifting restrictions in May and June 2020.

The distribution of when, where, and how people moved from place to place shifted dramatically under these orders. An immediate result of the stay-at-home orders was an abrupt decline in physical activity (Stockwell et al., 2021). For example, using self-reported survey data collected in June 2020, a nationally representative sample of US adults reported on average a 10% decline in local travel relative to pre-pandemic levels, with declines in personal vehicle use, public transit use, and walking, but no change in bicycling (Ehsani et al., 2021). In another example using device-based metrics, declines in step counts (i.e., an indicator of walking) were observed from January to June 2020 across many countries around the world, although the magnitude of decline varied (Tison et al., 2020).

The restricted mobility resulted in both negative and positive impacts on walking and bicycling for transportation or leisure, and on outdoor recreation. Many park and recreational spaces, greenways, trails, and other places to walk and bicycle were closed or put under access limits in order to reduce crowding (Park et al., 2022; Volenec et al., 2021). In contrast, other measures were instituted to expand safe spaces and access for walking and bicycling, such as restricting vehicle access to specific streets and reducing speed limits.

A systematic documentation of community-based actions resulting from the pandemic can help researchers understand potential mechanisms and specific influences on population-levels changes in physical activity. Additionally, such documentation is a critical first step in identifying practices to evaluate and share with other communities in preparation for future challenges that could impact our transportation systems, as well as for communities in search of innovative approaches to potentially support increases in walking and bicycling. Taking advantage of this unique time in history, the purpose of this study was to describe local level response to the pandemic in the US that might have impacted community-level walking and bicycling. We relied on a mixed methods approach, blending quantitative and qualitative methods, to provide a richer and more nuanced depiction of the community level response.

## 2. Methods

In the US on July 1, 2019, there were 314 US incorporated places (municipalities) with an estimated population size of at least 100,000 (United States Census, 2021). Built environment and policy changes resulting from the pandemic that might have impacted walking and bicycling were identified using two quantitative approaches in all 314 municipalities. Additionally, in-depth interviews were collected in a sample of municipalities to contextualize these findings and provide additional detail.

### 2.1. Quantitative assessment

First, we conducted a targeted search on every municipality's official website ( $n = 314$ ) between July and September 2020 seeking documentation of any built environment or policy change resulting from the pandemic that might have impacted walking and bicycling. Our search included meeting minutes, news releases, and alerts. We also reviewed the top web-based results from a general search on the impacts related to the pandemic for each municipality.

Second, we cross-referenced the web-based findings with a crowd-sourced database initiated as a result of the pandemic (Combs and Pardo, 2020). The Shifting Streets COVID-19 Mobility Database, initiated on March 4, 2020, compiled crowd-sourced information on mobility-related actions introduced as a direct response to the pandemic (Combs and Pardo, 2021). The crowd-sourced database spanned the same time period as the initial municipal-focused web-based searches but was conducted independently. The Shifting Streets database was assembled via requests for first-hand information on pandemic-related street-level design changes and related actions. Requests for information were distributed through social media, listservs, webinars, and word of mouth. An initial version of the Shifting Streets database was released on August 9, 2020, which contained records from 243 US municipalities. Using this database, our team verified the entries through the web-based searches. For 15 actions in the Shifting Streets database, we were unable to verify them through our initial web searching and therefore we did not include those in our analysis.

To maintain high reliability of data abstraction from websites and to identify any discrepancies where more data abstraction training or clarification was needed, a second rater independently collected data on a random sample of 37 municipalities (12% sample). The reliability assessment indicated high percent agreement for identifying specific pandemic impacts from a list of 21 actions. The identification of 20 of the 21 actions ranged from 89% to 100% agreement between pairs of raters. The coding of dedicated public space for outdoor dining had lower agreement at 76%. These results were provided back to team members abstracting the data early on for discussion and clarification on the abstraction tool to try to improve reliability. Team members met regularly to discuss any challenges throughout the collection process.

For the analysis, data are presented as frequencies, overall and stratified by mean population size (100,000–165,000, >165,000). The two categories equally split the total number of municipalities with a population of at least 100,000. We hypothesized that actions would more frequently be identified in municipalities with a larger population size compared to a smaller population size.

## 2.2. Qualitative assessment

To complement and corroborate the quantitative findings, and consistent with best practice guidance for information saturation (Hennink and Kaiser, 2022), we conducted in-depth interviews with 12 US municipality transportation leaders from municipalities with at least 100,000 population size between December 2020 and June 2021. Specifically, we interviewed the Vision Zero coordinator for each municipality, given their role in coordinating overall transportation system change to optimize safety and equitable mobility for all. Vision Zero is an initiative that aims to eliminate traffic-related fatalities and serious injuries while increasing and ensuring healthy and equitable mobility for all (Vision Zero Network, 2017). Interviewees were asked to reflect on the time period before and after the pandemic and to describe any changes in (i) travel mode, (ii) traffic-related injuries and deaths, and (iii) community-level changes that enabled or limited walking and bicycling. The interview procedures and guide were reviewed by the University of North Carolina – Chapel Hill Institutional Review Board (#20–2773) before interviews began.

All interviews were recorded with permission and transcribed verbatim. The interview transcripts were transferred to qualitative

**Table 1**

Frequency and percent of actions concurrent with the pandemic that might impact walking and bicycling in US municipalities overall and by population size.

Pandemic Actions	Population < 100,000		Population ≥ 165,000		Population 100,000 to 164,999		Explanation of Action
	n = 314	%	n = 157	%	n = 157	%	
<b>Limiting Access to Facilities</b>							
Specific closure of walking and/or bicycling facilities	34	10.8	31	19.7	3	1.9	temporary closure or restriction to a recreational facility (e.g., parks, beaches, trails, sidewalks, bicycle lanes, recreation areas)
Remove or limit parking	25	8.0	15	9.6	10	6.4	removal or limited parking to restrict access to a recreational facility (i.e., beach, park)
<b>Promoting Infrastructure</b>							
Expedited construction for walking or bicycling facilities	3	1.0	2	1.3	1	0.6	expedited planned construction to accommodate increased use due to the pandemic
Shift recreational offering	1	0.3	1	0.6	0	0.0	public golf course opened for walking
<b>Changes to Streets and Public Spaces</b>							
Dedicated public space to dining	139	44.3	68	43.3	71	45.2	convert street space and non-street space (i.e., sidewalks, parking spaces, parking lots) for dining; this kept important destinations which enhanced walking and bicycling
Closed streets to motor vehicles	53	16.9	37	23.6	16	10.2	closed to vehicles to accommodate dining, walking, and/or bicycling
Reallocate lanes and/or curb for more walking and/or bicycling	25	8.0	19	12.1	6	3.8	reallocated vehicular lanes and/or curbs to accommodate walking and/or bicycling; dining was not mentioned specifically although it may be done to accommodate dining
Shared, slow, open, active, or healthy streets; banned non-local traffic or filtered traffic	24	7.6	21	13.4	3	1.9	converted a street to allow for multiple modes of transportation or allowed vehicles to travel for local access but did not allow through traffic; also included flowing traffic in one direction
Reduced speed limit	3	1.0	3	1.9	0	0.0	citywide reduction in posted speed limits
<b>Signals</b>							
Automate walk signals	18	5.7	12	7.6	6	3.8	automated walk signals to prevent contact with the push button
Changed signal timing	4	1.3	3	1.9	1	0.6	shortening timing of light or switching to night mode
<b>Micromobility share</b>							
Free/reduced cost bicycle share	18	5.7	18	11.5	0	0.0	often offered to specific groups such as essential workers, health care workers, and business owners; a few provided the benefit to all residents
Policy changes around e-bikes and e-scooters	3	1.0	3	1.9	0	0.0	formally legalized e-bikes
Reduced cost bicycles to purchase or use	2	0.6	1	0.6	1	0.6	cost is lower for specific workers
Essential activity ordinance	1	0.3	0	0.0	1	0.6	classifying walking and bicycling to be an essential activity to allow it during restrictions

software (ATLAS.ti version 8) for coding and analysis. The data were reviewed line-by-line with codes assigned by a team member, with a second member checking for consistency and agreement. The two team members resolved discrepancies in coding through consensus. Themes specific to our project goals were generated from the deductive coding process and summarized.

### 3. Results

#### 3.1. Quantitative assessment

For the 314 municipalities, using web searching we identified 353 pandemic-related actions germane to walking and bicycling in 184 municipalities (58.6%). Approximately double the number of actions were identified in large-size municipalities (234 actions among 157 municipalities with population  $\geq 165,000$ ) compared to mid-size municipalities (119 actions among 157 municipalities with population 100,000 to 164,999).

The frequency of identified environmental and policy actions are summarized in [Table 1](#) and include both barriers that might decrease and facilitators that might increase walking and bicycling. Generally, fewer actions that might limit walking and bicycling ( $n = 59$ ) were identified in comparison to likely facilitators ( $n = 294$ ). We grouped actions into four focus areas, including changes to: access to facilities (including limiting and promoting); streets and public spaces; signals; and micromobility share.

##### 3.1.1. Changes to access to facilities

The first focus area related to changes to access to facilities that could change walking and bicycling. These actions were more common among large-size municipalities compared to mid-size municipalities. Actions related to limiting access to facilities included closing or restricting gatherings in parks, trails, beaches, piers, recreational areas, pools, golf courses, or natural areas ( $n = 34$ ) and removing or limiting parking for recreational use ( $n = 25$ ). For example, parking lots were closed for parks and trails in San Francisco, CA and for some trails in Chicago, IL. The documented closures were often a response to overcrowding or a management strategy for the increased traffic trying to access the destination. Some closures were applied only during holidays or on weekends, while others extended for longer time periods. For parking changes, some municipalities removed parking while others reduced the number of available spaces.

We found a few examples where facility changes likely supported walking and bicycling. Three municipalities were able to expedite pedestrian and bicycle projects, such as constructing bicycle lanes, as a result of the pandemic (Jersey City, NJ), neighborhood greenways (Bend, OR), and enhancing crosswalks (Charlotte, NC – construction was designated as an essential service and the low traffic volume enabled workers to complete projects faster). In San Francisco, CA, a public golf course closed for golf and opened for walking.

##### 3.1.2. Changes to streets and public spaces

The second focus area included five actions related to changes to streets and public spaces that may have facilitated walking and bicycling. The most common actions were dedicating public space for commerce (including sidewalks, street space, and parking areas;  $n = 139$ ) and closing streets to motor vehicles ( $n = 53$ ). Streets closed to motor vehicles usually allowed for expanded spaces to dine, walk, and/or bicycle. For an example related to dining, in Seattle, WA on-street parking spaces near restaurants were converted to temporary loading zones to enable curb-side meal pick-up. For an example related to physical activity, Portland, OR closed park roads to drivers to limit traffic and allow more walkers and bicyclists. Documentation on changes to the street varied widely; some municipalities mentioned just one street that was affected while other municipalities created a street program for their community. Some road closures were only on certain days of the week or hours of the day, while others were sustained over the week.

Additional enhancements to streets included reallocating lanes or the curb ( $n = 25$ ) to provide a bicycle lane or places to walk. Many of these initiatives were temporary. In a few municipalities, restaurants could apply to expand their parking area to enable more dining (examples: Greensboro, NC and San Francisco, CA). Twenty-four actions focused on specific street programming, including shared, slow, open, active, and healthy streets, as well as banning non-local traffic or filtering traffic. These initiatives generally slowed or rerouted vehicles but allowed access for those who lived along the street. For example, in Pittsburgh, PA residents could request that their street be designated as a “slow street”. An additional three actions reduced the speed limit on certain roads. For example, Minneapolis, MN reduced citywide speeds to 20 mph, an action that was part of their long-term transportation plan but accelerated due to the pandemic.

Changes to accommodate dining were found in similar proportions across mid- and large-size municipalities, while changes to streets, lanes, and traffic were more common among large-size municipalities compared to mid-size municipalities.

##### 3.1.3. Changes to signals

The third focus area related to signal timing that may have facilitated walking and bicycling. Eighteen municipalities automated or installed no touch walk signals that previously required pushing in certain areas of their city (example: Providence, RI; Cambridge, MA). Some of these changes were temporary while others were permanent. We found four actions that changed the walk signal timing to limit pedestrian queuing; three were shortened while one was lengthened. Changes to automate walk signals were found more often in large-size compared to mid-size municipalities.

##### 3.1.4. Changes to micromobility share

The final focus area related to bicycle share, e-bicycles, and scooters that may have enhanced walking and bicycling. We found 18

actions temporarily reducing or removing costs related to bicycle share, all of which were found in large-size municipalities. For example, essential workers could use the bicycles for free in New York City, NY or receive one free month in Washington DC. Healthcare workers received one free month for the bicycle share program in Boston, MA; reduced price or free rates in Chicago, IL; and free passes in Baltimore, MD; Denver, CO; Washington DC; Detroit, MI; and Tampa, FL. The bicycle share program was free to all residents in Memphis, TN, and free to both healthcare workers and business owners in Kansas City, MO. In Colorado Springs, CO and Austin, TX bicycle sharing was free for the first time period of the rental.

Three actions around policy changes for e-bicycles and e-scooters facilitated their use. Two actions reduced the cost of bicycles to purchase or use and one essential activity ordinance was passed to allow walking and bicycling to occur during restrictions.

**Table 2**

Description of actions due to the pandemic that might impact walking and bicycling in US municipalities from 12 in-depth interview participants.

Pandemic Actions	Example Quotes
<b>Access to Facilities</b>	
Expedited construction for walking or bicycling facilities	"[A]ll the other things that either we did or with the DDA, our Downtown Development Authority, were all about trying to build on our network of bike connections and making intersections more pedestrian accommodating."
Special events	The city created a safe walking and running 5- and 10-km event every weekend "just to have people outside instead of being inside."
<b>Changes to Streets and Public Spaces</b>	
Dedicated public space to dining	"We got a grant from <organization > to hire facilitators to help more minority businesses who may have not had great luck getting through the application process because maybe it was only in English or maybe they got through the first question. So anyways, we hired facilitators to help guide them through so that businesses in our equity index areas would be just as successful at getting these grants and permits to be able to do outdoor seating." "[S]o in our downtown district, the merchants themselves championed and closed downtown streets so that they could create tables and other outdoor dining." "We also did, not to the extent that many communities did, streeteries < street + eateries > ... We did a pilot ... where we created additional opportunities for dining al-fresco."
Closed streets to motor vehicles	"We closed some neighborhood streets to through traffic. We put barricades and barrels on some arterials to take the outside lanes and allocate them to bikes and peds for more social distancing. A mixed bag. The neighborhoods that had them loved them. The drivers that were otherwise unincumbered by any traffic, now realized that they had half the capacity, and they were back in traffic where there had been none for months. So mixed bag, but I think overall, it did prove that if you build it they will come." "The other thing that we did, which weren't so much thinking about from a safety perspective is we launched an open streets program in our [City] area. We shut down a section of streets and allowed people to walk and bike in the street. It was limited to weekend days but it was trying to create more outdoor space for people to safely walk and bike and also keep distance from each other." "We closed down some roads around parks for extra space for people to get outside."
Shared, slow, open, active, or healthy streets	"We did roll out an open streets program, so similar to what other cities did across the county, we implemented our own version here. We closed down some roads around parks for extra space for people to get outside." "We did some healthy streets work. You know it's been branded differently in different communities. We did some, cornered off streets during the summer months that allowed for people to experience their streets in a different way. We were finalizing in our evaluation report and will publish it. And we'll likely continue that going forward in some manner. There was, you know we joined the bandwagon, the urbanist bandwagon to make that happen, so that's a notable example."
Banned non-local traffic or filtered traffic	"We're actually one of the few cities that developed a permitting process so that neighborhoods could do it. They could shut down their blocks and make it a slow street, an open street." "[T]here is a group called Bike Walk [city] that is an advocacy organization that has done some interesting things like they did pop-up bike lanes a few years ago with the cooperation with the traffic engineering department. Some of those things actually became permanent. They've been doing projects in neighborhoods where they get artists in that area to basically design crosswalks. They've been doing open street events where you shut down streets to vehicles and have kind of a neighborhood party. And those things have continued with more distancing and more care to avoid transmission of disease. But that's really, that hasn't been a pandemic-driven change, it's something that's kind of been going on."
<b>Signals</b>	
Automate walk signals	"We also did some pedestrian recall, so adding ped recall to a bunch or intersections so that people didn't have to touch the push buttons during the pandemic ..... We have the pedestrian recall. [It] is still up at several, at a lot of intersections but the other stuff has kind of there was not the political willpower to keep it going. I'll just say that."

### 3.2. Qualitative assessment

For the qualitative assessment, we interviewed representatives from 12 municipalities and reached information saturation. There were three main domains discussed regarding pandemic-related transportation changes as a result of the pandemic: (i) travel mode, (ii) crashes and fatalities, and (iii) specific changes made in response to the pandemic that could impact walking or bicycling. Interviewee insights related to this third domain further contextualized the quantitative assessment, with exemplary interviewee quotes related to these actions documented in [Table 2](#).

#### 3.2.1. Travel mode

Interviewees reflected on shifts in travel modes as a result of the pandemic for their communities. Some interviewees described an increase in walking and bicycling since the pandemic, while others described no impact on walking and bicycling, or a shift from walking and bicycling on streets to trails. With this shift in travel mode and travel location, one interviewee remarked, "I'm hopeful that people saw their streets in a new way maybe who hadn't before, who maybe got on a bike and got to see the city differently. You certainly felt it. Everybody saw more people walking and biking because the streets were quieter."

#### 3.2.2. Crashes and fatalities

Several interviewees referenced an increase in highway-related traffic fatalities in their city. "Our highway fatal[ities] have gone through the roof, compared percentagewise." Another remarked, "We saw a significant increase in the people, the small population of people that are just speeding and driving like crazy because there isn't necessarily this level of congestion to prohibit them from doing that .... We've also noticed fatal crashes increase in [City]." Another described increases in vehicle speed: "Anecdotally, we've definitely felt people are driving faster which is a little bit of a discouragement for people to get out and bike and walk." Notably, several interviewees described a decrease in pedestrian- and bicycle-related fatalities for their municipality.

#### 3.2.3. Actions that may impact walking or bicycling

Interviewees described changes that negatively impacted pedestrians and bicyclists including canceled outdoor events and closed public spaces. However, more of the interviewee responses reflected environmental changes to accommodate the increase in pedestrians and bicyclists as a result of the pandemic, summarized in [Table 2](#). The most commonly reported changes were to (1) streets and public spaces to accommodate more outdoor dining and (2) closing streets or lanes temporarily to reduce vehicle use and accommodate more pedestrians (see "Changes to Streets and Public Spaces" in [Table 2](#)). Other changes mentioned less frequently included creating a bus-only lane, modifying pedestrian recall buttons at crossings to avoid touching them (see "Signals" in [Table 2](#)), and holding special events to be physically active (see "Access to Facilities" in [Table 2](#)). Interviewees did not specifically mention actions to limit walking and bicycling, such as closure of spaces or parking removal. They also did not mention changes to bicycle share, e-bikes, and scooters.

At the time of the interview, some open streets, healthy streets, or active streets programming were still ongoing while other programming had stopped. The initiatives had varying success. For example, one interviewee remarked that "we did kind of attempt an active streets program ... We had a hard time doing it. [City] is super car centric so many of the communities we thought would want an active street through their community were not interested." Another interviewee stated, "People want traffic calming so that they can walk and bike in their neighborhood. But it didn't feel like it really, kind of, that people didn't see it as part of a COVID response, they saw it as, 'I want people to drive slower through my neighborhood, so do this thing' which was challenging. None of our business areas, there was like zero interest in anywhere near a business having some of these things, because all of the businesses saw that they needed to have direct car access right in front of their building. So, I don't know. It was not the success I would have liked to see it be." In contrast, other interviewees mentioned several benefits of the open street program, beyond increasing walking and bicycling: it was "a way to engage with some different neighborhoods in conversations about walking in particular", it "raised some awareness amongst communities that wouldn't normally have known we were doing this work", "it gave us an opportunity to recognize what it looks like to do pop-up type things in our community", and it "opened people's eyes to considering other types of, even ways to approach infrastructure, because the way we're using our streets changed at least for a little while". The in-depth interviews reflected a variety of experiences to the pandemic and environmental and policy actions that might impact walking/bicycling.

## 4. Discussion

As a result of the COVID-19 pandemic, many US communities instituted environmental and policy changes which could impact walking and bicycling. Due to stay-at-home orders, there was a need for more outdoor spaces for physical activity. We found that several actions were taken to support such activity. Walking and bicycling were facilitated through street interventions, including closing streets to motor vehicles, reallocating lanes or curbs, filtering or banning traffic on some streets, and converting a street to allow multiple modes of travel. Additionally, changes to signals were made that facilitated walking, and free/reduced cost bicycle share was instituted. On the limiting side, due to potential of or occurrence of congestion and overcrowding, parks, beaches, and other recreational opportunities were closed or limited through parking restrictions. Overall, some municipalities responded to crowded public spaces by creating more restrictions, while others loosened restrictions, expanded access and capacity, or instituted a combination of approaches.

While the community level changes were occurring, changes in traffic safety were also impacting municipal response. In 2020, an estimated 38,824 people died in motor vehicle traffic crashes, and projections for 2021 indicate further acceleration with an estimated

42,915 deaths in 2021, the highest number since 2005 (National Highway Traffic Safety Administration, 2022). The number of deaths in 2020 mark a 7% increase over the year 2019, despite fewer miles driven in 2020 due to the pandemic (National Highway Traffic Safety Administration, 2021), and 2021 experienced a further 10.5% increase over 2020.

During this time, some municipalities were poised to make changes more easily than others, as the pandemic may have brought initiatives to the forefront that were already being considered but had not been implemented. Other municipalities may have had more of a challenge, without plans or policies to guide them during the emergency situation. From a case study in three Canadian cities, the most successful city in terms of speed of pedestrian and bicyclist-related action and implementation was the city with a strong active transportation plan, vetted already through extensive community consultation, that could be leveraged quickly (Fischer and Winters, 2021).

The success of the initiatives we identified is not known, but there is indication that municipal engagement with community members declined during this period. A national study found that community engagement among municipalities with Vision Zero initiatives was lower during 2020 as a result of the pandemic (Evenson et al., 2022). Thus, we hypothesize that many of the community-level changes to environments and policies we documented were accomplished without much input from the community during the pandemic. This is consistent with findings from an analysis of the Shifting Streets COVID-19 Mobility Database, which found that the majority of the documented responses were new actions, unconnected to existing planning efforts, and were not informed by community engagement processes (Combs and Pardo, 2021). Alternative methods for engagement could be utilized in the future, learning from the numerous resources and best practices for remote engagement developed during the pandemic (American Planning Association, 2020; Fedorowicz et al., 2020; What Works Cities, 2022).

As municipalities reflect on the environmental and policy changes made as a result of the pandemic that might impact walking or bicycling, both successful and unsuccessful, preparations for future disruptions, such as through integration of potential actions that might be taken during similar emergencies, are critical considerations for future routine planning processes. Horizontal integration of existing plans across departments, such that they are available to those likely to be managing emergency responses during disruptive events, may enable more rapid and cost-effective implementation of interventions that have already been vetted through public processes and are therefore more likely to be well-received. Other researchers offer recommendations to communities to plan for such times, such as creating healthy environments for all through the provision of planning intentional areas of green space and public space for recreation and leisure (Park et al., 2022; Slater et al., 2020). The planning of green space is especially important to consider in neighborhoods that lack access to parks and other infrastructure, so that disparities in walking and bicycling are not exacerbated by stay-at-home orders or transportation system disruptions.

#### 4.1. Strengths and limitations

The strength of this project is the mixed-method inquiry used to corroborate the web-based searching and crowd-sourced database with the in-depth interviews. Another strength is the systematic review of responses to the pandemic from all municipalities with a population size of at least 100,000 and the timely approach to capture changes happening in communities across the US. Further, we conducted checks of reliability to try to ensure high quality extraction from the websites.

However, the project had several limitations. First, municipalities for the in-depth interviews were selected due to their engagement in Vision Zero (Evenson et al., 2022); therefore, the qualitative findings may not be reflective of municipalities without Vision Zero. Second, reliance on web-based searching to document changes as a result of the pandemic likely under-estimated or missed changes that occurred elsewhere. We hypothesize that the web-based coding had high specificity, in so far as what we found was likely correct, which was corroborated through the Shifting Streets database. However, our sensitivity was lower, since some changes may not be documented on a website, such as playground and park closures. Some impacts may also be more likely to be documented on a website than other impacts. This indicates that our findings are important in describing the range of actions that municipalities instituted, but the absolute numbers of documented actions are likely an undercount.

Third, the actions we catalogued were from only one point in time as it took three months, from July to September 2020, to assess each of the 314 municipalities. This period of time occurred during the “pandemic phase” of the crisis (Centers for Disease Control and Prevention, 2022), whereby the number of cases became widespread (AJMC Staff, 2021). We do not know if the actions we identified were temporary or incorporated into a permanent change, nor why some municipalities made changes and others did not. We also do not know the trajectory of change within a municipality over the course of the pandemic; for example, shifts may have been made to restrict access to outdoor recreational facilities initially but then to encourage access later. An analysis of the Shifting Streets database, including data from 60 countries, suggests that changes to travel lanes, measures to improve access to work for healthcare workers, and creation of space for outdoor dining were intended only for the short-term, while full street closures and new bicycle lanes were often intended to last beyond the pandemic (Kutela et al., 2022).

Fourth, during the pandemic, municipalities reduced or ceased transit service as a result of declining ridership (Parker et al., 2021). This particularly impacts walking, since many trips to and from transit involve walking (Tribby et al., 2020). We attempted to document changes to transit schedules as part of the web-based assessment. However, we found that historic transit changes were often not documented and only the most current schedule was posted, so we dropped this approach.

## 5. Conclusions

Due to the COVID-19 pandemic, restrictions on mobility caused abrupt shifts in mode share which prompted many US communities to make environmental and policy changes. While the long-term impacts remain to be identified (Honey-Roses et al., 2021), this

mixed-method assessment provides an overview of the changes to environments and policies that US municipalities took as a result of the pandemic. We found more actions that facilitated walking and bicycling as opposed to actions that limited walking and bicycling.

The documentation of these actions can contribute to an understanding of population-level changes in walking and bicycling during this time, as well as to assist communities in the future with options they could implement. A next step in this line of inquiry could be to ascertain whether these actions were temporary or long lasting. An important question is to assess whether these actions spurred changes in pedestrian or bicycle funding, or population-level interest in walking or bicycling. More distally, researchers could quantify the impact of the pandemic actions on population prevalence and trends in walking and bicycling.

### CRedit author statement

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### Declaration of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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