What Influences Shifts in Urban Nature Site Visitation During COVID-19? A Case Study in Tel Aviv-Yafo, Israel

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Urban nature sites are crucial places for the promotion of human health and well-being during the COVID-19 pandemic, but there are few interdisciplinary studies that simultaneously investigate the impact of a range of social and environmental factors on potential shifts in urban nature site visitation. We sought to do this by analyzing both geospatial data of the amenities and environmental features of urban nature sites with a web-based survey of urban nature site visitation in Tel Aviv-Yafo, Israel. We found that 53% of surveyed participants decreased visitation during the pandemic, while 26% increased visitation, 21% had no change, and only 1.7% were first-time visitors of urban nature sites. We developed a multiple linear regression model for shifts in visitation frequency during the pandemic, and found that a relative increase in visitation was positively associated with higher ratings of the physical and mental health contribution of the urban nature sites, higher nature maintenance and accessibility ratings, and visiting with a spouse, but negatively associated with variables such as car transportation, visit length, shrub habitat, age, and visiting alone or for romantic dates. Our results suggest that the perceived health benefits and accessibility of urban nature sites could be key in motivating visitation during the pandemic more than the specific environmental features or amenities of these sites. Given the on-going threats of the pandemic and other environmental crises, it is imperative to continue supporting the creation, maintenance, and monitoring of urban nature sites for not only urban ecosystems and biodiversity, but also so that they can contribute to the health of all urban residents.

Keywords: urban nature, urban green space, outdoor recreation, COVID-19, greenspace accessibility, health and well-being

1 INTRODUCTION

The novel coronavirus (COVID-19) pandemic has infected more than 480 million people worldwide since its first known infection in December 2019 (Johns Hopkins Coronavirus Resource Center, 2022). In response to the threat of transmission, countries implemented a range of policies such as restricting the use of public lands, closing schools and workplaces, forbidding social gatherings, implementing stay-at-home lockdown orders, and limiting non-essential travel on local to international scales (Ugolini et al., 2020; Geng et al., 2021). These actions helped to reduce the transmission of COVID-19, but these restrictions resulted in some negative effects on human mental and physical health (Xie et al., 2020; Allen, 2021; Fasano et al., 2021). Social isolation during the pandemic has been associated with higher rates of depression, anxiety, and sleep disorders (Xie et al.,

2020; Ben-Ezra et al., 2021; Fasano et al., 2021; Olszewska-Guizzo et al., 2021), while restrictions of movement away from the home have been associated with reduced physical activity (Ugolini et al., 2020). During the COVID-19 pandemic, many of the most valuable and readily accessible places for the promotion of human physical and mental health have been urban nature (Heo et al., 2020; Shoari et al., 2020; Geng et al., 2021; O'Brien and Forster, 2021; Pouso et al., 2021; Robinson et al., 2021).

Visitation to urban nature such as parks, natural remnants, and gardens is generally associated with many physical and mental health benefits for people such as decreased rates of anxiety, stress, obesity, diabetes, and depression (Frumkin et al., 2017; Kothencz et al., 2017; Bratman et al., 2019; Schnell et al., 2019; Saadi et al., 2020; Berdejo-Espinola et al., 2021). Both urban green spaces (e.g., forests, scrub habitat, and places predominantly covered by vegetation) and urban blue spaces (e.g., all forms of natural and human made surface waters such as the sea, rivers, and ponds) are components of urban nature that have been shown to contribute positively to human health and well-being (Kaplan et al., 1998; Grellier et al., 2017; Olive and Wheaton, 2021; Pouso et al., 2021; Smith et al., 2021). People who visit urban nature more frequently and for longer periods of time tend to have higher contentment with their lives, improved social cohesion, lower rates of depression, and increased rates of physical activity (Shanahan et al., 2015, 2016; Xie et al., 2020; Yigitcanlar et al., 2020). Some studies demonstrated that visitation frequency and demand for urban nature generally increased since the beginning of the COVID-19 pandemic (Derks et al., 2020; Grima et al., 2020; Venter et al., 2020; Geng et al., 2021; Robinson et al., 2021; Weinbrenner et al., 2021), while others indicated that it tended to decrease (Xie et al., 2020; Curtis et al., 2021; Larson et al., 2021) or had very little change particularly in semi-natural and natural areas (Korpilo et al., 2021). As countries continue to adaptively manage their responses to the COVID-19 pandemic, there are still research gaps regarding which factors may impact urban nature visitation during this time and future crises (Venter et al., 2020; Korpilo et al., 2021).

Researchers are beginning to investigate how visitor perceptions of the physical and mental health contributions of urban nature may have changed during the COVID-19 pandemic, and how these perceptions may have influenced the use of urban nature (Chen et al., 2020; Berdejo-Espinola et al., 2021). Some studies showed that people generally visited nature for personal physical and/or mental health benefits to help them cope during the stress of the COVID-19 pandemic (Berdejo-Espinola et al., 2021; O'Brien and Forster, 2021; Robinson et al., 2021). For example, in a study of urban green space use in Brisbane, Australia, most participants attributed a higher level of importance to the personal physical and psychological benefits obtained from urban green spaces during the COVID-19 pandemic than before, and typically visited for these reasons more than for a sense of community (Berdejo-Espinola et al., 2021).

In addition to the physical and mental benefits of urban green and blue spaces, numerous factors may collectively influence how often people visit urban nature. These include land use and maintenance of natural and human-made features/amenities (Church, 2018; Talal and Santelmann, 2020, 2021; Talal et al., 2021), transportation options (Morzillo et al., 2016; Ugolini et al., 2020; Venter et al., 2020), and proximity/travel distance (Kaczynski et al., 2014; Shoari et al., 2020; Tu et al., 2020; Ugolini et al., 2020; Korpilo et al., 2021; Rice and Pan, 2021). Other influencing factors tend to include visitor perceptions of safety and accessibility (Hashim et al., 2016; Gu et al., 2020; Talal and Santelmann, 2021), demographics (Mak and Jim, 2019; Chen et al., 2020), and visitor motivations (Ugolini et al., 2020). Motivations for visiting urban nature during the COVID-19 pandemic may have shifted away from "non-essential" and/or "high risk" activities such as socializing with others toward "necessary" activities such as physical exercise and taking the dog out for a walk (Ugolini et al., 2020).
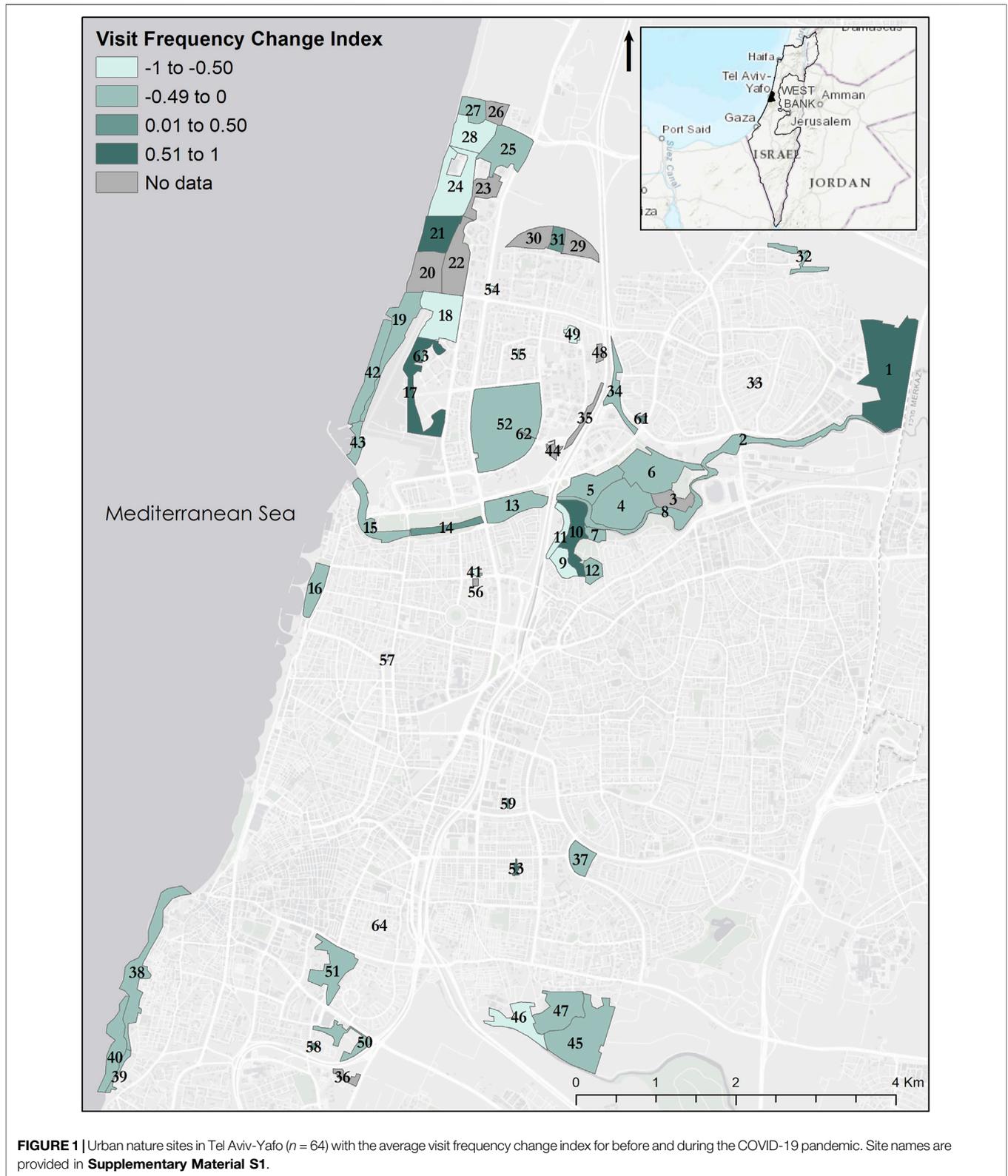
Altogether, recent studies provide more information on factors that may have influenced urban nature visitation frequency before and during the COVID-19 pandemic; however, there are few interdisciplinary studies that simultaneously investigated the combined impact of a range of social and environmental factors (Ugolini et al., 2020; Robinson et al., 2021). The purpose of our study was to better understand both the social and environmental factors (e.g., reasons for visits, transportation methods, amenities, environmental features, etc.) that may have influenced a potential shift in urban nature site visitation during the pandemic. We sought to address this research question by analyzing both geospatial data of the environmental features and amenities of urban nature sites with the results of a web-based survey regarding urban nature site visitation.

We predicted that the main drivers of shifts in urban nature site visitation would be related to the perceived mental and physical health benefits of the urban nature sites, the opportunity to socialize with others outside of their household in an outdoor setting during the closure of other indoor public spaces, and the ability access the sites without car or bus transportation (e.g., related to COVID-19 lockdown restrictions). We also anticipated that environmental features would be more influential for urban nature visitation than amenities, which might have introduced the potential for COVID-19 exposure. The findings of this type of interdisciplinary research may be used to enhance urban nature site management and improve the quality of life of residents at this time of the current pandemic and during potential future environmental and/or health crises.

2 MATERIALS AND METHODS

2.1 Study Area

Our study was conducted in Tel Aviv-Yafo, a metropolitan city in Israel located along the eastern side of the Mediterranean Sea with a human population of 463,808 as of 2020 (The State of Israel Central Bureau of Statistics, 2021). In response to the COVID-19 pandemic declaration on by the World Health Organization (WHO) (World Health Organization, 2020), the Israeli

FIGURE 1 | Urban nature sites in Tel Aviv-Yafo (*n* = 64) with the average visit frequency change index for before and during the COVID-19 pandemic. Site names are provided in **Supplementary Material S1**.

government began implementing public health measures on 11 March 2020 and instituted a national state of emergency on 19 March 2020, which was followed by a series of lockdown restrictions (Ben-Ezra et al., 2021; Kaim et al., 2021). Some of the restrictions included stay-at-home orders for non-essential workers, restrictions regarding transportation (e.g., the use of
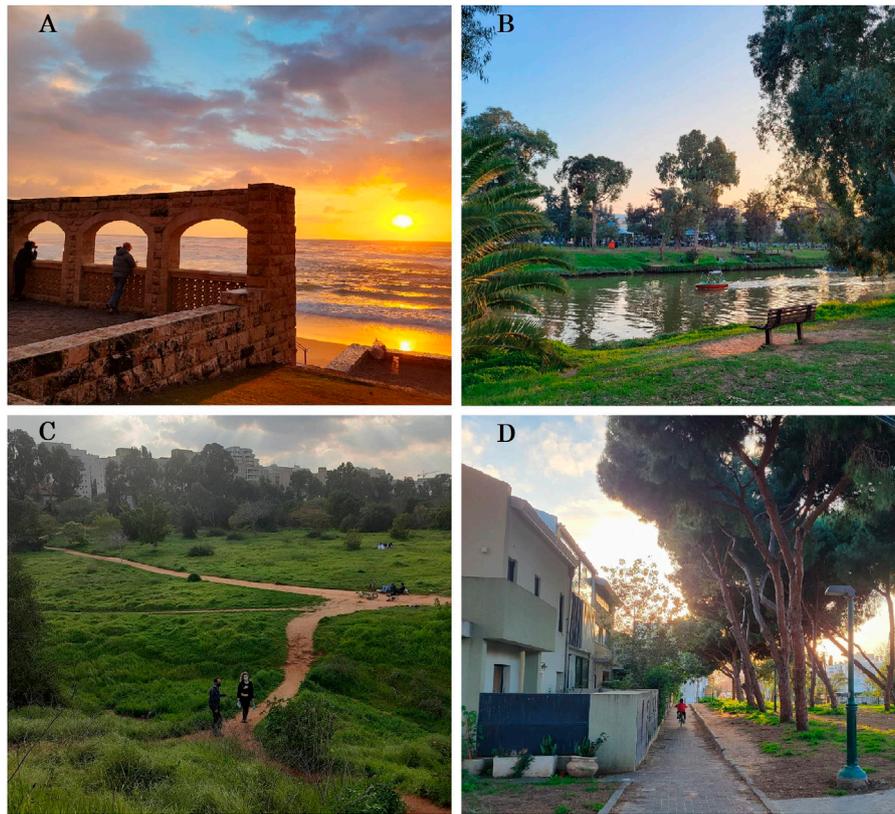
FIGURE 2 | Examples of urban nature sites in Tel Aviv-Yafo (with their corresponding numbers in **Figure 1** in parentheses): **(A)** Givat Aliya Beach and Gan Yitzhak Sadeh (39), **(B)** Nahal Yarkon Sportek section (14), **(C)** Afeka Center (31), and **(D)** Ramat Aviv A (52).

public buses, private cars, and taxis), enforcing a maximum permitted travel distance from home, and limiting public outings to only two people from the same household.

Within the approximately 52 km^2 city of Tel Aviv-Yafo, there were 64 urban nature sites as of April 2021 (Municipality of Tel Aviv-Yafo, 2021) (**Figure 1**). Urban nature sites are defined by the Tel Aviv-Yafo Municipality Environment and Sustainability Authority (2018) as public lands that are conserved, rehabilitated, and monitored to support nature and make them more accessible to the public for their enjoyment. The urban nature sites include features such as beaches, sand dunes, rivers, lakes, gardens, green roofs, and parks that were selected for additional protections based on a variety of reasons such as their ecological quality, species diversity, and connection to other sites within the city, which are defined in the city's master plan and implemented in the provisions of the TA/5000 Zoning Plan for Tel Aviv-Yafo (Grossman, 2016; Tel Aviv-Yafo Municipality Environment and Sustainability Authority, 2018). Some photographic examples of the urban nature sites in Tel Aviv-Yafo are provided in **Figure 2**.

2.2 Geospatial Data Collection

We obtained geospatial data for the urban nature sites in Tel Aviv-Yafo from the Tel Aviv-Yafo Municipality iView v7.89 (Municipality of Tel Aviv-Yafo, 2021), which included maps

and shapefiles for urban nature sites and a range of environmental features (i.e., beaches, community gardens, edible forest, sea, and special trees) and amenities (i.e., beach activities, bicycle routes, educational signs, dog parks, drinking fountains, fountains, garden sports activities, lamps, parking lots, playgrounds, sculptures, shelters, sports lots, tennis tables, and toilets). We obtained shapefiles for forest, river/stream/canal, scrub habitat, and wetland/lake from OpenStreetMap (OpenStreetMap contributors, 2021). Using ArcGIS Desktop 10.8.1, we calculated the area (hectares) of the urban nature sites and applied the intersect analysis tool to compute the geometric intersection of environmental features and amenities located within the urban nature site boundaries. We reviewed aerial maps to visually confirm the consistency and accuracy of the shapefiles for each of the urban nature sites, and then updated the data as necessary. The urban nature site environmental features and amenities variables included in the analysis are provided in **Table 1**.

2.3 Survey Instrument

We developed our web-based survey for urban nature site visitation with collaboration and feedback from Tel Aviv University faculty and students, a consultant for the Tel Aviv-Yafo Municipality Environment & Sustainability Authority, the Israeli Ministry of Environmental Protection, and Reichman

TABLE 1 | Urban nature site variables, including area (hectares), environmental features, and amenities.

Variable	Type
Area (hectares)	Numerical
Environmental Features	
Beach[a]	Binary
Community gardens[a]	Binary
Edible forest	Binary
Forest	Binary
River/stream/canal	Binary
Scrub habitat	Binary
Sea[a]	Binary
Special trees	Binary
Wetland/lake	Binary
Amenities	
Beach activities[a]	Binary
Bicycle routes	Binary
"Books on Maps" educational signs[a]	Binary
Dog parks	Binary
Drinking fountains[a]	Binary
Fountains[a]	Binary
Garden sports activities[a]	Binary
"Here Lived" educational signs	Binary
Lamps	Binary
Parking lots	Binary
Playgrounds	Binary
Sculptures[a]	Binary
Shelters[a]	Binary
Sports lots	Binary
Tennis tables	Binary
Toilets[a]	Binary

[a]Variable removed based on multicollinearity (ranked cross correlations of ≥0.8 and/or VIFs ≥ 5.0).

TABLE 2 | Survey variables describing the characteristics of participants' urban nature site visits.

Variable	Type
With Whom They Visit	
Visit alone	Binary
Visit with dog[a]	Binary
Visit with family	Binary
Visit with friends	Binary
Visit with kids	Binary
Visit with spouse	Binary
Transportation	
Travel by bicycle	Binary
Travel by bus	Binary
Travel by car	Binary
Travel by motorcycle	Binary
Travel by scooter	Binary
Travel by skateboard	Binary
Travel by walking	Binary
Travel by wheelchair[b]	Binary
Reasons for Visit	
Reason—beauty	Binary
Reason—bicycle ride	Binary
Reason—dog walk	Binary
Reason—educational activities	Binary
Reason—family	Binary
Reason—fishing	Binary
Reason—friends	Binary
Reason—isolation	Binary
Reason—kids	Binary
Reason—nature experience	Binary
Reason—other reason	Binary
Reason—photography	Binary
Reason—picnic	Binary
Reason—proximity to home/work	Binary
Reason—rest	Binary
Reason—romantic dates	Binary
Reason—running	Binary
Reason—walking	Binary
Reason—working[b]	Binary

[a]Variable removed based on multicollinearity (ranked cross correlations of ≥0.8 and/or VIFs ≥ 5.0).
[b]Variable removed due to not enough data.

University (IDC Herzliya) faculty. We also conducted a focus group with residents of Tel Aviv-Yafo to review and refine the survey questions and answer choices. The survey was administered in the Hebrew language and was part of a greater study that examined urban nature site visitation, contribution to quality of life, preferences, and perceptions of ecosystem services. The survey was approved by the Tel Aviv University Institutional Review Board (IRB) on 2 February 2021 (No. 0002670-1) (**Supplementary Material S2**).

Our web-based survey was administered to participants living in Tel Aviv-Yafo from a range of demographic sectors by a local survey panel company, Panel4All (http://www.panel4all.co.il) between 21 March and 5 May 2021. The start of this sampling timeframe took place approximately 1.5 months after the end of the third lockdown in Israel. All survey participants were at least 18 years old and were residents of Tel Aviv-Yafo. Each participant provided informed consent and received a small monetary payment for completing the survey. We determined our participant sample size to be an optimal size of 384 participants, which was based on the Tel Aviv-Yafo population size with a margin of error of 5% and a confidence level of 95% (Bartlett et al., 2001; Rea and Parker, 2005). Our probabilistic sampling effort was limited by funding considerations, but we continued sampling until we achieved more than the optimal size of participants alongside an adequate theoretical saturation of responses.

The survey asked participants to select the urban nature site that they visit most in Tel Aviv-Yafo (i.e., if applicable), and then answer subsequent questions regarding their visitation frequency before and during the COVID-19 pandemic, if they visited alone or with others, transportation method(s), distance from home, length of visit, and reasons for visiting. The survey also included questions about the participants' demographics and their ratings of the urban nature site's contribution to their physical and mental health, accessibility, maintenance of natural and human-made features, and their overall experience. The survey is provided in the English language in the **Supplementary Material S2**.

2.4 Analysis
We prepared the survey data for analysis by translating the responses from Hebrew to English, reviewing the responses for consistency, and removing any surveys that were incomplete and/or had contradictory responses. We

TABLE 3 | Survey variables, including those for distance from home, visit length, health, ratings, and participant demographics.

Variable	Type
Distance from home (km)	Numerical
Length of visit (hours)	Numerical
Health	
Mental health contribution (of urban nature site) during COVID-19 pandemic ("1—never" to "5—always")	Ordinal/Numerical
Physical health contribution (of urban nature site) during COVID-19 pandemic ("1—never" to "5—always")	Ordinal/Numerical
WHO (five) Well-Being Index (World Health Organization, Regional Office for Europe, 1998)	Numerical
Ratings of Urban Nature Sites (scale of "1—bad" to "5—excellent")	
Rating—accessibility	Ordinal/Numerical
Rating—human-made maintenance	Ordinal/Numerical
Rating—nature maintenance	Ordinal/Numerical
Rating—safety	Ordinal/Numerical
Rating—visit	Ordinal/Numerical
Demographics	
Age	Numerical
Civil status (1 = resident, 0 = non-resident)	Binary
Education level	Ordinal/Numerical
Employed during COVID-19 pandemic (1 = employed, 0 = unemployed)	Binary
Gender (1 = male, 0 = female)	Binary
Living situation (1 = with others, 0 = alone)	Binary
Religion/Ethnicity—Christian[a]	Binary
Religion/Ethnicity—Druze[a]	Binary
Religion/Ethnicity—Jewish[a]	Binary
Religion/Ethnicity—Muslim[a]	Binary
Religion/Ethnicity—Other[a]	Binary

[a]Variable removed due to not enough data.

calculated descriptive statistics for the participants' demographics, transportation methods, with whom they visited, visit length, reasons for visiting, distance from home, and their ratings. The survey variables are provided in **Tables 2** and **3**. We performed data analyses in R statistical software (R Core Team, 2021) and examined Cronbach's α coefficients to measure the internal consistency evaluate the reliability of the constructs for the Likert scale questions (Cronbach, 1951) using the psych package (Revelle, 2021).

We developed a multiple linear regression model for the change in visitation frequency using the MASS package (Venables and Ripley, 2002). We estimated the visitation frequency per year for each participant by recalculating their self-reported number of visits in the survey in terms of number of visits per year (e.g., 1 visit/week = 52 visits/year). We created a visitation frequency change index to measure the relative change in urban nature site visitation before and during the COVID-19 pandemic as a simple ratio, which we calculated to take on values between −1.0 and 1.0:

$$\text{Visitation change index} = \frac{(\text{Frequency during COVID19} - \text{Frequency before COVID19})}{(\text{Frequency during COVID19} + \text{Frequency before COVID19})}$$

During the process of building the multiple linear regression model with the visitation change index as the dependent variable, we examined variable multicollinearity by creating a ranked cross-correlation matrix of the independent variables using the lares package (Lares, 2021) and computed a Variance Inflation Factor (VIF) for each independent variable using the car package (Fox and

Weisberg, 2019). The model began with 80 independent variables, which also included the dummy variables for the categorical variables (**Supplementary Material S1**). To reduce multicollinearity, we examined the ranked cross correlations of ≥0.8 and VIFs ≥5.0 to guide our sequential elimination of variables. We removed the variables with the highest VIFs one at time, and recalculated VIFs in the model with the remaining variables until all VIFs were <5.0. We removed some variables due to a lack of sufficient data, which are noted in **Tables 2** and **3**. In the next steps of the model development, we used 61 independent variables.

We met the normality assumption for the model by evaluating residual plots and q-q plots with the ggplot2 package (Wickham, 2016), and also with the Kolmogorov-Smirnov ($p = 0.789$) and Shapiro-Wilk ($p = 0.102$) tests for normality using the olssr package (Hebbali, 2020). We identified and removed outliers that had a least a Cook's distance of 3 times the mean, and the dependent variable did not require a transformation to achieve normality of the residuals. We then performed stepwise multiple linear regression for the model with the stepAIC() function (i.e., direction = "both") using the MASS package (Venables and Ripley, 2002). At each step of the stepwise multiple linear regression, independent variables were selected by adding or removing them in succession and testing them based on p-values and their ability to reduce the Akaike information criterion (AIC) values (Akaike, 1974). After we developed the final stepwise linear multiple regression model, we standardized the regression coefficients along the same scale using the lm.beta package (Behrendt, 2014).

TABLE 4 | Demographics for participant visitors, participant non-visitors, all participants, and the Tel-Aviv Region population.

Demographic	Visitors	Non-visitors	All participants	Tel aviv region[a]
Age	42 (mean) 38 (median) 18–84 (range)	46 (mean) 44 (median) 21–91 (range)	42 (mean) 38 (median) 18–91 (range)	34 (median)
Gender	57% Female 43% Male	49% Female 51% Male	56% Female 44% Male	51% Female 49% Male
Education	2% < High school completion 23% High school 12% Partial college 35% Bachelor's degree 25% Master's degree 3% PhD	0% < High school completion 27% High school 11% Partial college 46% Bachelor's degree 16% Master's degree 0% PhD	2% < High school completion 24% High school 12% Partial college 36% Bachelor's degree 24% Master's degree 2% PhD	12% < High school completion[b] 26% High school[b] 23% Bachelor's degree[b] 14% Second academic degree or higher[b]
Religion/Ethnicity	0.24% Christian 0.48% Druze 98.8% Jewish 0.24% Muslim 0.48% Other	0.0% Christian 0.0% Druze 100% Jewish 0.0% Muslim 0.0% Other	0.22% Christian 0.44% Druze 98.9% Jewish 0.22% Muslim 0.44% Other	0.7% Christian 0.0% Druze 93.7% Jewish 1.0% Muslim 4.5% Other
WHO (five) Well-Being Index (World Health Organization, Regional Office for Europe, 1998)	58 (mean) 60 (median) 0–100 (range)	56 (mean) 60 (median) 0–100 (range)	58 (mean) 60 (median) 0–100 (range)	N/A
Employment before COVID-19 pandemic	69% Full-time 15% Part-time 3% Unemployed 6% Retired 2% Soldier 5% Student	59% Full-time 11% Part-time 8% Unemployed 14% Retired 5% Soldier 3% Student	68% Full-time 15% Part-time 3% Unemployed 6% Retired 2% Soldier 5% Student	69% In civilian labor force[b] 31% Not in civilian labor force[b]
Employment during COVID-19 pandemic	52% Full-time 21% Part-time 16% Unemployed 6% Retired 1% Soldier 4% Student	54% Full-time 11% Part-time 16% Unemployed 14% Retired 5% Soldier 0% Student	52% Full-time 20% Part-time 16% Unemployed 7% Retired 2% Soldier 4% Student	N/A
Total	421 (92%)	37 (8%)	458	392,4682 (in 2008)

[a]Data from the 2008 Census of Population (The State of Israel Central Bureau of Statistics, 2009).
[b]Percentage includes individuals at least 15 years old.

3 RESULTS

In the following subsections, we provide information on survey participant demographics, a summary of the urban nature site visitation survey responses, and the results of our multiple linear regression analysis.

3.1 Participant Demographics

A total of 472 participants completed our web-based survey for urban nature site visitation (average completion time of 10 min), of which 14 were removed from the analysis based on incomplete and/or contradictory responses. The demographics of our 458 remaining participants, including both visitors and non-visitors in comparison to residents in the Tel Aviv-Yafo region, are provided in **Table 4**. The average age of the participants was 42 years old (range of 18–91 years old) and the group included 56% females and 44% males. Of the participants who were at least 27 years old (i.e., the average graduation age for a bachelor's degree in Israel), 64% had at least a bachelor's degree. The combined percentage of full-time and part-

time employment was slightly higher for visitors than non-visitors before the COVID-19 pandemic, but unemployment increased for both groups during the pandemic. The self-reported WHO (five) Well-Being Index (World Health Organization - Regional Office for Europe, 1998) for visitors and non-visitors was approximately the same.

Overall, the demographics of the participants were relatively comparable to the Tel Aviv region (The State of Israel Central Bureau of Statistics, 2009), except for a slightly higher age (i.e., our study only included participants aged 18 or older), slightly more female and less male participants, a greater percentage of participants with at least a bachelor's degree or higher, a slightly lower percentage of underrepresented religious/ethnic groups, and a greater percentage of employed participants. It is important to note that the last completed census for the Tel Aviv Region was in 2008 and our study was conducted in 2021. In addition, some of the census variables included data for individuals 15 years old and older, whereas all of our study participants were at least 18 years old.
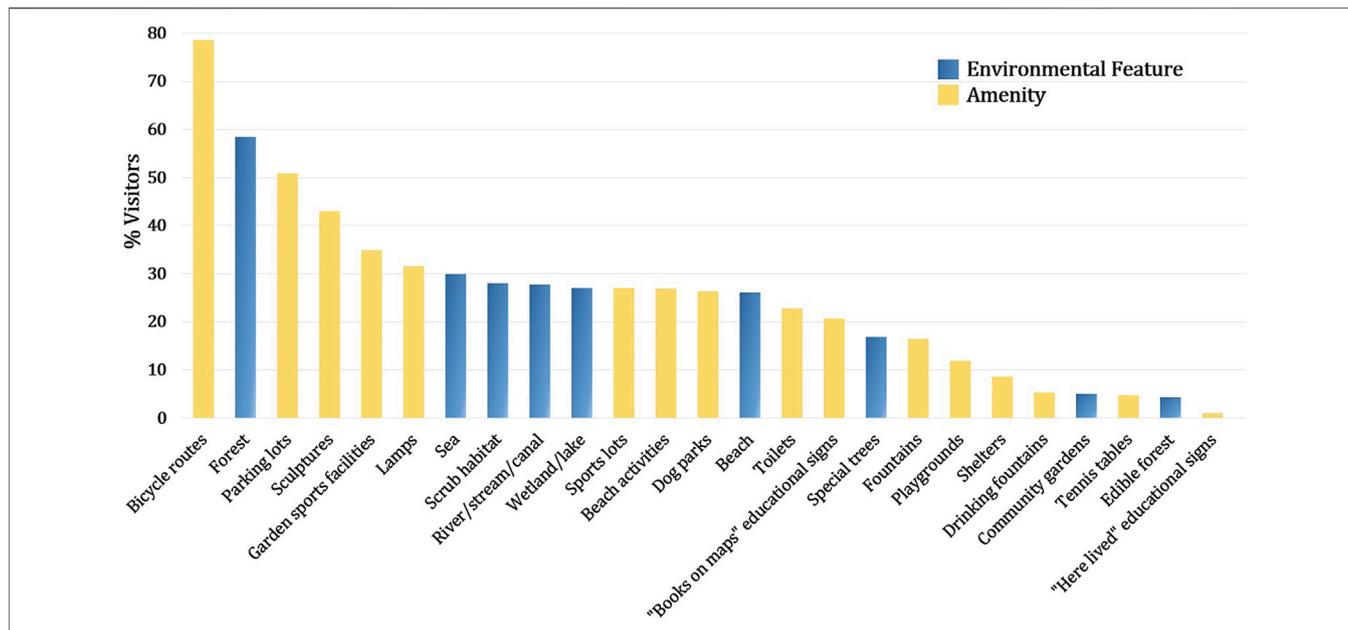
FIGURE 3 | Environmental features and amenities of urban nature sites by percentage of visitors.
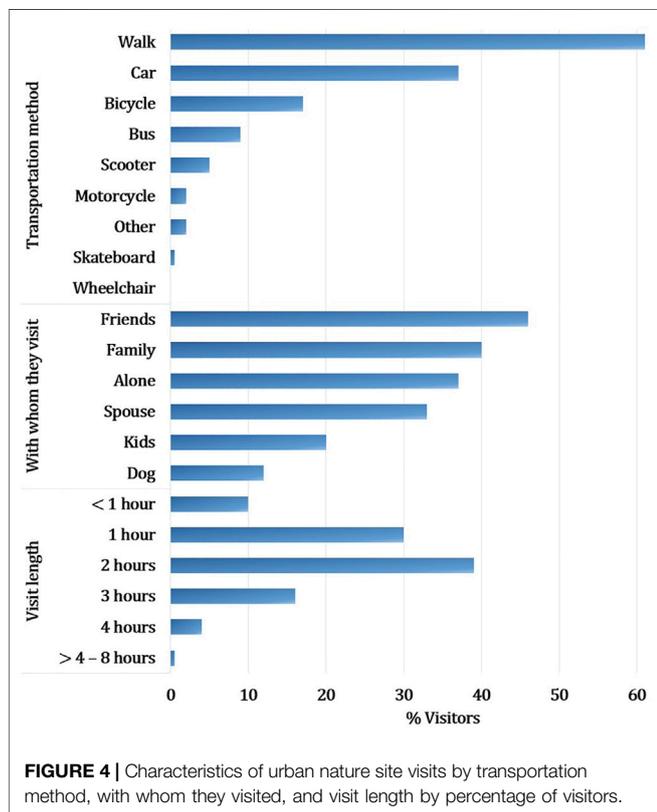

FIGURE 4 | Characteristics of urban nature site visits by transportation method, with whom they visited, and visit length by percentage of visitors.

3.2 Survey Results

The urban nature site visitation survey revealed that 421 participants (57% female, 43% male) visited urban nature sites in Tel-Aviv Yafo at least once before or during the COVID-19 pandemic, while 37

participants were non-visitors (49% female, 51% male) (**Table 4**). The average age of the urban nature site visitors was slightly lower than non-visitors. Of the 64 urban nature sites in Tel Aviv-Yafo, 50 urban nature sites (78%) were selected by participants as the ones that they visited most often. **Figure 3** shows the environmental variables and amenities of the urban nature sites that were most often visited by the survey participants.

We compared visitation frequency of urban nature sites before and during the COVID-19 pandemic, and found that 53% of the surveyed visitors decreased visitation, 26% increased visitation, and 21% had no change. Only 1.7% of the participants were first-time visitors of urban nature sites during the pandemic. The average number of urban nature site visits before the pandemic was 81 visits per year, while the average was 66 visits per year during the pandemic. There was a positive Spearman's rank correlation between visitation frequency before and during the pandemic, r (419) = 0.425, $p < 0.001$. **Figure 1** shows the average visitation change index for our participants according to urban nature site.

The visitors provided information about their visits, such as their transportation method, if they visited alone and/or with others, and their visit length (**Figure 4**). The most common ways of visiting the urban nature sites were with friends, family, or alone, and 48% of visitors selected two or more options. The average visit was approximately 1.8 h, with a median of 2 h. In regards to transportation, 76% of visitors had one preferred method of transportation to the urban nature sites, while 24% selected two or more ways. The most popular modes of transportation were walking (61%) and traveling by car (37%). The results indicated that when an urban nature site was 5 km or less from home, 70% of visitors selected walking; however, when an urban nature site was more than 5 km from home, 78% of visitors used car transportation. The urban nature sites were
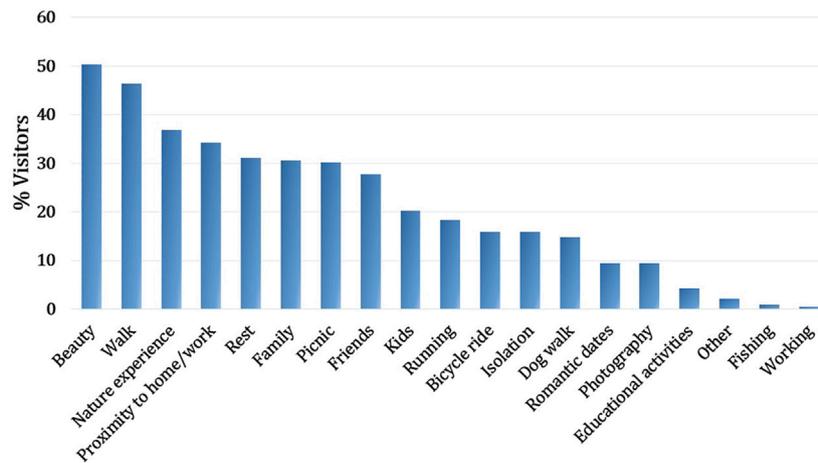
FIGURE 5 | Reasons for visiting the urban nature sites by percentage of visitors.

TABLE 5 | Multiple linear regression model results for the visitation frequency relative change index.

Variables	Beta coefficients
Length of visit (hours)	−0.12*
Environmental Features	
Edible forest	−0.09
Forest habitat	−0.08
Scrub habitat	−0.12*
Wetland/lake	−0.11*
Amenities	
Tennis tables	−0.08
With Whom They Visit	
Visit alone	−0.17***
Visit with kids	−0.12**
Visit with spouse	0.14**
Transportation	
Travel by bicycle	−0.08
Travel by car	−0.30***
Reasons for Visit	
Reason—bicycle ride	0.08
Reason—friends	−0.06
Reason—proximity to home/work	0.07
Reason—romantic dates	−0.11**
Reason—walking	0.07
Health	
Mental health contribution of urban nature site (during COVID-19)	0.15*
Physical health contribution of urban nature site (during COVID-19)	0.16*
Ratings of Urban Nature Sites	
Rating—accessibility	0.13**
Rating—nature maintenance	0.10*
Rating—visit overall	−0.26***
Demographics	
Age	−0.20***
Education level	−0.10*
Gender	0.06
R^2	0.44
R^2 (adjusted)	0.40
Residual standard error: 0.45 on 335 degrees of freedom	
F-Statistic: 11 on 24 and 335 DF, $p < 2.2e-16$	

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

located an average of 2.9 km from participants' homes with a range of 0–15 km.

When asked about their reasons for visiting the urban nature sites, the most common responses were to enjoy the beauty, go for a walk, and have a nature experience (**Figure 5**). Approximately 34% of visitors indicated that they visited because the urban nature site was in close proximity to their home and/or work and 81% percent of visitors had two or more reasons for visiting. The visitors also provided their ratings of the accessibility, safety, maintenance of human-made features, nature maintenance, and their overall visit to the urban nature sites (e.g., as "excellent", "good", "fair", "bad", "very bad"). The median ranking for each of these categories was "good", with the exception of "human-made structures," which received a median answer of "fair". In terms of the reliability, the Cronbach's α for the independent variables constructed from the Likert scales were all above the threshold of 0.7, which is considered to be reliable.

3.3 Multiple Linear Regression Model Results

The results of the stepwise multiple linear regression model for the visitation change index with the statistically significant variables is shown in **Table 5**. Each of the 24 variables selected for the final model contributed to the model's predictive ability and helped to improve performance by reducing the Akaike Information Criterion (AIC) values. The results of the final regression equation explained 44% of the variance and the model was a significant predictor of visit frequency change index, F (24, 335) = 11, $p < 0.001$.

The model showed that the visitation change index was positively associated with the higher ratings of the physical and mental health contribution of the urban nature site during the COVID-19 pandemic, higher accessibility and nature maintenance ratings, and visiting with a spouse. The model was negatively associated with length of visit (hours), scrub and wetland/lake habitats, visiting alone or with kids, traveling by car, visiting for the purpose of romantic dates, overall visit rating, age, and education level. In other

words, the participants who had a relative increase in urban nature visitation during the COVID-19 pandemic tended to prefer shorter duration visits with a spouse that did not require car transportation. These participants tended to be younger and visited urban nature sites that they felt were highly accessible, had good nature maintenance, and contributed to their mental and physical health more than for their specific environmental features or amenities.

4 DISCUSSION

Our study examined a range of social and environmental factors associated with the frequency of urban nature site visitation during the COVID-19 pandemic. We found that urban nature site visitation decreased for the majority of our participants during the pandemic, which is consistent with some studies (Xie et al., 2020; Curtis et al., 2021; Larson et al., 2021), but contrary to other research that showed a relative increase in visitation frequency during the pandemic (Derks et al., 2020; Grima et al., 2020). We also found that only 1.7% of our participants were first-time visitors to urban nature sites, which was far lower than another study that showed that 45% of previous non-users of urban green space were first-time users during the pandemic restrictions period (Berdejo-Espinola et al., 2021). These differences may be related to the types and intensity of pandemic-related restrictions (Geng et al., 2021) or due to the accessibility of urban nature sites in Tel Aviv-Yafo compared to other cities or regions.

Consistent with our predictions, the participants in our study who had a relative increase in urban nature site visitation during the pandemic reported that urban nature sites had high contributions to their mental and physical health. This result is similar to the results of other studies that characterized urban nature as some of the most valuable places for the promotion of human physical and mental health during the pandemic (Heo et al., 2020; Shoari et al., 2020; Geng et al., 2021; O'Brien and Forster, 2021; Robinson et al., 2021). Our participants who visited urban nature sites relatively more often during the pandemic also gave higher ratings for accessibility and nature maintenance, which were previously shown to play important roles in urban nature visitation (Talal et al., 2021; Talal and Santelmann, 2021). In line with our predictions, participants in our study tended to not use car transportation; however, they also preferred shorter duration visits to urban nature sites in closer proximity to home or work, which are likely related to accessibility and a desire to follow pandemic-related restrictions. Surprisingly, the participants' ratings of accessibility and the mental and physical health benefits of the sites were more positively associated with visitation frequency than ratings for overall experience, which implies that even shorter duration visits to accessible urban nature sites still had health benefits for participants even if they may have preferred a better overall experience.

We predicted that a higher visitation frequency would be associated with socializing with others outside of their household in an outdoor setting, but found that participants who visited urban nature sites relatively more often during the COVID-19 pandemic tended to visit with a spouse rather than with friends, children, alone, or for romantic dates. This result may be related to visitors obtaining some of the health benefits of urban nature with a domestic partner while also reducing the risk of COVID-19 exposure and following pandemic-related restrictions. In addition, our results indicated that visitation frequency was not positively associated with amenities such as tennis tables or sports facilities even though these are designed to promote physical activity. The low appeal of these amenities during the pandemic may have been because they were perceived as posing unnecessary health risks related to socializing with others in their communities. Previous studies also reported that urban nature visitors during the pandemic prioritized a sense of community lower than the personal physical and psychological benefits of urban nature (Berdejo-Espinola et al., 2021), and that motivations for visiting urban nature during the pandemic may have shifted away from "high risk" activities such as socializing with others (Ugolini et al., 2020).

We anticipated that environmental features would be more associated with a relative increase in urban nature visitation than amenities during the COVID-19 pandemic, but the results of our study did not show many clear environmental preferences. We found that urban nature visitation was negatively associated with scrub and wetland/lake habitats, but there were no significant positive associations with other environmental characteristics. There is extensive previous research that describes how humans have strong preferences for both urban green and urban blue spaces (Kaplan and Kaplan, 1989; Grellier et al., 2017; Häggström, 2019; Smith et al., 2021; Talal et al., 2021); however, perhaps in the context of the pandemic, it is likely that numerous social factors and motivations had stronger associations and influence on urban nature site visitation. It is also possible that urban nature site visitors had an increased level of flexibility during the pandemic in terms of visiting a wider variety of urban nature sites regardless of their specific environmental features or human-made amenities, provided that they were adequately accessible and had the potential to deliver mental and physical health benefits.

Our results indicated some patterns in the demographics of participants who visited urban nature sites. We found that higher urban nature visitation during the pandemic was negatively correlated with age and higher levels of education. Our finding related to age is comparable to other studies that showed less frequent urban nature visitation during the pandemic among older adults (Berdejo-Espinola et al., 2021; Curtis et al., 2021; Rice and Pan, 2021), but different from research that found that older adults were one of the demographic groups more likely to use urban nature during the pandemic (Uchiyama and Kohsaka, 2020; Yamazaki et al., 2021). A decrease in urban nature visitation by older adults during the pandemic may have been related to an awareness of their increased risk of COVID-19 transmission and its serious health implications in comparison to younger populations (Curtis et al., 2021). In addition, some older adults may have been more likely than younger individuals to follow social distancing recommendations and stay-at-home orders (O'Brien and Forster, 2021; Rice and Pan, 2021); however, this may have also resulted in them being disproportionately vulnerable to social isolation during the pandemic, as well as intensified the on-going inequitable access to urban nature for older residents (Onose et al., 2020).

4.1 Limitations and Future Research

Our study elucidated many of the social and environmental factors associated with the relative change in urban nature visitation during the COVID-19 pandemic, but there also were some potential limitations. The web-based survey was conducted during a particular window of time of the pandemic, thereby limiting a deeper understanding of changes in urban nature site visitation between various lockdown periods in Tel Aviv Yafo. In addition, the web-based format of the survey was only accessible to individuals who had internet access and the survey panel company only involved individuals who were fluent in the Hebrew language. We did not have any participants who used a wheelchair, and so future studies should aim to include participants with a broader range of physical and mental health conditions.

In our survey, we asked participants about the urban nature site that they visited the most in order to be able to correlate them with specific variables of that particular site and also so that participants would be able to complete the survey within an available timeframe; however, it is likely that participants visited a variety of urban nature sites before and during the COVID-19 pandemic. Future studies would benefit from a Public Participation GIS (PPGIS) approach (Korpilo et al., 2021) or a combined qualitative-participatory GIS approach (Hand et al., 2017), in which participants would be able to mark multiple urban nature sites and provide more in-depth information about their experiences and the characteristics of their visits. Our initial data collection plan was to also conduct an on-site survey of visitors to the urban nature sites, as these can often reveal more authentic, in-depth responses not available in an off-site context (Qiu et al., 2013), but this was not possible due COVID-19 transmission concerns.

Our study was specifically about public lands designated as urban nature sites in Tel Aviv-Yafo, but it did not include all types of urban nature in the city such as private gardens, green boulevards, urban parks, bioswales, and street trees. Additional studies across different types of urban nature and visitor activities will be helpful in discerning potential similarities or differences in use and accessibility (Ugolini et al., 2020; Dawwas and Dyson, 2021). We also acknowledge that there may be additional variables that might have not been captured in the stepwise multiple regression analysis. Future studies would benefit from an on-site survey of urban nature visitors and also be conducted in a range of languages and in a variety of types of urban nature and climates. In this manner, future research would improve our understanding of the many social and environmental factors that influence urban nature visitation during the pandemic and potential future crises.

4.2 Conclusions

Our research suggests that urban nature sites are crucial places for the promotion of human health and well-being during the COVID-19 pandemic. Visitation to urban nature sites generally decreased for most of our participants, but individuals who had a relative increase in visitation reported that the physical and mental health benefits, nature maintenance, and accessibility were key factors. We found that these participants tended to be younger in age and preferred shorter duration visits that did not require car transportation. In addition, they tended to visit urban nature sites with a spouse rather than with kids, alone, or for romantic dates. In many aspects, social factors and accessibility appeared to have greater associations with a relative increase in urban nature site visitation during the pandemic than the particular environmental features or amenities of the urban nature sites. Even so, based on the positive physical and mental health benefits of urban nature, it is imperative to continue supporting the creation, maintenance, and monitoring of urban nature sites during and after the pandemic for both people and the environment.

Given the continued threats of the pandemic and other environmental crises, we recommend that urban nature sites be made more accessible in terms of their proximity, amenities, and safety and security for people of all ages, mental and physical health conditions, and sociodemographic backgrounds (Rigolon, 2016; Smiley et al., 2016; Talal and Santelmann, 2020; De Haas et al., 2021). Based on the current map of urban nature sites in Tel Aviv-Yafo (**Figure 1**), there appears to be an inequitable distribution favoring the northern part of the city, which is known to have higher-income neighborhoods that are less socio-demographically diverse than neighborhoods in the southern portion of the city. The inequitable distribution of urban nature may not only minimize urban residents' fair access to the many mental and physical health benefits of urban green and blue spaces, but it may also expose underserved populations to a range of environmental hazards such as the urban heat island effect, flooding, water and air pollution, and other environmental injustices (Agyeman et al., 2016; Meerow and Newell, 2017; Ibsen et al., 2021).

Planners, policymakers, and managers should seek to involve a diverse range of stakeholders and partners (Guenat et al., 2021) and use participatory methods to engage local communities (Floyd, 2014; Malanson et al., 2021) and improve the accessibility and maintenance of urban nature sites for people of all sociodemographic backgrounds, particularly in underserved neighborhoods. In addition, Tel Aviv-Yafo and other cities should seek to implement improved funding mechanisms to better maintain, restore, and protect urban nature from future infrastructure development. Throughout the COVID-19 pandemic and potential future health and environmental crises, urban nature will continue to play an extensive role in promoting human health and well-being, as well as mitigating the increasing pressures of climate change, intensive land use, human population growth, and threats to biodiversity within our cities.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Tel Aviv University Institutional Review Board (IRB) on February 2, 2021 (No. 0002670-1). The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MT and MG contributed to the conception and design of the study. MT organized and analyzed the data, performed the data analysis, and wrote the manuscript. MG provided guidance and review for the data analysis and manuscript revisions. Both MT and MG approved the submitted version.

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SUPPLEMENTARY MATERIAL

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