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Implications of COVID-19 Mitigation Policies on Recreational Trail Users: Exploring Antecedents to Physical Distancing on Trails Across the Rural-Urban Continuum

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Cover Page Footnote

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ABSTRACT
The COVID-19 pandemic and subsequent travel restrictions led to a worldwide increase in greenspace use. The U.S. Centers for Disease Control and Prevention encouraged policies including physical distancing and COVID-related signage. However, the extent to which these policies influenced behavior is unknown. To fill this gap, we report on a 2020

observational study at 14 trails across six U.S. states framed within a social-ecological model. Behavioral observations of 8,093 groups assessed compliance rates with infection-mitigation behaviors. Additionally, we noted the presence of COVID-related signs, the days between the observation and stay-at-home order start date, the setting (i.e., urban, suburban, and wildland-urban interface), and correlation with the distance between groups that encountered one another. Group size, presence of signage, days since stay-at-home order implementation, and trail setting significantly correlated with physical distancing compliance, while controlling for trail design and encounter rate. Hence, both policy and setting appear to influence COVID-19 mitigation behavior.

KEYWORDS
Public health behavior, recreation policy, signage, social ecological model

INTRODUCTION

The COVID-19 pandemic highlighted the interconnectedness of people and institutions around the world. Not only did the disease spread to every populated continent within six months from onset (van Dorp et al. 2020), it also impacted the way most people worked, played, and generally interacted in 2020 and beyond. For example, the pandemic highlighted the health disparities between regions (e.g., public health infrastructure and vaccine availability) (Nhamo et al. 2021), as well as vaccine acceptance variance within and among nations (e.g., race and ethnic differences in likelihood of infection) (Lopez, Hart, and Katz 2020). Beyond healthcare institutions and the practice of medicine, the COVID-19 pandemic has impacted the way people work and experience leisure. For example, employment loss and working from home impacted people’s work-life balance, as well as individual and family dynamics (Uddin 2021). Furthermore, the pandemic-related closure of recreation and leisure venues (e.g., theaters, libraries, sporting events, gyms, and community centers) led to increased global participation in outdoor activities (Morita, Nakamura, and Hayashi 2020; Oftedal 2020; Venter et al. 2020).

As in other nations, in the United States the COVID-19 pandemic brought to the forefront essential public health management and policy changes necessary to meet the next health crisis (e.g., Bearman et al. 2020). However, a quick review of the literature revealed a paucity of research directed at examining the future of management and policy of public services that play unique, but nonetheless direct and important, roles in physical and mental health. This is especially true for park and greenspace management. Little work has explored park and recreation management and policies in regard to pandemics and health crises. In their review of the literature, Thomsen, Powell, and Monz (2018) reported natural resource amenities managed by park and recreation agencies afforded numerous public benefits. Specifically, outdoor recreation 1) increases physical activity, thus improving cardiovascular health, 2) increases muscle strength and bone mass, 3) decreases depressive symptoms and perceived stress, and 4) enhances psychological coping mechanisms. Moreover, the physical activity afforded by park and recreation programs and facilities “may be an important strategy for optimizing the functional integrity of the immune system to prevent or attenuate severity of infection” from COVID-19 and future diseases (Laddu et al. 2021:103).

Managers of park and recreation programs and facilities must address the realities of multiple rapidly changing contexts to keep their visitors safe. Early on in the COVID-19 pandemic, researchers identified that the virus spread via aerosolized exhaled droplets, but this transmission could be mitigated by physical distancing and increased ventilation (Sun and Zhai 2020). Hence, to maintain physical activity and mitigate the spread of COVID-19, many public health officials encouraged physical activity outdoors. For example, the U.S. Centers for Disease Control and Prevention (CDC 2020a) provided the following guidance on April 11, 2020: “Individuals are encouraged to use parks, trails, and open spaces safely as they are able while following current guidance to prevent the spread of COVID-19.” Throughout 2020 the guidance evolved, along with the scientific understanding of SARS-CoV-2 transmission. Later in April 2020, physical distancing of at least 6 feet, covering coughs and sneezes, and hand washing were recommended. Mask wearing, when physical distancing is difficult, was added on June 9th (CDC 2020b). Throughout the pandemic, the U.S. CDC has advised park and recreation managers to consider displaying posters and signs to “remind visitors to take steps to prevent the spread of COVID-19” (CDC 2020a). As of May 2021, the CDC (2021) no longer recommends physical distancing and mask wearing for fully vaccinated people, especially when outdoors (e.g., hiking or biking along a trail).

Beyond the changing public health landscape, park and recreation managers also have to adjust to the *context of place*, which refers to regional and local differences in “economic, social, and political forces that structure environmental conditions and distributions of power to access and regulate these conditions within society” (Williams and Patterson

2008:130). Related to COVID-19, these conditions included a lack of public funding for pandemic mitigation in rural as compared to urban areas in the United States (Lakhani et al. 2020) or implementation of mask mandates and stay-at-home orders (e.g., many states and/or local governments did not implement or removed mask mandates and stay-at-home orders prior to the changed CDC recommendations). Beyond these considerations, park and recreation managers must also consider how their resources are used (e.g., what is the average group size using a trail), and how this use impacts visitor management strategies during health-related emergencies.

As scientific understanding of COVID-19 and the public's reaction to it evolved, park and recreation managers have had to implement and adjust policies to encourage people to use public parks and trails safely. However, the extent to which these policies influenced people's behaviors is relatively unknown. Given the connections between public health and the complexities of managing park and recreation areas during a pandemic, the purpose of this investigation was to identify the social-ecological contexts in which these policies were enacted on the public's adoption of COVID-19 mitigation behaviors. Specifically, we investigated the extent the following management policies and contextual characteristics correlated with physical distancing between groups of trail users: presence of COVID-related signs, days between the observation and stay-at-home order start date, group size, and trail setting (i.e., urban, suburban, and wildland-urban interface).

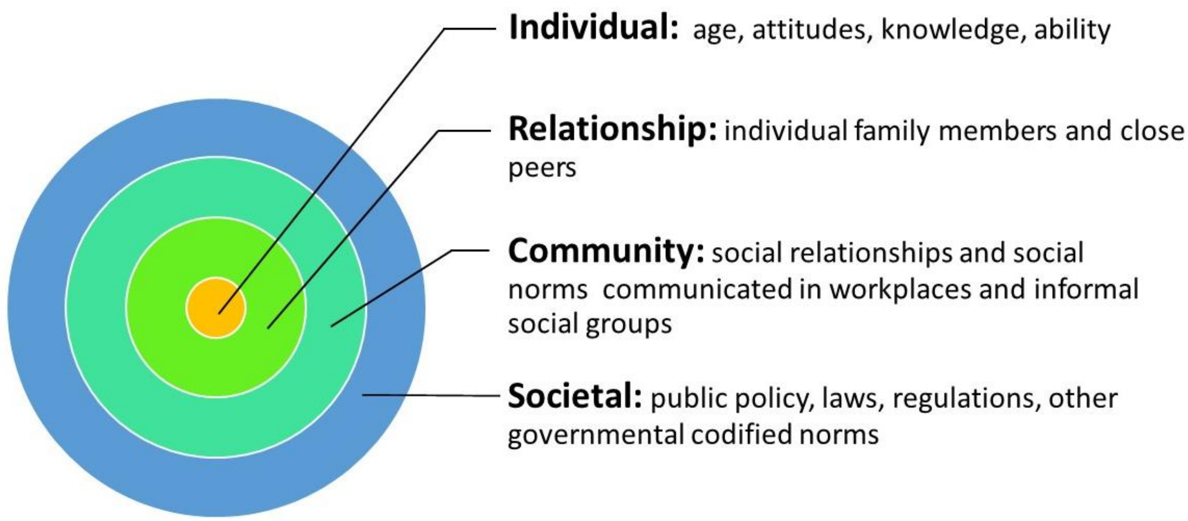
LITERATURE REVIEW

To guide this investigation on users' adoption of physical-distancing guidelines while recreating on trails, we applied a social-ecological framework. *Social-ecological models* (SEMs) have been used in public health-based community research for several decades (CTSA 2011) and have their foundation in Bronfenbrenner's (1979) ecological systems theory. In brief, health promotion SEMs posit that people's adoption of health recommendations is the result of interactions of people with their physical and socio-cultural environments (Rimer and Glanz 2005). Hence, the following review of literature relevant to this project includes a brief overview of SEMs and the constructs observed in this investigation (i.e., policies related to stay-at-home orders, signage as a form of messaging, and trail setting).

Social-Ecological Models

This study adopted the CDC's (2004) social-ecological model of health (Figure 1). This model identifies factors that act at four levels to influence people's behavior, most often depicted as nested concentric rings: the individual, their relationships (interpersonal), the community, and society (CTSA 2011). The innermost ring, individual factors that affect health decisions, includes age, attitudes, knowledge, and perceived abilities (Nyambe, Van Hal, and Kampen 2016). At the relationship level, "a person's closest social circle-peers, partners and family members-influences their behavior" (CTSA 2011:22). Social relationships, related to formal (e.g, schools and workplaces) and informal (e.g., neighborhoods and social clubs) institutions where social norms can be communicated (Rimer and Glanz 2005), comprise the third ring. The overarching level in the CDC framework is society. Societal influences include public policy recommendations, laws, regulations, and other norms codified or prescribed by local, state, and national governments "that help to create, maintain, or lessen socioeconomic inequalities between groups" (CTSA 2011:22; Nyambe et al. 2016).

Figure 1: Social-Ecological Model of Health. Source: CDC 2004, figure amended by authors



SEMs, like the CDC model, have been used extensively to guide health promotion programs and research. For example, Grzywacz and Fuqua's (2000) review of the SEM literature documents that these frameworks have been used to explore socioeconomic status and risk behaviors (e.g., smoking and binge drinking), family structure and mental well-being in times of crisis, workplace policies and programs related to lifestyle choices, and the effect of school policies on psychological stress. More recently, SEMs have explored people's responses to COVID-19 guidelines. For example, Casola et al. (2021:152) argued that the SEM can be used to understand "the multifactorial influences on mask wearing during COVID-19" in order to aid in "the creation and distribution of inclusive public health messaging." Furthermore, researchers investigating COVID-19 vaccine intentions observed that gender and racial identification, political ideology, and COVID-19 skepticism were correlated with vaccine intentions (where being female, Caucasian, liberal leaning, and non-skeptical was associated with lower vaccine hesitation) (Latkin et al. 2021). Lastly, Folk et al. (2021) reported several factors from all four of the CDC social-ecological model health levels that influenced COVID-time physical activity intensity. At the societal level, Folk et al. suggested that stay-at-home orders and elements of racism lowered physical activity levels. At the community level, access to outdoor recreation areas, gyms, and sport leagues increased reported activity intensity. Similarly, lack of relationships with others willing to exercise and fear of contracting and/or transmitting the virus negatively impacted participants' activity level. Finally, the ability to achieve physical activity goals at home or outside and the use of activity as a stress-coping mechanism led participants to increase activity intensity.

Although the SEM literature aids in the identification of the antecedents to health behavior adoption, alone it does not provide clear guidance as to how to influence those antecedents to mitigate disease transmission. However, there are several frameworks that can guide the development of public health policies to mitigate disease transmission. For example, the health-reduction framework compliments the SEM in that it acknowledges the social and individual factors that influence behavior choice (Riley and O'Hare 2000). Riley and O'Hare suggested that harm reduction developed largely as a framework to mitigate the harmful effects of drug abuse. For instance, the harm-reduction framework tends to suggest policies that reduce the harm of a negative action, not necessarily the action itself (e.g., providing clean needles to intravenous drug users to mitigate the spread of HIV). Related to COVID-19, Weinstock (2020) used the harm-reduction framework to argue for vaccine passports and flex-use of space and time policies to increase physical distance and decrease interactions in public spaces.

Group Size

Visitor group size and the related visitor-density (i.e., objective number of people in a given area), carrying capacity (i.e., management decision based on the number of people an area can accommodate according to a range of social and ecological indicators), and crowding (i.e., perceptions related to the number of people in an area) literature has been prominent in the recreation discipline for decades (Manning 2011). In their review, Godtman Kling, Fredman, and Wall-Reinius (2017) reported that increased visitation has been associated with environmental degradation, lower levels of recreation experience satisfaction, increased inter-visitor conflict, and other management concerns. Related to this investigation, the number of people that comprise a group using a trail has implications for both the relationship and the individual levels of the SEM. At the relationship level, the group size may be thought of as a rough indicator of the social relationships that are involved in recreation and trail use. Group sizes greater than one may also be indicative of the active and/or immediate presence of social norms toward visitor behaviors, such as physical distancing. At the individual level, group size may be an indicator of the possible presence of socio-psychological phenomena. For instance, Li et al. (2017) concluded that increased visitor numbers decreased the attractiveness of outdoor recreation venues to individuals. This may be particularly true during a pandemic. Specifically related to COVID-19, Kim and Kang (2021:8) observed that person-to-person distances of 6-13 feet were “insufficient to lower perceived crowding and risk perception” toward various leisure activities among a survey of Korean respondents.

COVID-19 Signage

At the community level of the SEM, social norms are communicated by formal institutions. In the context of recreational trails, park and recreation agencies use signs as an everyday environmental management tool to encourage appropriate behaviors that reflect local, state, or national policies (Campbell, McMillen, and Svendsen 2019). Given the limited resources of most management agencies, signs are the most common way of providing information and encouraging desired behavior among visitors (Saunders et al. 2019). The effectiveness of signs as an education tool or as an instrument of behavior modification is mixed. On the one hand, Vande Kamp, Johnson, and Swearingen (1994) argued that, in combination with other techniques, signage reduced non-compliant visitor behavior. Similarly, data have indicated that signs had at least partial influence on visitor off-trail behavior (Bradford and McIntyre 2007; Goh

2020; Hockett, Marion, and Leung 2017). On the other hand, there are several studies that indicate signs are ineffective, at best, and detrimental, at worst. For example, Hendricks, Ramthun, and Chavez (2001) found that signage did not influence mountain bike trail visitor etiquette. Moreover, Guo et al. (2015: 774) observed that trail signs "with a behavioral message (Please stay on the trail), normative message (Help protect our resources), and brief rationale (Hiking around objects widens trails, impacts vegetation, and causes erosion)" did not influence responsible hiking behaviors and led to an increase in off-trail behavior.

In a public health context, the results of sign effectiveness are mixed as well. For example, anti-smoking signs reduced evidence of smoking at seven Gainesville, Florida, city parks, but not at three others (Platter and Pokorny 2018). Similarly, signs in stores that contained COVID-19 prevention messages were positively correlated, directly and/or indirectly, with shoppers' intention to comply with various messages (i.e., physical distancing, mask wearing, or hand washing) (Kellaris, Machleit, and Gaffney 2020). Lastly, in a recreation context, sign messages were ineffective at reducing hikers' decisions to go off trail and to avoid a potentially dangerous falling rock and ice zone in Washington's Mt. Baker-Snoqualmie National Forest (McMahan, Ellis, and Wynveen 2018).

Stay-at-Home Orders

Bridging the SEM's community and society levels are local and state public health directives designed to mitigate disease transmission. In the case of COVID-19, the stay-at-home orders directed by local and/or state governments during the spring of 2020 provide examples of such orders. These orders had elements of the societal level in that they derived their authority from public health laws designed to keep all groups safe, but especially those groups that were at higher risk of contracting COVID-19. At the community level, public policies such as the stay-at-home orders impacted peoples' experiences at workplaces, schools, and other local institutions and helped solidify social norms regarding the pandemic and prevention strategies. Like many policies, stay-at-home orders in 2020 were a "mixed bag" (Knell at al. 2020). For example, concerning COVID-19 transmission, "stay-at-home social distancing mandates, when they were followed by measurable mobility changes, were associated with reduction in COVID-19 case rates" (Gao et al. 2020:9). However, there were also unintended consequences. For example, Tull et al. (2020:5) observed that "being under a stay-at-home order was associated with greater health anxiety, financial worry, and loneliness."

In regard to stay-at-home order compliance, initial research indicated implementation of stay-at-home orders was correlated with an increase in other risk reduction behaviors (e.g., mask wearing and social distancing) (Liu and Mattke 2020). Likewise, Hamidi and Zandiatashbar (2021) reported in a multi-state longitudinal study that compliance increased immediately following the mandate. However, at a particular point (undefined, but probably due to local contextual factors) the correlation reversed. In other words, as the time since the order was put in place increased, compliance with the stay-at-home order decreased.

Place

The outer ring of the SEM is society, which includes factors related to health, economic, educational, and social policies. A proxy that can be used as a broad indicator of societal differences is place, as different regions, states, and local jurisdictions have varying policies or perceptions of similar policies. For example, Masuda and Garvin (2008) indicated that residents of rural and urban-rural interface areas held differing thoughts and feelings about development of areas near their homes and workplaces. In an outdoor recreation context, hikers placed high importance on trails located in wildland-urban interface (WUI) areas that were ascribed with thoughts and feelings related to escape, nature learning/exploration, and a preference for natural features (Kil et al. 2012). Moreover, Wynveen et al. (2020), in a study of place at seven locations across North America and Europe, observed that respondents' concept of place differed depending on the level of development in which the outdoor recreation venue was situated. Related to COVID-19, Lyu and Wehby (2020) concluded that stay-at-home policy differences between states were correlated with rates of disease. Specifically, they suggested that the Iowa counties studied without a stay-at-home mandate had a 30 percent greater incidence of COVID-19 than bordering counties in Illinois with a mandate. Moreover, in their commentary on distancing behavior in rural areas, Adunlin et al. (2021) argued that social norms and cultural values are transmitted differently in rural versus more urban areas due to differences in type of work available (e.g., physical and in-person) and level of internet access. Based on protection motivation theory (Rogers 1975), they argued that rural "individual's decision to participate in risk preventative behaviors is based on their motivation to protect themselves from "health threats" and their ability to mitigate the risks (Adunlin et al. 2021:170).

A complication of measuring the influence of place is that it is not just an objective location, but also a social construction (Short Gianotti et al. 2016). Practically, this affects how the concept of place is measured. For instance, in the context of putting place on a rural-urban continuum, “there is little direct empirical evidence that federal urbanization definitions align with how Americans describe” (3) the place where they live, and the lack of a suburban definition “obscures the stylized fact that a majority of Americans live in a suburban setting” (Bucholtz, Molfino, and Kolko 2020:4). Hence, Bucholtz and others developed the Urbanization Perceptions Small Area Index (UPSAI) that describes census tracts as rural, suburban, and urban based on a range of 21 indicators better aligned with resident perceptions. Residents’ perceptions, rather than prior metrics, were used because perceptions play an important role in the confirmation and/or expression of identity, influence behaviors and attitudes related to social issues and health decisions, and can further sub-divide the rural/urban classification (Bucholtz et al. 2020).

In sum, the literature surrounding management policies and other factors that may influence peoples’ adoption of recommended disease mitigation behaviors is rapidly evolving and often contradictory. This may be an artifact of the relative speed of new science concerning COVID-19 and because of the cross-sectional survey nature of many of the published studies to date. Hence, this project used methods and longitudinal data derived from behavioral observations rather than relying on simulations or participant recall. Given these data collection methods, we were unable to measure many of the factors typically included in the SEM. As noted above, we were able to observe phenomena related to managerial policies that either are related directly to, or can serve as proxies for, at least one construct in each of the SEM levels.

METHODS

Study Settings

Study sites reached across six states to include fourteen multiple-use, publicly managed trails across U.S. urban-suburban environments. Based on UPSAI (Bucholtz et al. 2020) and assessment of trail-adjacent areas, five of the sites were categorized as urban, four as suburban, and five as in the *wildland-urban interface* (WUI: defined in this project as rural census tracts adjacent to urban or suburban tracts) (Table 1). All sites were within walking or biking distance for researchers to ensure access during potential lock-down or strict stay-at-home situations. While the team members all had an existing relationship with the team lead from various professional interactions, an attempt was made to include team members (trail sites) from across the United States.

Table 1: Trail Site Details for Physical Distancing Observations

Trail name	Community population	Trail width (feet/m)	Trail length (miles/km)	Signage present part of data collection
Urban Trails				
Florida-Depot Park	133,997	10 /3.1	~1/1.6	yes
Florida-Loblolly Woods Nature Park	133,997	5/1.5	1/1.6	no
Illinois-Hessel Park	88,908	8 /2.4	~1/1.6	yes
Minnesota-Lake of the Isles	429,606	8/2.4	~2.6/4.2	yes
Texas -Waco River	139, 236	12/ 3.7	2.5/4.02	yes
Suburban Trails				
California-Baywood Park	14,276	5/1.5	~1/1.6	no
Minnesota-Wedgewood Park	7,676	8/ 2.4	< 1/1.6	yes
Minnesota-Sather	25,875	10/3.1	~10/16.09	yes
Texas -Cotton Belt	139, 236	15/ 4.6	~5/ 8/-5	no
Wildland-Urban Interface Trails				
Colorado-Chautauqua	105,673	11/3.4	0.8/1.3	yes
Colorado-Marshall Mesa	105,673	4/1.2	0.6/0.97	yes
Colorado-Sanitas Valley	105,673	11/3.4	1.2/1.9	yes
Colorado-Sage trail	105,673	12/3.7	1.9/3.1	yes
Florida-Hawthorne	133,997	10/ 3.1	~17/11.26	yes

Urban sites included two trails in Florida, and one each in Illinois, Minnesota, and Texas. The two Florida trails were both in or near Gainesville (population 133,997; U.S. Census 2019): Depot Park and Loblolly Woods Nature Park (LOB). Within downtown Gainesville, Depot Park is 32 acres with a little more than one mile of 10-foot paved trail connecting local cultural, commercial, and natural assets. Loblolly Woods

Nature Park consists of 159 acres of forest land at the confluence of Hogtown and Possum Creek in northwest Gainesville and contains a one-mile system of four- to six- foot wide trails. In Illinois, Champaign's Hessel Park Trail was selected (population 88,909; U.S. Census 2019). The eight-foot wide paved path takes about a mile to loop around the 22.2-acre park, replete with urban park amenities such as a large playground, splash pad, picnic pavilions, tennis courts, and volleyball courts. In Minnesota, Minneapolis's Lake of the Isles (LOI) trail qualified as urban (population 429,606; U.S. Census 2019). Part of the city's chain of lakes, this eight-foot wide, 2.6-mile paved trail borders Lake of the Isles and connects it to other lakes in the area. Waco, Texas's River Trail was the urban site in Texas (population: 139, 236; US Census 2019). The 12-foot-wide trail, about five miles long, serves as a connector trail for downtown Waco and nearby neighborhoods and, as its name implies, is adjacent to two rivers: the Brazos and the Bosque.

Suburban sites included single trails in California and Texas as well as two in Minnesota. Los Osos (population 14,276; U.S Census 2019) includes the Baywood Park Boardwalk and Pier. Situated along the California Central Coast, the five-foot wide boardwalk skirts the Morro Bay Estuary as a loop to various neighborhood walks, an informal beach trail, downtown Baywood Park, and Audubon bird watching lookout, and trails in two nature preserves. In Texas, Waco's city-managed Cotton Belt Trail was a suburban site. This 15-foot wide trail meanders through fields, along a creek, and flows into a city park. Minnesota's two suburban sites were Mahtomedi's Wedgewood Park Trail and White Bear Lake's Sather Trail. Largely a community and neighborhood trail in Mahtomedi (population 7,676; US Census 2019), Wedgewood's trail is eight feet wide and less than one mile long, looping around the 11.25-acre park. In contrast, White Bear Lake's (population 25,875; US Census 2019) ten-foot-wide Sather Trail is part of a larger ten-mile trail system, anchored by two beach areas and connecting two city-owned parks.

Five sites were within the WUI: one in Florida and four in Colorado. In Florida and on the edge of Gainesville, the Gainesville-Hawthorne State Trail was a WUI site. The ten-foot-wide trail is managed by the City of Gainesville and adjacent to a former railroad corridor, which also connects to Paynes Prairie Preserve State Park. The Colorado sites were all located in Boulder, CO (population 105,673; U.S. Quick Facts 2019), and managed by the city. Chautauqua Trail is a 0.8-mile, 11-foot-wide trail that leads to many other trailheads southwest of Boulder. The area is well-known for opportunities to view wildflowers, valley vistas, and an upward view of the Flat Irons. The Sanitas Valley Trail is located northwest of Boulder. This 11-foot-wide trail travels through the valley between Mount Sanitas and Dakota Ridge and offers views of Boulder and the Flat Irons. The next trail, Marshall Mesa, is a 4-foot-wide, 0.6-mile trail that connects the Marshall Valley and Community Ditch Trails. The final trail selected was Sage Trail, a small part of the greater Boulder Valley Ranch Trail. This 1.9-mile, 12-foot-wide trail travels along the farmers' irrigation ditch and was selected as a backup to the Marshall Mesa location when wet trail conditions precluded data collection.

Observation Protocol

Trail observations ensued using a systematic observation protocol. Informed by past research, the protocol was pilot tested and refined toward more complete and accurate data collection. Observers were trained (via a combination of videos and in-person sessions) on behavior observation and distance estimation (e.g., using small markers to help observers gauge distances). Along each trail, observers were safely and unobtrusively positioned to view trail user groups along a predetermined "observation zone." Observation zone length varied among the sites due to the physical characteristics of the trail, but zone lengths and observer placements were chosen to minimize observation error due to distance and view angle (e.g. observations at a distance less than ~150 ft). Consistent zones at each trail were used to minimize effects of the trail characteristics within the observations.

Our unit of analysis was a visitor group: one or more people travelling together. As a group entered the observation zone, it was observed throughout the zone. Only one group was observed through the zone at a time, regardless of how many other groups entered the zone during that time (unless they interacted with the group being observed). These observations occurred across three months, throughout the day and week between March 29 and June 30, 2020. We divided the day into four observation time blocks (sunrise to 9:59 am, 10:00 am to 1:59 pm, 2:00 to 5:59 pm, and 6:00 pm to sunset) and typically observed between one and two hours to maximize reliability (Rowley 1978). Observations occurred throughout the week avoiding hazardous weather warnings.

Observed and Calculated Variables

Observers used a pilot-tested worksheet to guide their observations of trail visitor groups. The following observation period characteristics were recorded: date, day of the week, time and length of observation, trail location, temperature and weather conditions, and presence of COVID-19 related signage along or near the trail. Regarding visitor group characteristics, pertinent to the current analysis, the observation guide included the number of groups observed, the number of encounters each observed group had with another group, the observed groups' primary activity during the observation period, and the group size. The same group activity and size information was recorded for any party that the observed group encountered. An encounter was defined as two or more groups passing one another, regardless of level of interaction between the parties. Lastly, the observers were prompted to record the distance between the observed group and encountered party (at the closest body parts) within four categories (0=physical contact, 1=.1-2.9 ft, 2=3 to 5.9 ft, and 3=6 ft and over). (It is important to note that while the observers were trained and used markers to aid in judging distances, the definitions of each distance category are not intended to denote a level of precision, but rather we asked observers to place each encounter into one of the four categories using methods taught in the training provided). In addition to the observed information, the data set also included trail width for each of the trails.

Next, we used observed data to calculate other variables for the analysis. Specifically, we used the "count" of the number of observations during an observation period to calculate a maximum number of observations variable. This variable was used as a proxy for trail use density (i.e., the greater the number of observations the greater the use density during the observation period). We also calculated the number of days that had elapsed between the observation date and the stay-at-home order start date for each trail locale. Next, we categorized both the observed group and encountered group size variables. Lastly, we recoded the physical distance observation as either compliant (6 or more feet) or non-compliant (< 6 feet).

Finally, we used UPSAI data to create a variable that indicated local residents' perceptions of the level of development (i.e., rural, suburban, urban) of the census blocks in which the trails were primarily situated. Furthermore, trails located in rural blocks adjacent to more developed areas on at least one side and state or federal protected areas on one or more of the other sides were identified as being in the WUI.

Analysis

We began our analysis by calculating statistics to describe the groups we observed and the variables we recorded and calculated. In order to explore the associations among management policies and trail visitors' adoption of COVID-19 mitigation behaviors, we conducted binary logistic regression analyses with the physical distance compliance indicator as the dependent variable. After confirming that the data met the regression assumptions, we assessed model fit via the chi-square, Hosmer and Lemeshow test, and pseudo-R-square values. Given the large sample size and sensitivity of the aforementioned statistics/tests to sample size, we also evaluated the accuracy of the model by calculating the predictive efficacy via a variant of the proportional reduction in error statistic (PRE) (White 2013).

RESULTS

Observation Description

During the observation period, our team observed 8,093 groups of trail users resulting in 14,436 unique cases where the observed group may or may not have encountered another group on the trail. Of these cases, 76.3 percent (11,020) involved encounters between two groups. Eighty-seven cases had missing data, hence the sample size for this analysis was 10,933 encounters between two visitor groups (a group was defined as 1 or more persons) on the trail. Seventy-nine percent (n=8,862) of these encounters took place on trails where at least one COVID-19 related sign was present. Lastly, we calculated the number of days between the encounter observation and the date that stay-at-home orders were implemented in each of the trail locales. The mean number of days that had elapsed was 51.75 (sd=24.99).

Group Characteristics

The 10,000+ encounters were made by observing the interaction of 4,669 observed groups. The observed groups had a mean size of 1.69 (sd=.93) and ranged from 1 to 16. Walking/dog walking/walking with a stroller was the most frequently observed activity (n=3,227, 69.3 percent). Biking (n=653, 14 percent) and running (n=548, 11.8 percent) were also frequently engaged in. Skateboarding/scootering (n=18, .4 percent), and "other" (n=25, .5 percent) or "mixed activity types among individual group members" (n=187, 4 percent) were the least participated in activities.

The descriptive statistics for the encountered groups mirrored the observed groups. The encountered group size averaged 1.64 (sd=.91) and the most frequently participated in activity was the various forms of walking (n=2,575, 55.3 percent) described above. Walking was followed by biking (n=704, 15.1 percent) and running (n=680, 14.6 percent). Mixed activities (*n*=549, 11.8 percent), "other" (*n*=131, 2.8 percent), and skateboarding/scootering (*n*=25, .5 percent) were less frequent.

Physical Distance Compliance

Regarding the ability of trail users to adhere to physical distancing guidelines while using the trails, 11 (0.1 percent) groups had physical contact, 11.4 percent (*n*=1,245) maintained a .1 to 2.99 ft distance, and 35 percent (*n*=3,826) were separated by 3 to 5.99 ft. Hence, in just over half of the encounters (*n*=5,851, 53.5 percent), the parties were compliant with the recommended 6 ft minimum physical distance between people.

Table 2: Correlates to Physical Distance Compliance (n=10,933)

Policy/Setting Variable	*β*	*SE*	Wald	*p*	Odds Ratio
Number of days between observation and stay-at-home start	-.01	.001	93.01	<.001	.99
COVID related sign present†	.36	.054	43.55	<.001	1.43
Group A size=2*	.28	.063	19.18	<.001	1.32
Group A size=1*	1.14	.064	317.02	<.001	3.12
Group B size=2*	.29	.066	19.16	<.001	1.34
Group B size=1*	1.09	.066	276.39	<.001	2.98
Trail Setting=Suburban#	.56	.054	110.20	<.001	1.76
Trail Setting=WUI#	.67	.051	176.95	<.001	1.96

Reference categories: † sign not present; * group size 3 or greater; #urban trail setting

Group A=observed group; Group B=encountered group

χ^2=1284.18, *p*<.001; Nagelkerke R^2=.15; H&L test χ^2=15.46, *p*>.05; PRE=58.4%

In order to determine the correlation between physical distancing and management policy and setting characteristics we conducted a binary logistic regression (Table 2). Our starting model included the following independent variables: days between observation and stay-at-home order, COVID sign presence, level of development, group size of the observed and encountered groups, trail width, and state in which the trail was located. Initial results indicated that the model did not accurately predict physical distancing compliance and could be improved by dropping the trail width and state location variables. Based on the chi-square test

(χ^2=1284.18, p<.001), pseudo R-square (Nagelkerke R^2=.15), and Hosmer and Lemeshow test (χ^2=15.46, p>.05), we determined the final model fit the data. The model correctly predicted 64.2 percent of the physical distancing cases, which was a significant increase over chance as indicated by the proportional reduction in error (PRE=58.4 percent). The data indicated that the hypothesized management policy (i.e., COVID-sign presence and days since stay-at-home order implement), trail setting (i.e., WUI, suburban, and urban), and group size of both the observed and encountered groups, were significantly correlated with physical distancing compliance.

Specifically, for each one-day increase between the observation and the stay-at-home order implementation, there was a one-percent decrease in the likelihood that the encounter would be compliant with the 6-foot distance guideline (β=-.01, *s.e.*=.001, p<.001). Regarding COVID-related signage, the presence of a sign increased the odds of compliance by 43 percent (β=.36, *s.e.*=.054, p<.001). Group size was also significantly correlated to distancing: as compared to observed groups of three or more people, observed groups of two people increased distance compliance by 32 percent (β=.28, *s.e.*=.063, p<.001) and single-person groups increased compliance by 312 percent (β=1.14, *s.e.*=.064, p<.001). Similarly, encountered groups with two people increased the odds of compliance by 34 percent (β=.29, *s.e.*=.066, p<.001) as compared to groups of three or more. Encountered groups of one increased the odds of distance compliance by almost 300% (β=1.09, *s.e.*=.066, p<.001). Lastly, the area's level of development was correlated with 6-foot physical-distancing compliance. As compared to urban areas, those using trails set in suburban zones were 76 percent more likely to maintain distance compliance (β=.56, *s.e.*=.054, p<.001). Correspondingly, trail users in WUI settings were 96 percent more likely than those in urban contexts to comply with physical distance guidelines (β=.67, *s.e.*=.051, p<.001). Further analysis indicated that significance, relative magnitude, and direction of the correlates described remained even while controlling for encounter rate (i.e., density of trail use) and trail width.

DISCUSSION

This project sought to identify the impacts of management policies and the contexts in which these policies were enacted on the public's adoption of COVID-19 mitigation behaviors. Following connections outlined in the social-ecological model, the data from the current observational study of trail users at multiple sites across the United States empirically support the roles that policies and setting context play in people's choice to adopt behaviors desired by park and recreation managers. Specifically, group size, presence of COVID-19 related signage, days since implementation of stay-at-home orders, and trail setting (i.e., urban, suburban, or WUI) were correlated with trail visitors' compliance with physical distancing guidelines. These findings contribute to the literature and hold policy implications for the remainder of the current crisis and for the management of park and recreation resources during future pandemics and health crises.

Individual: Individuals' Perception of Group Size

The observation that as group sizes increase so does the likelihood of physical distance non-compliance corresponds to Kim and Kang's (2021) observed association between crowding and risk perception in outdoor recreation activities during the COVID-19 pandemic. Both sets of data suggest that messaging and other forms of education about disease transmission raise trail visitors' sensitivity to visitor density and its relationship to risk. These risk perceptions influence individuals' likelihood to adopt a behavior that lowers proximate crowding and risk, which in turn increases physical distance. If true, managers should be able to lower the sense of crowding, perceived risk, and disease transmission by implementing one or more of the following use policies: limit the total number of trail users at a given time, mandate direction of travel on trails to minimize encounters, institute a lottery or queue system, and/or limit group size on the trail. Not only will these actions limit individual contact, but they will also raise individuals' awareness of the need for disease mitigation behavior (assuming that the rationale for the management actions is explained). Future studies should explore the effect strength of each of these possible management actions on distancing compliance.

Community: Signage

Beyond the psychological phenomenon occurring at the individual level, communication of social norms at the community level have also been posited to influence people's behavior (Campbell at al. 2019). In the current study signs were indicators of such communication. Sign presence varied greatly at the study sites: some never had signs and others had signs posted for lesser or greater portions of the data collection period. Given the mixed results concerning the effectiveness of sign messaging, our finding that sign presence was correlated with physical distancing compliance is encouraging in regard to mitigation of the COVID-19 pandemic and supports Kellaris et al.'s (2020) similar results regarding signs in shopping centers. One possible explanation of why signage seems to be effective during COVID-19, but not in the context of other concerns (e.g., McMahan et al. 2018 and Hendricks et al. 2001) may be that COVID-19 signs are reinforcing and reminding trail users of messages simultaneously spread across multiple mediums (to a much greater extent in response to the COVID-19 global pandemic than most other information campaigns). In contrast, studies that have found signs to be ineffective often involve behaviors specific to one issue, at a certain site, with messaging first being experienced at that site. Whether or not this explanation is accurate was beyond the scope of this observation study, but it does deserve further exploration in future research. Hence, the implication for policy is that managers should use signage to effect behavior change, especially when the signs coincide with other messaging techniques. To have the greatest impact, greenspace managers should work to ensure that signs along the trail reinforce messaging promoted by other community organizations (e.g., public health district, state and local government leaders, community groups, and schools). Future research should explore the effect of sign quantity, placement location, and content.

Societal: Urbanization Level and Stay-at-Home Orders

Lastly, our data indicated that differences in societal factors, as measured indirectly via trail setting, were correlated with physical distancing compliance. The less developed the context in which the trail was located (urban to WUI), the more likely trail visitors were to maintain at least a 6-foot distance between one another. Although our data do not provide insight as to the cause of this relationship, previous literature provides some possible explanations. For instance, rural residents "tend to be older, sicker, and more likely to be underinsured or uninsured than their urban counterparts" (Adunlin et al. 2021:169). Hence, it may be possible that users of rural trails/trail sections may be more prone to adopt protective behaviors. Alternatively, visitors to less developed areas prefer less crowded settings when recreating (Manning 2011). Conversely, it may be that those living in urban settings and using urban trails are more comfortable being in close proximity to one another due to their lived experiences prior to the pandemic (Burton et al. 2021). Therefore, it is possible that WUI trail visitors consciously (or subconsciously) adopt behaviors that spread themselves out from others along the trail. As these data indicated that trail width did not improve the model, we suggest that these socio-psychological factors of place play a greater role in the correlation identified than some of the physical characteristics of place.

While not all the contextual factors and motivations suggested are directly linked to physical distancing compliance, they all have the same end result on the transmission of disease. Moreover, park and greenspace managers, alone, cannot change the root causes of societal issues, such as health inequality between urban and rural areas. However, managers can recognize the social and environmental factors that impact visitors to the trails and parks they manage. In doing so they can develop programs and make management decisions in light of these factors (e.g., healthy living programs that encourage exercise outdoors). Specific to these data, our findings suggest that managers should focus their efforts on adopting active disease mitigation policies (e.g., use of volunteer trail ambassadors to actively remind people to distance or follow mask mandates) on more developed trail segments (where a greater need to further encourage distancing has been identified) and use more passive reminders and strategies (e.g., signage) for less developed trails.

Besides the level of development in which the trails were situated, the data also indicated an effect of stay-at-home orders. Similar to Hamidi and Zandiatashbar (2021) where time was inversely related to COVID-19 travel, data indicated that as time passed since the stay-at-home order implementation, trail physical distancing compliance declined. These observations may be explained by a range of socio-psychological factors, including pandemic fatigue (Alexander and Karger 2021) or epidemiological and demographic profiles (e.g., personal knowledge or impact of COVID-19 infection and age, and/or political ideology) (Kosnik and Bellas 2020). Identifying the specific cause of the behavior observed is beyond the scope of this investigation, but nonetheless the correlation does hold policy implications. For example, if managers know that stay-at-home orders provide diminishing returns on disease mitigation behaviors along trails, then it is important for them to adopt other use policies early on in a pandemic. Beyond the mitigation strategies already described, in line with the harm reduction framework, 2020 saw several metropolitan regions close streets to motor vehicles and open them up to pedestrians to ease congestion and increase physical distance between users. Again, these policy actions serve not only to increase recreational space allowing for greater physical distancing, but also serve as reminders that influence the individuals' knowledge and perceptions concerning disease mitigation.

Limitations

As with all investigations, this study was limited in several ways. Most notable, our study was observational in nature. Ideally, we would have been able to combine our observations with a survey, focus-group, or quasi-experimental design study to understand the motivation for the behaviors observed. However, the realities of research safety or the moratorium on in-person research at most universities set in place during the COVID-19 pandemic made such methods impossible. Furthermore, given the range of physical and other contextual differences between the trails and management policies represented in this study, it was not possible to record or observe all the possible antecedents to physical distance compliance. Hence, we may have inadvertently missed recording pertinent data. In sum, these limitations and the areas of research needs cited above leave ample room for future research regarding recreation visitors' responses to policies designed to limit disease transmission during this and future pandemics.

CONCLUSION

Our observations of the contextual and policy related drivers of physical distance among trail visitors during the COVID-19 pandemic is one of the few studies based on observations of actual behavior to date. Most previous articles have been editorial essays or reports of surveys regarding behavioral intentions. Moreover, to our knowledge, this is the first set of empirical data to document the association between place (i.e., urbanization level) and physical distancing compliance in a recreational setting. Furthermore, the longitudinal and multi-site nature of this project allowed us to make inferences on the effect, over time, of sign presence and stay-at-home order start dates at various locations. Hence, this article contributes to the literature in that it relates trail context and policy implications to a range of topics in the literature (e.g., crowding, managing along the urban-rural continuum, signage, and public health policy) and provides evidence supporting the notion that public health issues can be addressed by examining the various SEM layers. Furthermore, we have provided data-based recommendations for a range of policy decisions park and recreation managers currently face in the ongoing COVID-19 pandemic and are likely to face in the next public health emergency.

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