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Public risk perception of covid-19 transmission and support for compact development

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In the last few decades, there has been a definitive shift in public support for compact development – characterized by high densities, more multifamily residential use, and effective public transit. The allure of compact development is because, along with sustainability benefits, it offers multiple lifestyle benefits, such as more significant opportunities for socialization and easy access to amenities. Greater possibilities of frequent and longer interpersonal interactions attract residents to such communities. However, given the recent pandemic, it is logical to be concerned about how future public support for compact development may change. This study analyzes data from a national online survey ($n = 1100$) conducted in the United States toward the end of the COVID-19 pandemic (April 2022). This research aims to assess the relationship between perceived concern for COVID-19 transmission and public support for compact development. The results from SEM analysis suggest that people more concerned about COVID-19 transmission are less supportive of compact development policies. People from areas with higher density and more COVID-19 cases are likely to have greater concern for COVID-19 transmission, which may decrease support for compact development in these areas (mediated relationship). Individuals who rely on news, online media, friends or family for COVID-19 information and single-family residents are also less likely to support compact development. In contrast, while older adults are likely to have higher concern for COVID-19 transmission, they are likely to support compact development. Higher-income households are less likely to be concerned about COVID-19 transmission but are more supportive of compact development. These findings suggest that the perceived threat of disease transmission will likely result in decreased public support for compact development. To ensure continued public support, urban policymakers must allay public fear of virus transmission in compact built environments by incorporating public health measures for controlling virus transmission in compact urban environments.

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Introduction

With the COVID-19 pandemic ebbing down and the world stumbling toward new normalcy, concerns about the future direction of urban development are starting to surface. Epidemiological research on COVID-19 transmission suggests that urban development patterns, including housing patterns, distribution of services, and accessibility, play a critical role in virus transmission (Dietz et al. 2020; Verma et al. 2021; Wong and Li, 2020). The urban built environment, including buildings, transportation facilities, and other urban spaces, is a potential vector for virus transmission by inducing interactions among individuals and viral exchange through the air and infected surfaces (Andersen et al. 2021). However, recent research suggests that the relationship between urban form and virus transmission rates is very complex (Mouratidis and Yiannakou, 2022). While studies based on simplistic measures of density have shown that confirmed COVID cases increased in compact cities with higher population density (Carozzi et al. 2020), studies considering multiple measures of urban form, including self-sufficiency, accessibility, and land-use mixes, suggest differently (Gandy, 2021; Mcfarlane, 2023a).

Compact cities are typically characterized by higher neighborhood density, greater reliance on public transport, and smaller dwellings (Dye, 2008; Glaeser, 2012) and offer multiple environmental, societal, and economic benefits compared to urban sprawl (Chen et al. 2016; Johnson, 2001; Mouratidis, 2018). In Europe, the compact city concept has for decades been a critical strategy for addressing pressing urban issues such as climate change, environmental damage, economic growth, and social unity (Kain et al. 2022). With emphasis on chrono-urbanism, that that quality of urban life is inversely proportional to the amount of time invested in transportation, compact urban form has become an aspirational goal for many cities across the world (Logan et al. 2022; Moreno et al. 2021). In the New Urban Agenda, the United Nations advocated for appropriate density and compactness to enhance urban resilience and sustainability (Vaidya and Chatterji, 2020; Watson, 2016). However, the focus on compact development in the US as a strategy for promoting sustainable urbanism and smart growth is relatively recent (Wang et al. 2021). This development approach became increasingly popular among researchers, planners, developers, and policymakers in the years leading up to the pandemic. However, there remains some degree of skepticism in the ability of the local governments to achieve the compact city form because of the long history of public preference for low-density development and the use of personal automobiles among the US population (Handy, 2020; Pozoukidou and Chatziyiannaki, 2021).

While it is early to speculate on the changes in cities post-COVID, media coverage and research opinions suggest significant concerns about the public fear of compact development specifically, population density, demand for larger home sizes, and reduced ridership in public transit (Boujari et al. 2023; Pojani and Alidoust, 2021). During the pandemic, several studies found increased public preference for low-density development (Kang et al. 2021), larger home sizes (Wolday and Böcker, 2023) and low ridership rates in public transit (Parker et. al. 2021) While there is a lack of sufficient post-COVID data to estimate how long these trends are likely to last, several researchers have suggested that preference for lower density, demand for larger homes that are adaptable to changing work conditions, and avoidance of crowded public transit systems is likely to last at least into the near future (Florida et al. 2021). In a recent study, Peiser and Hugel (2022) provided evidence of increased post-pandemic migration into small urban communities from larger population centers in the US. Colomb and Gallent (2022) found similar evidence of acceleration in European counterurbanization trends. Several researchers have suggested that lifestyle adjustments made in response to COVID have changed the pre-COVID urban preferences, and are likely to fuel demand for more space, less density and reduced use of public transit (Brail and Kleinman, 2022; Florida et al. 2021; Jeong and Lim, 2023; Strielkowski et al. 2022).

Therefore, from a development policy perspective, it is critical to understand the relationship between perceived fear of COVID-19 transmission and public support for compact development policies. It is particularly relevant in the US, where public support significantly influences local development policies (Burstein, 2003; Erikson et al. 1993). To date, beyond media speculations, no research study has yet addressed the relationship between public concern for COVID-19 transmission and policy support for compact development policies. Drawing from the literature on public policy support, risk perception, and public health behavior, this study presents an early assessment of the relationship between perceived risk from COVID-19 transmission and self-stated support for compact development. Data for this study were collected through a national online survey conducted in April 2022 using SurveyMonkey® Audience, a proprietary survey panel.

Literature survey

Public health, pandemics, and epidemics have been a critical part of the history of cities (Matthew & McDonald, 2006). The bubonic plague in the 18th century led to the clearing of overcrowded areas, the creation of large public spaces, and the development of early quarantine facilities (Duhl and Sanchez, 1999). In 19th century London, British physician John Snow identified that cholera was transmitted by contaminated water, resulting in the recognition of sewage systems as an essential city service (Newsom, 2006). The threat of diseases such as cholera and typhoid in industrialized cities led to the sanitary reform movement that sought to incorporate urban cleanliness, including ensuring clean water supplies and sewage removal as an integral part of city development (Corburn, 2007; Ringen, 1979). As such, the urban planning profession emerged in response to the horrifying housing conditions and epidemics of booming industrial cities (Hall, 2014).

Since then, biomedical advances in antibiotics and vaccination have significantly reduced the incidence and spread of infectious diseases. Consequently, in recent history, concerns about contagious diseases and the role of the urban environment in disease transmission have largely been abated except for occasional outbreaks – such as SARS, H1NI, MERS, Ebola, and Zika virus – which were limited to specific geographic regions and were successfully controlled through a combination of pharmaceutical and public health response interventions (Heymann, 2014; Hoffman and Silverberg, 2018; Tulchinsky and Varavikova, 2014). Subsequently, urban policymakers have sought to focus on sustainability, equity, and resilience concerns.

Contemporary interest in increasing urban compactness is in response to rapid urbanization and environmental degradation (Burton 2002). Scholars and practitioners advocate for compact development as the appropriate urban policy to promote prosperity and environmental sustainability (Ewing et al. 2014; Jenks and Burgess, 2000). Following this global trend, the United States also experienced increasing support for adopting planning strategies to promote compact development (Ewing and Hamidi, 2015). Key planning strategies to promote the goal of compact development include increasing the density of the population (Lee et al. 2015), mixing land use to reduce travel distances (Mubareka et al. 2011), and promoting sustainable transportation and public transit (Davoudi and Sturzaker, 2017).

The pandemic reignited the discussion on the relationship between compact development and public health concerns. Early research and media debates identified built environment characteristics as a fundamental determinant of COVID-19 transmission and distribution. Among these, urban density and public transit have been widely debated for their contribution to virus transmission (Cartenì et al. 2020; Goujon et al. 2021; Kulu and Dorey, 2021). Tazerji et al. (2022) in their analysis of risk factors associated with morbidity and mortality of coronavirus disease from different countries, including Bangladesh, Brazil, China, Central Eastern Europe, Egypt, India, Iran, Pakistan, and South Asia, Africa, Turkey, and UAE, found that higher population densities were associated with greater risk. In the United States, Wheaton and Thompson's (2020) analysis of per-capita infection rates in 351 Massachusetts cities found that population density had a statistically significant positive effect on disease incidence. However, several studies suggest that implementing public health measures, such as lockdowns and physical distancing regulations, has diminished this relationship. For example, a study by Hamidi et al. (2020) conducted after the initial implementation of public health measures, found no effect of density on COVID-19 prevalence at the county level after controlling for population size. Possible reasons for this may be the greater effectiveness of stay-at-home orders, better health infrastructure, and general behavioral response in denser cities. Several studies have also documented the impacts of COVID-19 on the ridership of a public transit system (Hu and Chen, 2021; Wilbur et al. 2023). Interpersonal interactions are expected to be higher when more people use the same mode of transportation, such as trains and buses. Thus, collective mobility makes public transit particularly vulnerable to a pandemic. Zhang et al. (2020) and Yoshida and Ye (2021) evidenced this in empirical analyses of infection cases in Japan that showed strong associations between increased infection rate and transport accessibility. Similar trends in a significant reduction in the use of public transportation have been documented worldwide (Abdullah et al. 2021; Basbas et al. 2021).

A key characteristic of this pandemic was the role of media in improving awareness and sharing information with health workers worldwide and the general public (Gralinski and Menachery, 2020; Tsoy et al. 2021). Various television media outlets provided expert views and perspectives on built environment factors, particularly density and its influence on virus transmission rates (McFarlane, 2023b). These media outlets also provided platforms for politicians to share their perceptions of pandemic risks with the public. For example, against the backdrop of increasing COVID-19 infections in New York City, several media outlets reported Governor Andrew Cuomo's characterization of high densities in New York as destructive (Rosenthal, 2020). An Associated Press report speculated that Los Angeles was spared the same fate as New York City because of more widespread development and lower population density (Melley, 2020). Some recent studies suggest that prolonged media exposure to COVID-19 news and information may have led to greater risk perceptions and psychological strain (Bendau et al. 2021; Fabio and Suriano, 2021; te Poel et al. 2021). Therefore, it is logical to assume that continued media coverage highlighting higher virus transmission risk in high-density areas and the use of public transportation is likely to generate greater public fear of these places, thereby decreasing support for policies that promote such compact development.

Research framework

In this research, public support for compact development is conceptualized as a consisting of support for three key aspects: higher density, more multifamily residences, and greater access to public transit. The primary research goal of this study is to analyze the relationship between public concern for COVID-19 transmission and support for compact development. Several control variables likely to influence public opinion are also included in the model. These include two locational attributes of the respondents – county population density and COVID-19 cases. Other control variables included in the model include sources of COVID information - news and online media, family/friends, and sociodemographic characteristics - residence type, age, gender, education, and household income (Fig. 1).

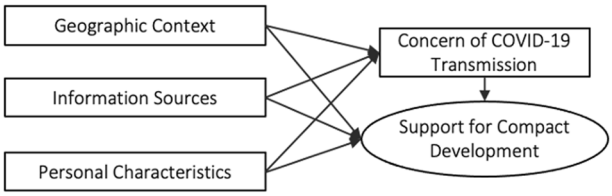

Fig. 1 Conceptual Framework for Determinants of Public Support for Compact Development.

Specifically, the following research hypotheses are tested in this study. H1: Higher concern for COVID-19 transmission will result in lower support for compact development. H2: Higher population density will be positively related to concern for COVID-19 transmission (H2a) and positively related to support for compact development (H2b). H3: A higher number of COVID-19 cases will result in increased concern for COVID-19 transmission (H3a) and lower support for compact development (H3b). H4: Greater reliance on news and online media for COVID information will be associated with greater concern for COVID-19 transmission (H4a) and lower support for compact development (H4b). H5: Single-family home residents are likely to have lower concern for COVID-19 transmission (H5a) and lower support for compact development (H5b). H6: Older respondents are likely to be more concerned about COVID-19 transmission (H6a) and be more supportive of compact development (H6b). H7: Women are likely to be more concerned about COVID-19 transmission (H7a) and more supportive of compact development (H7b). H8: Higher levels of education are likely to be associated with lower concern for COVID-19 transmission (H8a) and higher support for compact development (H8b). H9: Higher-income respondents are likely less concerned about COVID-19 transmission (H9a) and less supportive of compact development (H9b).

Data and methods

Given the lingering concerns of COVID-19 transmission, in-person surveys were not feasible; therefore, an online survey was conducted in April 2022. The survey was administered to members of the SurveyMonkey® Audience panel, a proprietary survey panel that recruits from a diverse population of more than 30 million people who complete SurveyMonkey surveys. A pilot survey was administered online to 10 respondents using the SurveyMonkey platform. All respondents completed the surveys successfully within the anticipated time and did not express any problems or issues in understanding the survey questions. Therefore, no changes were made to the initial questionnaire. Thereafter, SurveyMonkey sent email invitations to panel members aged 18 years or more who were residents of the contiguous US. Survey invitations were balanced for gender and age based on American Community Survey 2016-2020 5-year estimates. A total of 1100 completed responses were collected and analyzed. Data were also collected for respondents' county of residence, residence type, age, gender, educational level, and annual household income. The dataset includes respondents from 817 counties of 44 contiguous states and the District of Columbia in the US.

Table 1 Variables and response rates.

Variables (Mean | SD)	Response Categories	Response Rate N (%)
Outcome Variables		
Concern for COVID-19 transmission	Not at All	133 (12.09)
	Small Extent	242 (22.00)
(Mean = 2.97 | SD = 1.17)	Moderate Extent	380 (34.55)
	Great Extent	214 (19.45)
	Very Great Extent	131 (11.91)
Support for increased housing density	Not at All	49 (4.45)
	Small Extent	88 (8.00)
(Mean = 3.80 | SD = 1.14)	Moderate Extent	293 (26.64)
	Great Extent	272 (24.73)
	Very Great Extent	398 (36.18)
Support for more multifamily homes	Not at All	100 (9.09)
	Small Extent	140 (12.73)
(Mean = 3.45 | SD = 1.24)	Moderate Extent	301 (27.36)
	Great Extent	280 (25.45)
	Very Great Extent	279 (25.36)
Support for great access to public transit	Not at All	149 (13.55)
	Small Extent	250 (22.73)
(Mean = 2.95 | SD = 1.21)	Moderate Extent	334 (30.36)
	Great Extent	232 (21.09)
	Very Great Extent	135 (12.27)
Predictor Variables		
Residence Type	Single Family Home	850 (77.27)
(Mean = 0.77 | SD = 0.42)	Others	250 (22.73)
COVID-19 Information Source - news/online media	Not at All	54 (4.91)
	Small Extent	262 (23.82)
(Mean = 3.01 | SD = 0.97)	Moderate Extent	484 (44.00)
	Great Extent	215 (19.55)
	Very Great Extent	85 (7.73)
COVID-19 Information Source - family/friends	Not at All	119 (10.82)
	Small Extent	397 (36.09)
(Mean = 2.73 | SD = 1.08)	Moderate Extent	333 (30.27)
	Great Extent	166 (15.00)
	Very Great Extent	85 (7.73)
Age (Mean = 3.49 | SD = 1.07)	18–29 (1)	258 (23.45)
	30–44 (2)	273 (24.82)
	45–60 (3)	332 (30.18)
	>60 (4)	237 (21.55)
Gender	Male	533 (48.45)
	Female	567 (51.55)
Education	Less than high school (1)	15 (1.36)
(Mean = 4.16 | SD = 1.39)	High school degree/ equivalent (2)	156 (14.18)
	Some college but no degree (3)	229 (20.82)
	Associate degree (4)	145 (13.18)
	Bachelor's degree (5)	348 (31.64)
	Graduate degree (6)	207 (18.82)
Annual HH Income	$0-$9999 (1)	0 (0)
(Mean = 4.74 | SD = 2.19)	$10,000-$24,999 (2)	102 (9.27)
	$25,000-$49,999 (3)	247 (22.45)
	$50,000-$74,999 (4)	300 (27.27)
	$75,000-$99,999 (5)	170 (15.45)
	$100,000-$124,999 (6)	100 (9.09)
	$125,000-$149,999 (7)	47 (4.27)
	$150,000-$174,999 (8)	23 (2.09)
	$175,000-$199,999 (9)	9 (0.82)
	$200,000+ (10)	102 (9.27)
Population Density	Mean = 1179.57 | SD = 4939.49	
Cumulative COVID-19 cases until March 2022	Mean = 80928.51 | SD = 168516.90	

The online survey elicited respondents' support for increased housing density, more multifamily development, and greater access to public transit in their neighborhoods. Responses were collected on a scale of 1–5, with 1 representing no support and 5 indicating a very great level of support. Cumulatively, these responses represent the respondents' support for compact development. Respondents were also asked to rate their level of concern regarding COVID-19 transmission on a scale of 1–5. Respondents were asked about their residence type – single-family home or other. Respondents also indicated how much they relied on news and online sources for COVID-19 information and their reliance on friends and family for COVID-19 information. Respondents also provided information on sociodemographic variables of age, gender, education, and household income. Based on the county of residence, data on county population density (American Community Survey 2016–2020 estimates) were added for each respondent. Reported cumulative COVID-19 cases per 10,000 population in the respondent's county until March 2022 (Dong et al. 2020) were also added to the dataset.

Results

The response rates of the outcome variables and predictor variables are presented in Table 1. First, zero-order correlational analysis was conducted to assess relationships among all variables (shown in Table 2).

Then, a structural equation model (Fig. 2) was constructed to assess the relationship between population density, COVID-19 caseload (cases per 10,000 residents), residence type, CVOID information-seeking behavior, demographic factors, and concern for COVID-19 as well as support for three compact development policies. The model fit statistics (maximum likelihood method) were chi2(20) = 118.95, $p < 0.001$, SRMR = 0.027, RMSEA = 0.049, and CFI = 0.97, suggesting an acceptable fit (Lecompte et al. 2022; Xia and Yang, 2019). The multicollinearity assumption was not violated for the model, as none of the variables had a variance inflation factor over 2. To adjust for the violation of the normality assumption, a robust MLR method for model estimation was used (Kline, 2015).

Support for compact development policies. Among the three measures of compact development, most respondents expressed great or very great support for high density (60.9%), followed by multifamily development (47.9%) and access to public transit (33%). Correlational analysis reveals a statistically significant positive relationship between the three variables (alpha = 0.72). Bivariate correlational analysis reveals that support for each of these policies is negatively correlated with perceived concern for COVID-19 transmission. Support for higher density is positively correlated with age, education, and household income. It is negatively correlated with single-family home residence type, population density, and both sources of COVID-19 information (news/internet and family/friends). Support for greater access to public transit is positively correlated with the COVID-19 caseload, age, and household income. It is negatively correlated with population density, COVID-19 information sources such as family/friends, and education. Support for multifamily development is positively correlated with only age and household income. It is negatively correlated with population density and both sources of COVID-19 information.

Perceived concern for COVID-19 transmission. Among the respondents, 31.1% expressed great or very great concern, 34.3% expressed moderate concern, and 34.7% expressed no concern or slight concern about COVID-19 transmission. Correlational analysis reveals a positive relationship between perceived concern and population density, both sources of COVID-19 information and education. Perceived concern for COVID-19 transmission is negatively correlated with household income.

Determinants of perceived concern for COVID-19 transmission. Zero-order correlations provide statistical evidence of bivariate relationships but do not provide a complete test of relationships influenced by multiple variables. Therefore, a structural equation model (SEM) was constructed with all dependent and independent variables. The results of the SEM indicate that population density and COVID-19 caseload are positively related to perceived concern for COVID-19

Table 2 Correlations between predictor and outcome variables in the SEM.

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Support for increased housing density	1												
2	Support for more multifamily homes	0.54***	1											
3	Support for greater access to public transit	0.40***	0.45***	1										
4	Concern for COVID-19 transmission	−0.30***	−0.32***	−0.32***	1									
5	Population Density	−0.11***	−0.13***	−0.11***	0.26***	1								
6	Cumulative COVID-19 cases (March 2022)	−0.17***	−0.18***	−0.16***	0.39***	0.33***	1							
7	Residence Type	−0.10**	−0.08**	−0.06*	0.07*	0.03	0.02	1						
8	COVID-19 Information Source – news and online media	−0.32***	−0.33***	−0.26***	0.26***	0.12***	0.18***	0.08**	1					
9	COVID-19 Information Source – friends and relatives	−0.31***	−0.22***	−0.08*	0.19***	0.09**	0.13***	0.12***	0.42***	1				
10	Age	0.14***	0.17***	0.09**	0.03	0.01	−0.04	0.05	−0.28***	−0.16***	1			
11	Gender	−0.03	0	0.01	−0.04	0.05	0	0	−0.02	−0.04	0.02	1		
12	Education	0.06*	0.02	−0.16***	0.07*	0.07*	0.04	0.04	0.02	−0.09**	0.13***	0.07*	1	
13	Annual HH Income	0.14***	0.12***	0.03	−0.06	0.02	0	0.03	−0.04	−0.06*	0.12***	0.10***	0.26***	1

*$p < 0.05$, **$p < 0.01$, ***$p < 0.00$.

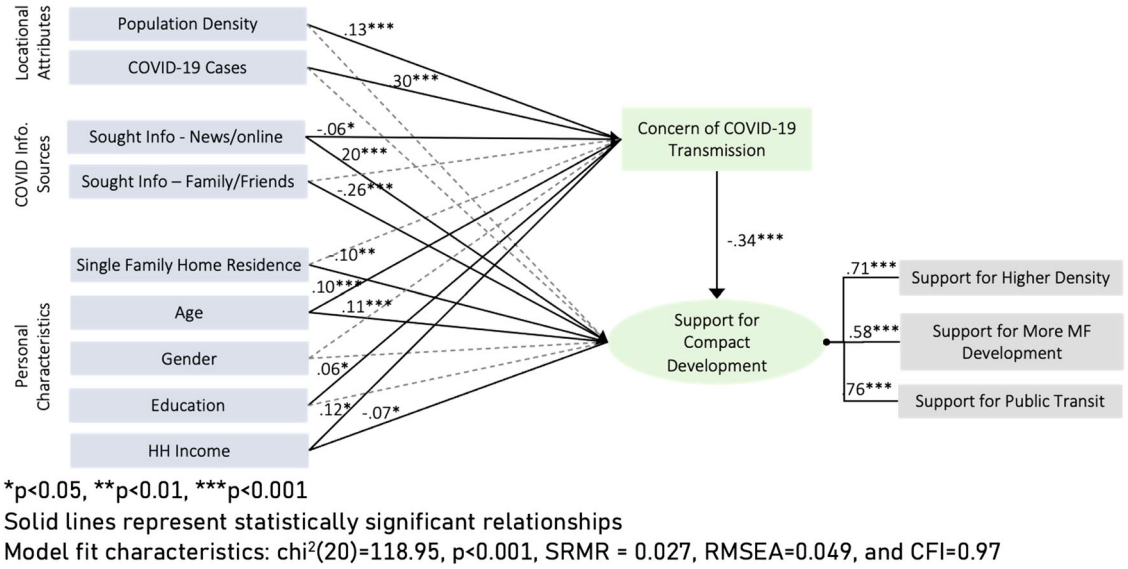

Fig. 2 SEM Results - Determinants of Public Support for Compact Development.

transmission. Among the two sources of COVID-19 information, news and online media are positively related to concern for COVID-19 transmission. Among the sociodemographic variables, age and education are positively related, and household income is negatively related to concern for COVID-19 transmission. Single-family residents and gender show no statistically significant relationship with concern for COVID-19 transmission.

Determinants of support for compact development. The SEM results showed that concern for COVID-19 transmission and single-family residence type were negatively related to support for compact development. Among respondents' county characteristics, population density had no relationship, but COVID-19 caseload was positively related to support for compact development. Both sources of COVID-19 (news/online media and family/friends) information were negatively related to support for compact development. Among the demographic variables, age and household income were positively related to support for compact development. No statistically significant relationship was present between either gender or household income and support for compact development.

Discussion

The primary goal of this study was to assess the relationship between public risk perception of COVID-19 transmission and support for compact development. The survey results suggest that individuals with greater concern for COVID-19 transmission are unlikely to support compact development in their neighborhoods. These results are as expected evidence collected during the pandemic suggests that restrictions imposed during the pandemic resulted in a fear of density and crowded places (Liu and Su, 2020; Park et al. 2021; Whitaker, 2021). All three indicators of compact development included in this study are associated with increased intensity of urban uses and resident interactions. At the same time, epidemiological studies have linked increased frequency and intensity of

person-to-person interactions with increased risk of virus transmissibility. Thus, lack of public support for compact development is indicative of continued fear of compact urban environments that are likely to promote increased virus transmission. It is likely that at the time of survey, there continued to be public preference for more interpersonal space to limit interpersonal interactions in the built environment to reduce the risk of virus transmission.

Among the locational attributes, SEM analysis of the survey data showed no significant relationship between population density and support for compact development. However, the bivariate correlation between density and public support for each of the three compact development policies was statistically significant and negative. These results echo the lack of a consistent relationship between density and support for compact development policies previously documented by other researchers (Barak et al. 2021). For example, in a survey of Dublin residents, Howley (2009) found that the majority of the residents in high-density neighborhoods expressed a preference for lower-density locations. In contrast, Mouratidis (2018) found greater satisfaction and support for compact development among residents of high-density neighborhoods in Oslo. While the SEM did not provide statistical support for the hypothesized relationship between density and public support for compact development, density was positively related to public concern for COVID-19 transmission. This suggests that a lack of public support for high-density development is mediated by a high level of concern for COVID-19 transmission among high-density residents. Similarly, SEM analysis revealed a lack of relationship between COVID caseload and public support for compact development, whereas COVID-19 caseload was positively related to concern for COVID-19 transmission. These results are similar to another recent study (Jie, 2022), wherein researchers found that people perceived a higher risk from COVID-19 in areas with more total cases. Thus, the results suggest that people do not perceive a direct relationship between COVID-19 caseload and density. Indeed, the COVID-19 caseload is associated with several community-level vulnerabilities, including age, disability, language, race, occupation, and quality of healthcare systems (Andersen et al. 2021). Therefore, even though the COVID-19 caseload influences public concern for COVID-19 transmission, there is no evidence of its influence on public support for compact development.

Another key variable explored in this research was the influence of information from two key sources – traditional/online news and friends/relatives. Respondents who frequently sought information from TV/radio/online sources had a positive association with concern for COVID-19 transmission. This was expected because to stimulate public response and persuade to comply with preventive actions, mainstream media highlighted the severity of the outbreak to increase the perception of risk from COVID-19 (Olagoke et al. 2020). Additionally, as expected, the relationship between these sources of COVID-19 information and support for compact development was negative. This can also be attributed to increased coverage in the mainstream media of risks associated with overcrowding and in denser urban environments. In contrast, respondents who frequently sought information from family/friends were not concerned about COVID-19 transmission but were less supportive of compact development. These results are significant from a housing and urban development perspective, as past research suggests that homebuyers often consult with family/friends during the selection and purchase of new homes (Levy et al. 2008; Salzman and Zwinkels, 2017). It is likely that persistent negative public perception of compact development and its association with virus transmission may continue beyond the media coverage cycle through social networks and thus may have a lasting effect on home-buying behavior.

Among the sociodemographic variables, analysis of the survey data suggests continued opposition to compact development by residents of single-family homes, even though they were not concerned about COVID-19 transmission. This group of residents has traditionally been reluctant to support compact growth and has often pursued regulatory protection of their low-density suburban neighborhoods (Song, 2005). Single-family home residents are often the largest resident group in most cities and thus play an important role in influencing the adoption and implementation of local development policies (Tian et al. 2015). Lack of support from these stakeholders will continue to hinder future efforts for compact development.

The SEM also included four more sociodemographic variables identified in prior research as determinants of public risk perception and policy opinion. These earlier studies suggest that respondents are likely to have a higher perception of risk with increasing age due to a reduced sense of invulnerability commonly associated with younger age and a greater sense of health responsibility (Cohn et al. 1995). In this study, age was found to be positively associated with greater concern for COVID-19 transmission. This seems logical given that public health researchers identified older adults as particularly vulnerable to COVID-19 infection. At the same time, age was also positively associated with support for compact development in the SEM. One of the possible reasons could be the previously documented preference of older adults for compact development (Smith and Billig, 2012; Tuckett et al. 2018). These studies suggest that with increasing age, people, particularly empty nesters, prefer compact city-style living for its amenities and opportunities for socializing. It is likely that these perceived benefits outweigh concern for COVID-19 at this time when the spread of the virus has been successfully contained and there is widespread availability of the vaccine. Another possible reason could be that the questionnaire employed in this study did not capture the multiple dimensions of the perceived risk of COVID-19 transmission. While this study used a single question to elicit respondents' perceived risk of COVID-19 transmission, some researchers in public health indicate differences in the perception of risk vulnerability and risk severity (Bruine de Bruin, 2021). A recent study of the COVID-19 outbreak revealed that older adults perceived lower vulnerability but greater severity of COVID-19 infection (Rosi et al. 2021). Thus, it is likely that despite the COVID-19 pandemic, older adults will continue to support compact development.

Gender showed no relationship with concern for COVID-19 transmission or support for compact development. This was surprising, as several recent studies of COVID-19 risk perception suggest higher levels of fear and worry among the female population due to greater psychological vulnerability (Alsharawy et al. 2021). Similarly, earlier studies on environmental attitudes also indicate that women are likely to exhibit greater support for pro-environmental policies (Dietz et al. 2002). However, a few researchers have also found a lack of a consistent relationship between gender and pro-environmental support (Somma and Tolleson-Rinehart, 1997). In a recent study, Reed-Thryselius et al. (2022) also failed to find a relationship between gender and COVID-19 risk perception. Thus, the lack of evidence of the influence of gender on perceived concern for COVID-19 transmission and support for compact development adds to the mixed results from other similar research studies.

Education was positively related to concern for COVID-19 transmission, but the relationship with support for compact development was not statistically significant. Several other studies have also found a positive relationship between education and perceived risk from COVID-19 (Bischof et al. 2022; Reed-Thryselius et al. 2022). This relationship can likely be explained by greater access and exposure to public health research that has continued to provide evidence of an unprecedented high rate of COVID-19 transmission. The lack of a relationship between education and support for compact development is surprising because generally higher levels of education are related to pro-

environmental behavior (Meyer, 2015). However, the relationship between education and support for compact development is often more complex and often influenced by several other contextual factors (O'Connell, 2008). A potential reason for this could be that formal education is not necessarily a good measure of environmental awareness – specifically as related to local development outcomes. Additionally, it is possible that local concerns related to desired neighborhood form and property prices may outweigh the broader environmental benefits of compact development.

Household income was negatively related to concern for COVID-19 transmission and positively related to support for compact development. Lower concern for COVID-19 transmission is likely due to a heightened sense of security among higher-income households. A similar relationship between higher income groups and risk perceptions has been reported in prior research (McDaniels et al. 1992). The positive relationship of household income with support for compact development was also as expected and reflects similar results reported by other researchers (Hawkins, 2014). Continued support of higher-income households in promoting compact development is critical because of the role they often play in local politics and policy leadership. While their support does not always guarantee favorable outcomes, a lack of support from higher-income households can be a significant obstacle in the adoption and implementation of compact development policies.

Conclusions and limitations

The recent COVID-19 pandemic has undoubtedly raised several questions about the future of local development policies that promote compact development. This study provides empirical evidence of a negative relationship between concern for COVID-19 transmission and public support for compact development policies. Specifically, individuals with higher concern for COVID-19 transmission are less likely to support compact development policies that result in higher densities, more multifamily development and greater access to public transit. These results highlight the gap between the actual relationship between the risk of COVID-19 transmission and urban density and the public perception of this relationship. While recent research results do not provide consistent evidence of a relationship between COVID-19 transmission and density, research evidence suggests that crowding is likely to enhance virus transmissibility. It is likely that people tend to associate the compact development form with crowding, resulting in lower support for such development policies. This is not surprising, as prior research suggests that the public often associates higher urban densities, multifamily developments, and public transit with crowding (Aghabayk et al. 2021; Bonnes et al. 1991; Kim and Kang, 2021). It is likely that people continue to have a higher perception of risk of COVID-19 transmission in compact development communities, which seems to be driving decreased public support for compact development.

This research also provided evidence of the critical role of media in shaping public perception of transmission risk and support for compact development policies. While media cycles are limited by the saliency of a current issue, they continue to influence public opinion through information propagation among social networks. The results of this study suggest that even though the media focus on COVID-19 transmission and compact development had waned, social networks continued to negatively influence public support for compact development.

These results are a cautionary sign for proponents of sustainable development. While it is too early to foretell what the post-pandemic city would look like, there should be no doubt that fear of COVID-19 transmission will continue to influence public support for future urban development policies. At a minimum, communities will need to adopt policy measures to reduce virus transmission in urban environments through more stringent cleanliness practices in public spaces and measures to avoid urban overcrowding. However, another similar outbreak in the near future could further fuel the fear of compact development and result in a post-pandemic urban environment characterized by increased suburbanization and use of private vehicles. Nonetheless, sustained public communication through media outlets will continue to play a critical role in addressing the perceived fears of virus transmission in compact development and increasing public support for such developments.

It is important to highlight that these results reflect the public sentiment at the time of the survey. Most communities had recently come out of the pandemic and were in the process of resuming normal operations. As past research suggests, public opinion can be transient depending on the saliency of the issue. Therefore, concern for COVID-19 transmission and public support for compact development may change over the next few years. At the same time, any further COVID-19 or similar outbreaks in the future may lead to further decline in public support for compact development policies. Undoubtedly, post-COVID urban policymaking will require a more holistic approach to address the concurrent needs of public health, sustainability, and social equity in cities.

As with any other cross-sectional study, the results of this study limit the ability to make causal references. Additionally, as in any survey research, response bias cannot be ruled out. Furthermore, while opt-in panels have advantages of being convenient and cost-efficient, there may be potential bias due to undercoverage and self-selection. However, with gender and age balancing and at least three respondents from all but six US states (total of 50 states), the findings of this research reflect the opinions of the US population. Nonetheless, the use of an existing online panel limits the generalizability of the findings, and more longitudinal research is needed for further validation.

Overall, COVID-19 has refocused the attention of urban planners and local development authorities on the relationship between urban form and public health outcomes. While further studies are needed to truly understand the impact of the COVID-19 experience on long-term public support for compact development, the initial results suggest that local development policies will need to focus on public health and safety concerns while pursuing the sustainability agenda.

Data availability

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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Author contributions

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Competing interests

The author declares no competing interests.

Ethical approval

The questionnaire and methodology for this study were approved by the Human Subjects Division of the University of Washington (IRB ID: STUDY00015264)

Informed consent

Informed consent to participate in this study was granted by all participants.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1057/s41599-023-02431-1.

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