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Research Paper

Exploring how urban nature is associated with human wellbeing in a neotropical city

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HIGHLIGHTS

- Exposure to nature in green/blue spaces is associated with human wellbeing in Guyana.
- Visit patterns were associated with nature-relatedness, age, and safety concerns.
- Visits lasting >25 min are associated with improved positive experiential wellbeing.
- There was no association between visit patterns and four other wellbeing metrics.

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ABSTRACT

Human population growth and urbanisation are putting pressure on urban green and blue spaces worldwide. These spaces provide habitat for biodiversity and, as evidence from the Global North shows, can provide health and wellbeing benefits to urban dwellers. Nonetheless, there is a paucity of evidence regarding the wellbeing benefits associated with urban green and blue spaces from the Global South, where the fastest rates of population growth and urban expansion are occurring. Here, we examine green and blue spaces in Georgetown, Guyana, exploring whether frequency and duration of use is (1) associated with nature-relatedness, safety concerns, and sociodemographic characteristics, (2) associated with specific visit motivations (e.g. physical, cognitive, social), and (3) associated with wellbeing (positive and negative experiential, evaluative, eudaimonic, and mental wellbeing). Participants (n = 512) were more likely to visit green and blue spaces if they had higher nature-relatedness, no safety concerns, aged <35 years, and educated above secondary level. Visit frequency was not related to wellbeing. Visit duration did not differentiate according to visit motivations. Visits to green and blue spaces of more than 25 min were associated with increased positive experiential wellbeing. No comparable patterns were found for the other wellbeing dimensions. These findings can inform public health campaigns targeted at specific sociodemographic groups. Moreover, decision-makers could minimise health inequalities by incorporating new green and blue spaces into future development plans (including the provision of backyards), and enhancing existing spaces (e.g. reducing people's safety concerns). These measures will help maximise wellbeing across all sectors of society.

1. Introduction

By 2050, the human population living in cities is expected to reach 5.6 billion people globally (United Nations, 2018). Less-developed regions in the Global South are expected to account for 87% of this total urban population (United Nations, 2018), with the concomitant expansion of urban landcover projected to grow by 585% between 2000 and 2050 (Angel et al., 2011). As a result, there are increased pressures on the persistence and quality of urban green and blue spaces, such as parks, riversides, and backyards (Pauchard et al., 2006; Richards et al.,

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2017), which provide habitat for biodiversity (Baldock et al., 2015; Ives et al., 2016). Simultaneously, there is recognition across the Global North that green and blue spaces also provide benefits for human health and wellbeing (World Health Organization, 2016), although scant evidence exists from the Global South (Nawrath et al., 2021; Rigolon et al., 2018). The provision of '*universal access to safe, inclusive, and accessible green and public spaces*' is now explicitly recognised in Sustainable Development Goal 11 (United Nations, 2016). As such, there is a need to understand the role urban green and blue spaces play in underpinning human wellbeing in the Global South, to inform sustainable land-use planning interventions that help tackle ecological and public health demands in the face of global environmental change.

Currently, cities in the Global South are characterised by high levels of inequality and unequal provision of public green and blue space (UN-Habitat, 2016). Understanding how patterns of use vary amongst different sociodemographic groups can provide insight into where these inequalities lie. For example, in Sweden, Ode Sang et al. (2016) showed women were more active in urban green spaces, and older people participated in more nature-related activities. In contrast, a UK-wide survey showed infrequent users of green spaces were more likely to be women, and older individuals (Boyd et al., 2018). Moreover, understanding why people visit green and blue spaces can highlight locally specific nuances. For instance, when examining motivations for visiting green space in Colombia, users report seeking shade from the tropical sun (Ordóñez-Barona & Duinker, 2014), while in the USA, users simply mention they are motivated by the close proximity of the green space (Sonti et al., 2020). Capturing the sociodemographic characteristics of green and blue space users (and non-users), as well as their visit motivations, can subsequently be used to target interventions that overcome barriers to use and encourage visitation (Dallimer et al., 2014; Irvine et al., 2013).

Understanding the frequency of use or duration of time that people need to spend visiting urban green and blue spaces to make quantifiable wellbeing gains is important for informing policy recommendations. Several dimensions of human wellbeing have been outlined: positive and negative experiential (emotions of pleasure and pain), evaluative (assessment of life as a whole), and eudaimonic (purpose and meaning in life) (Stiglitz et al., 2010). In the UK, increased visit frequency to natural environments relates to higher eudaimonic and positive experiential wellbeing (White et al., 2017), and spending at least 120 cumulative minutes of time across seven days in nature relates to improved evaluative wellbeing (White et al., 2019). Scales with clinical relevance have also been used in a dose–response context. For instance, in Hong Kong, Garrett et al. (2019) suggest that visiting blue spaces for recreation relates to a statistically lower risk of depression. Taken together, gauging the frequency and duration of use alongside clinically relevant measures of wellbeing can help structure and maximise the efficacy of public health recommendations.

People's visit patterns and motivations may be dependent on geographical location, cultural relevance, or other factors that dictate how people derive wellbeing benefits from visiting green and blue spaces (Bell et al., 2019). These could include where people have grown up (Engemann et al., 2019), their perception of safety (Weimann et al., 2017), or how connected they are with nature (Shanahan et al., 2016). Measures of nature-relatedness, for example, have correlated with improved wellbeing (Nisbet et al., 2011), and reduced anxiety (Martyn & Brymer, 2014), as well as positive attitude toward the environment, engagement with sustainable practices (Nisbet et al., 2009), and more visitation to green space (Lin et al., 2014). As such, considering these factors in the study of urban green and blue space use for human wellbeing will help capture the variation of experiences and help target any recommendations that arise (Ives et al., 2017).

The aim of this study was to explore the associations between urban green and blue space and human wellbeing in a city in South America, a continent forecast to undergo the fastest rate of urban expansion into biodiversity-rich regions (Güneralp & Seto, 2013). Guyana is set to become the fastest growing economy in South America, after the discovery of large oil deposits (Panelli, 2019). Simultaneously, the country has the highest estimated global suicide rate, with psychological health disorders linked to significant societal stigmas and a mental health support system that remains in its infancy (Arora & Persaud, 2019; World Health Organization, 2014). Therefore, this is a timely opportunity to highlight how sustainable land-use planning interventions, incorporated into new development plans for Georgetown, could positively contribute to both public health and conservation.

We examine how Georgetown's green and blue spaces are associated with the wellbeing of its residents through three main research questions: (1) Are nature-relatedness, safety concerns, or sociodemographic characteristics associated with visit frequency and visit duration? (2) Are visit frequency and visit duration associated with specific motivations for visiting green and blue spaces? (3) Are visit frequency and visit duration associated with human wellbeing? To the best of our knowledge, this is the first study from a developing city in the Global South to explore what motivates people to visit urban green and blue spaces, and whether an association exists between five dimensions of human wellbeing (positive and negative experiential, evaluative, eudaimonic, and mental wellbeing) and patterns of use.

2. Methods

2.1. Study system

Guyana is characterised by the fact that over 85% of its landcover remains tropical forest (Bicknell et al., 2017). Georgetown (Fig. 1), has a human population of ~119,000 spread across 63 wards (neighbourhoods) (Bureau of Statistics, 2012). There are public outdoor spaces

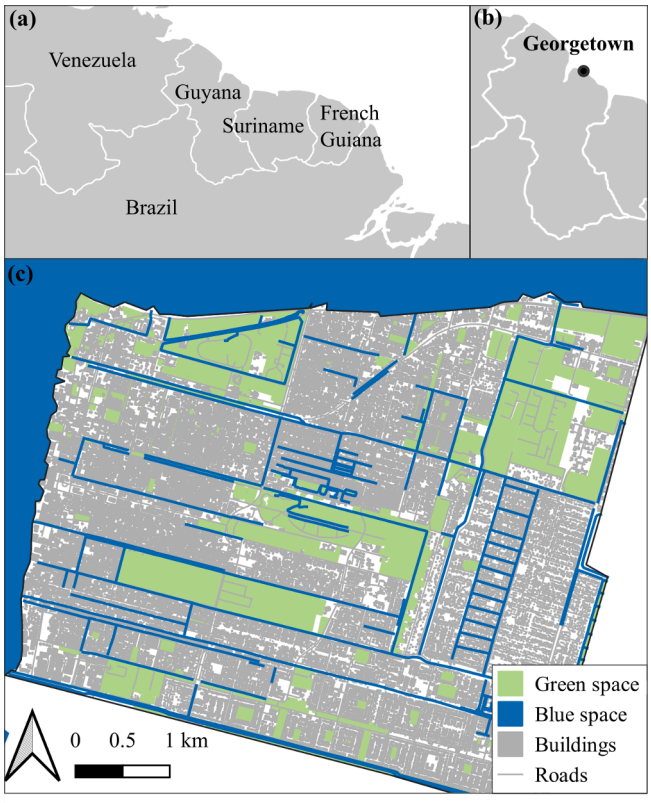

Fig. 1. (a) Location of Guyana in northern South America, (b) location of Georgetown, capital of Guyana, and the distribution of (c) green spaces (green), blue spaces (dark blue), and impervious surfaces (i.e. buildings, roads) (grey) across the city. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

distributed across the city, with green spaces including three main public parks (the National Park, Botanical Gardens, Promenade Gardens), several small neighbourhood parks, and backyards linked to residential properties. Indeed, many properties have a private backyard. Blue spaces constitute a dense network of tree-lined waterways and a sea wall (~6.5 km long) that protects Georgetown from flooding.

2.2. Questionnaire

A short questionnaire was conducted face-to-face, during daylight hours (9am to 6 pm), in May-June 2017. This questionnaire collected information about participant wellbeing, nature-relatedness, visit patterns to green and blue space, concerns for personal safety, and sociodemographics (detailed below). The questionnaires were delivered in public locations, such as markets and malls, frequented by a wide range of socioeconomic groups. Participant numbers were monitored throughout the data collection period to ensure that the sample from each ward in Georgetown broadly matched the proportions from the most recent census (Bureau of Statistics, 2012) (Appendix A: Supplementary Material Table S1). Every third passer-by was approached, and first asked if they lived in Georgetown and were at least 18 years old. If the response was affirmative, participants were invited to take part in a survey on what Georgetown residents thought about outdoor spaces in town. No monetary or other incentive was offered to secure participation. Individuals that declined to participate were recorded as non-respondents. The questionnaire was cognitively tested and piloted to ensure that it was understandable by all sectors of the population. Show cards were used throughout the questionnaire, following best practice for collecting wellbeing data (OECD, 2013), allowing participants to consider and select answers. The study was approved by the University of Kent Faculty of Social Sciences Research Ethics Advisory Group for Human Participants (Ref. No. 0511617).

Participants were asked to identify how happy they felt yesterday (positive experiential, 'happiness') and how anxious they felt yesterday (negative experiential, 'anxiety'), how satisfied they feel about their life in general (evaluative, 'life satisfaction'), and the extent to which they feel the things they do in their life are worthwhile (eudaimonic, 'worthwhileness') (Supplementary Material text Section S1). While the first two questions focus on 'yesterday' specifically, which may not be a typical day for a participant, these measures are generally found to reliably reflect happiness and anxiety across the entire year (Graham et al., 2018). All responses were given on a continuous 11-point scale from 0 (*Not at all*) to 10 (*Completely*) (ONS, 2016).

We also used the World Health Organisation WHO-5 scale (WHO, 1998) to capture and assess mental wellbeing. This scale can also be translated as a screening tool for depression (Topp et al., 2015). For each of five statements, participants indicated how they have felt over the past seven days on a six-point scale (1 = *At no time*, 2 = *Some of the time, 3 = Less than half the time, 4 = More than half the time, 5 = Most of the time, 6 = All of the time*) (Supplementary Material text Section S1). One of the statements used the word '*vigorous*', which caused confusion during testing and was replaced by '*energetic*'. The reference time frame was shortened from '*two weeks*' to '*the last seven days*' to reduce recall bias and align with data collected on green space use (see below). Scores for each statement were totalled to generate a raw overall score, ranging from five to 25, and multiplied by four to create a percentage. We calculated Cronbach's alpha to verify that the scale was internally consistent ($\alpha = 0.78$).

We used the six-item Nature-relatedness (NR6) scale (Nisbet & Zelenski, 2013) to measure connectedness with the natural world (Supplementary Material text Section S2). For each of six statements, participants gave an answer from one to five (1 = *Strongly disagree*, 2 = *Disagree a little, 3 = Neither agree nor disagree*, 4 = *Agree a little*, 5 = *Strongly agree*). All statement scores were averaged to create a continuous score ranging from one to five. NR6 was internally consistent ($\alpha = 0.77$).

We asked participants '*Which public spaces, if any, did you purposefully visit or spend time in over the last seven days?*', with examples provided (e.g. *city parks, sea wall, waterways, recreational spaces, or your own backyard*). We included private backyards to capture the total time spent visiting urban green spaces in the past seven days, given their positive contribution to human wellbeing in the Global North (de Bell et al., 2020; Young et al., 2020). The reference time frame of '*the last seven days*' was chosen to reduce recall bias and align with data collected on wellbeing (see above). For each space reported, we collected a categorical measure of visit frequency during the week (*Once, 2 – 3 visits, 4 – 6 visits, 7 or more visits*), and we asked '*What was the main reason for visiting*' (open question) and the average duration of time spent there (minutes). From this, we calculated weekly patterns of visit frequency (when the participant had visited ≥ 2 spaces, we summed the midpoint of visit frequency for each space, then re-categorised visit frequency for the total week), captured participant's visit motivation, and estimated visit duration in minutes (midpoint of the visit frequency category multiplied by the average time spent visiting summed for the seven days). We collected the same information for any visits to '*the outdoors, or the bush*' outside of Georgetown, during the same week. As such, our findings relate to the visit patterns participants exhibited across the past seven days, which is more accurate than asking participants to recall a random visit.

Participants were asked whether they were concerned about their personal safety in any of Georgetown's green or blue spaces (*yes* or *no*). Sociodemographic questions, comparable to the Guyana census (Bureau of Statistics 2012), and information about household income were included in the final section of the questionnaire. Participants were also asked where, if anywhere, they had lived prior to Georgetown. Two categories of 'residential history' were then derived from these data: (1) Georgetown only (entire life spent in Georgetown), or (2) other (time spent living in rural Guyana, or living abroad).

2.3. Data analyses

All statistical analyses were performed using R version 3.5.0 (R Core Team, 2019). We first used a G-test to assess whether the sociodemographic background of our sampled participants (age, gender, education, ethnicity, religion) was representative of Georgetown's wider population. Ethnicity and religion both contained many missing values so were not included in further analyses. We checked for associations between nature-relatedness, safety concerns, and sociodemographic characteristics (age, gender, education, household income, residential history) prior to modelling to reduce inflated variance, using chi-squared tests for categorical variables. We removed household income as it was strongly associated with education, and had many missing values. We retained nature-relatedness, safety concern (yes or no), and dichotomous measures of age (18–35 years old or 35+ years old), education (low, defined as up to secondary, or high, post-secondary and above), gender (male or female), and residential history (Georgetown only, or other). Dichotomous measures were used to preserve statistical power given our sample size, reducing the degrees of freedom needed in the modelling processes. We constructed a multinomial logistic regression and hurdle model to investigate research question 1, conducted a qualitative analysis followed by quantitative statistics for research question 2, and used ordinal logistic regression and a generalised linear model for research question 3. For all analyses, we used the natural logarithm + 1 for visit duration (minutes rounded to the nearest whole number to reduce estimation errors) to normalise the residuals in the models, but we present the findings using the untransformed data to aid their interpretation.

To examine whether nature-relatedness, safety concerns, or any particular sociodemographic background characterised visit frequency to green and blue spaces within Georgetown, we used a multinomial logistic regression model. For visit duration (mins), a high proportion of the data contained zeros (non-users; 43.8%), so we used a hurdle model

(Zeileis et al., 2008) ('pscl' package; Zeileis et al., 2008). This fits a binary logistic regression for zero counts, and a negative binomial regression for positive counts. The hurdle model was better placed to manage the zero-inflated data than the negative binomial regression model (Vuong non-nested likelihood ratio tests: z = -28.895, $p < 0.001$). Goodness-of-fit was tested using rootograms (Kleiber & Zeileis, 2016), and variance inflation factors presented no multicollinearity issues (VIF < 1.06).

To investigate motivations for visiting green and blue spaces, we looked at all the individual visits people had made and coded whether they were to green (e.g. park, private backyard) or blue space (e.g. sea wall, waterways). We then conducted a content analysis of the qualitative visit motivations, classifying them into codes, before grouping the coding into themes and domains (physical, cognitive, space qualities, unstructured time, social, global wellbeing) (Table S2), based on an existing typology (Irvine et al., 2013) that was adapted for Guyana (Supplementary Material text section S3). The coding was conducted independently by two authors (JCF, KNI), who showed high levels of agreement (Kappa = 0.68, $p < 0.01$). The points of disagreement were subsequently coded iteratively between the two authors. Decisions on coding were further informed by the space the participant was visiting (e.g. sea wall, private backyard), and the frequency and duration of the visit. We tested for differences in visit motivations at the domain level due to sample size limitations. Kruskal-Wallis tests were used to assess associations between log visit duration (mins) and visit motivations, with Dunn's tests (Dunn, 1964) to explore differences post-hoc, with p values adjusted for multiple comparisons. Wilcoxon rank-sum tests were used to compare the visit duration (mins) to green versus blue spaces, for each motivation.

To assess how visit frequency or log visit duration (mins) are associated with human wellbeing, we created ordinal logistic regression models for each of our four wellbeing outcomes (happiness, anxiety, life satisfaction, worthwhileness). We tested visit frequency and log visit duration (mins) as independent variables in separate models as the latter was constructed from the former, and so inflated the variance. Models were adjusted for nature-relatedness, safety concerns, and sociodemographic characteristics (age, education, residential history). Due to the skewed distribution of the ordinal wellbeing outcomes, all models used the complementary log–log link function (probability of a high category is higher), and the cauchit link function for anxiety (higher probability of extreme values). We also checked our results for robustness by dichotomising the wellbeing scales around the median (below the median, or equal to and above the median), and modelled them using binomial general logistic regressions, following White et al. 2017. As the findings from both approaches were consistent, only the ordinal logistic regressions models are reported. For the ordinal regression models, we ensured the proportional odds assumption was not violated using the Brant test (Schlegel & Steenbergen, 2018). Goodness-of-fit was then assessed using Lipsitz, Hosmer-Lemeshow, and Pulkstenis-Robinson chi-squared and deviance tests (Fagerland & Hosmer, 2016). A generalised linear model was used for mental wellbeing (WHO-5) as an outcome with a negative-binomial error structure due to over-dispersion, assessed using model adequacy statistics in R (Harrison et al., 2018). Variance inflation factors presented no issues of multicollinearity between independent variables in the visit frequency models (VIF < 1.10) and the log visit duration models (VIF < 1.08).

We standardised all regression models and model averaged using Akaike Information Criterion (AICc) for smaller sample sizes (Burham & Anderson, 2002) in the 'MuMIn' R package (Bartoń, 2018). We averaged models across ΔAICc < 2 (the difference between each model and the best model). We used this stringent threshold to reduce model selection to only those with substantial support. This higher level of certainty is important as the associations we identify could have important public health implications. Model averaged coefficients and corresponding 95% confidence intervals (CI) were used to calculate odds ratios. Log visit duration (mins) was then untransformed and plotted to visualise the association between visit duration (mins) and happiness. To do this, we excluded outlying data that fell above the 95th percentile of observations (1201 min) (leaving $n = 407$).

3. Results

A total of 512 questionnaires were completed, with a response rate of 71% ($n = 211$ non-respondents). The sample was 52% female, 53% under the age of 35 years old, and was representative of the city's population according to Georgetown's most recent census (Bureau of Statistics, 2012) (Table S3). Just under half the participants (47%) were educated up to secondary school level. A large proportion (78%) were concerned about personal safety in Georgetown's green and blue spaces. Just over half the participants (56%) had lived in Georgetown their whole lives, while 44% had either lived in rural Guyana or abroad. The mean nature-relatedness score for participants was 3.96 (SE = 0.04).

We excluded any participants who had made visits only, or in addition, to green or blue outside of Georgetown in the last seven days, as we were interested in the effect of Georgetown's green and blue spaces specifically. After rows containing missing values were removed, a total of 431 participants remained, who had either not visited any green or blue spaces in the past seven days (non-users, $n = 212$), or had visited spaces just within the city, including private backyards (users, $n = 219$). Across the whole sample, the distribution of wellbeing was right-skewed for happiness, life satisfaction, worthwhileness, and mental wellbeing, and left-skewed for anxiety (Table 1).

3.1. Are nature-relatedness, safety concerns, or sociodemographic characteristics associated with visit frequency and visit duration?

The odds of visiting a green or blue space once, as opposed to not at all, increased significantly for participants who reported higher nature-relatedness (Table 2). Moreover, there were significantly higher odds of visiting 2–3 or 4–6 times if participants had no concerns for their personal safety. By contrast, those aged 35 + years old were significantly less likely to visit than younger participants. Gender, education, and residential history were not important independent variables as they were not represented in the model set.

The odds of a participant spending at least 1 min in a green and blue space (zero-hurdle) significantly increased with higher nature-relatedness, no safety concerns, and education to a high level (Table 3). Participants who were aged 35+ years old were significantly less likely to visit. The odds of spending a longer period of time visiting green and blue space (non-zero counts) were not associated with any sociodemographic background characteristic in particular, implying that users belonged to a wide range of backgrounds. Gender, however, was not represented in either of the model sets.

3.2. Are visit frequency and visit duration associated with specific motivations for visiting green and blue spaces?

During a seven-day period, the users were motivated to visit green and blue spaces mainly (39%) for physical reasons (Table 4). For

Table 1
Summary of wellbeing scores from 431 participants responding to a questionnaire in Georgetown, Guyana about green and blue space use ($n = 219$ users, $n = 212$ non-users). Five measures of wellbeing were used. Happiness, anxiety, life satisfaction, and worthwhileness are ordinal (median, range), while mental wellbeing is continuous (mean, standard error).

Wellbeing measures	Total sample	Users	Non-users
Happiness (Positive experiential)	8 (0–10)	8 (0–10)	7 (0–10)
Anxiety (Negative experiential)	5 (0–10)	5 (0–10)	4 (0–10)
Life satisfaction (Evaluative)	7 (0–10)	8 (0–10)	7 (0–10)
Worthwhileness (Eudaimonic)	8 (0–10)	8 (0–10)	8 (0–10)
Mental wellbeing (WHO-5)	64.25 (0.94)	65.61 (1.34)	62.62 (1.51)

Table 2
Model-averaged (ΔAICc < 2 model set) odds ratios (OR) and 95% confidence intervals investigating whether sociodemographic background characteristics (nature-relatedness, safety concern, gender, education, residential history, age) predict visit frequency to green and blue spaces in Georgetown (multinomial regression) (n = 431). The odds ratio is significant if the confidence intervals do not cross 1 (bold values), with those above one positively related, and those below one negatively related, to visit frequency. Reference category = 0 visits.

Variable	Once			2–3 visits			4–6 visits			7 or more visits		
	OR	**2.5%**	**97.5%**	**OR**	**2.5%**	**97.5%**	**OR**	**2.5%**	**97.5%**	**OR**	**2.5%**	**97.5%**
Nature-relatedness	**1.45**	**1.04**	**2.02**	**2.01**	**1.35**	**2.98**	1.37	0.87	2.15	**1.53**	**1.00**	**2.35**
Safety concern (No)	0.99	0.50	1.95	**2.28**	**1.22**	**4.26**	**2.69**	**1.23**	**5.88**	1.80	0.86	3.77
Age (35+ years old)	**0.53**	**0.31**	**0.91**	0.57	0.32	1.02	**0.32**	**0.14**	**0.70**	0.73	0.37	1.44

Table 3
Model-averaged (ΔAICc < 2 model set) odds ratios (OR) and 95% confidence intervals investigating whether nature-relatedness, safety concern, and socio-demographic characteristics (gender, education, residential history, age) predict log visit duration (mins) to green and blue spaces in Georgetown, Guyana (hurdle model) (n = 431). Zero hurdle part gives a binary response (zero minutes versus everything above zero), while the count model represents increases in log visit duration (mins) (data that fall above zero). The odds ratio is significant if the confidence intervals do not cross one (bold values), with those above one positively associated, and those below one negatively associated, to log visit duration (mins).

Variable	Zero-hurdle			Non-zero counts		
	OR	2.5%	97.5%	OR	2.5%	97.5%
Nature-relatedness	**1.57**	**1.22**	**2.01**	0.99	0.92	1.07
Safety concern (No)	**1.79**	**1.13**	**2.85**	1.03	0.91	1.17
Education (High)	**1.66**	**1.11**	**2.49**	1.01	0.89	1.13
Residential history (Other)	1.09	0.77	1.54	0.99	0.93	1.06
Age (35 + years old)	**0.59**	**0.39**	**0.89**	0.93	0.82	1.05

analytical purposes, the Global Wellbeing domain was removed due to the low sample (n = 4). Visit motivations for visiting green as opposed to blue space were non-significant at the domain level (X^2 = 7.045, df = 4, p = 0.133).

Participants were more likely to visit just once in the week (49%) rather than more often (2–3 visits = 26%; 4–6 visits = 10%; 7 or more visits = 15%) (Table 5). Visit motivations were associated significantly with visit frequency (X^2 = 32.82, df = 12, p = 0.001). Amongst green spaces, there was an association between visit frequency and visit motivation (X^2 = 37.53, df = 15, p = 0.001), with more frequent visits associated with physical or cognitive domains. No such pattern (X^2 = 7.967, df = 12, p = 0.787) was apparent for blue spaces.

Across a seven-day period, participants spent an approximately equal amounts of time visiting green and blue spaces across the visit motivation domains (All visits: X^2 = 3.33, df = 4, p = 0.50; Green: X^2 = 6.97, df = 4, p = 0.14; Blue: X^2 = 3.09, df = 4, p = 0.54) (Fig. 2). When visit duration (mins) per visit motivation was compared between green and blue spaces, no significant differences were apparent.

3.3. Are visit frequency and visit duration associated with human wellbeing?

Visit frequency to green and blue space in the last seven days was not associated with any wellbeing measure (Table S5). Nonetheless, an increase in log visit duration in the last seven days was significantly associated with increased happiness (Fig. 3; Table S6).

In all models, participants who reported higher nature-relatedness, also had higher levels of happiness, life satisfaction, worthwhileness and mental wellbeing, but also higher anxiety. Concern for personal safety was not directly associated with any wellbeing measure. The odds of higher wellbeing measures increased if participants were aged 35+ years old, although not for anxiety. Participants who had lived outside of Georgetown (either in rural Guyana or abroad) felt more worthwhileness, when compared with people who had always only lived in Georgetown. Education did not pass the proportional odds assumption so was not retained.

When investigating the association between visit duration (mins) and happiness as a continuous variable, increases in happiness above the median reported for non-users (happiness = 7) were apparent after ~25 min. This continued up until ~120 min, after which there is fluctuation (Fig. 4).

4. Discussion

Identifying how urban green and blue spaces benefit human wellbeing can inform their prioritisation in urban land-use planning and management decision-making (Richards et al., 2017; van den Bosch & Nieuwenhuijsen, 2016). We find that intentionally spending more time in urban green or a blue space, for any reason, was associated with improved positive experiential wellbeing in Georgetown, Guyana. To the best of our knowledge, this is the first time a that an association has been found for this region of the world, and suggests the cross-cultural importance of exposure to urban green and blue space for improved wellbeing (Garrett et al., 2019; Nath et al., 2018; Shanahan et al., 2016; White et al., 2017, 2019). This finding is supported by our qualitative analysis of visit motivations, which was illustrative of the mechanisms through which people derive wellbeing benefits in nature, including 'restoring capacities' (e.g. relaxation), and 'building capacities' (e.g. exercise) (Markevych et al., 2017). Public health authorities in Georgetown responsible for policy recommendations should note the minimum of 25 min exposure to urban green or blue spaces, while undertaking any activity, could increase positive experiential wellbeing. Campaigns based on this recommendation could be targeted specifically at older people from low educated backgrounds, as this sector of society is, currently, less likely to visit. Such individuals could be deterred by the tropical humidity, personal safety concerns, or lack of public green and blue space in close proximity (Cronin-de-Chavez et al., 2019), but targeted research is needed to identify the specific barriers. Nonetheless, ensuring that accessible urban green and blue spaces are spread across the city is another important consideration.

Although our findings support the notion that there is a positive association between nature-exposure and particular aspects of human wellbeing, some subtleties were uncovered. Indeed, we show that log visit duration (mins) was not associated with improvements in the other four measures of wellbeing (anxiety, life satisfaction, worthwhileness, mental wellbeing), while visit frequency was not associated with any wellbeing measures. These findings differ from work conducted in the Global North that uses the same measures, but found increased visit frequency related to higher life satisfaction (Coldwell & Evans, 2018) and greater eudaimonic wellbeing (White et al., 2017), and that increased duration (up to 120 min) was associated with higher life satisfaction (White et al., 2019). This illustrates the importance of researchers and decision-makers clearly distinguishing between the multiple dimensions of wellbeing when making recommendations and developing interventions to improve people's quality of life on the whole (Dolan et al., 2016).

The absence of an association between green and blue space use with anxiety, life satisfaction, worthwhileness and mental wellbeing, concurs

Table 4
Motivations for visiting green and blue spaces in Georgetown, Guyana, in the past seven days, in response to the question '*What was the main reason for visiting?*'. Table displays the number of times (total $n = 379$) each coded visit motivation was mentioned, grouped into themes and domains, with the percentage of the total presented in brackets for the domain. *41 visits for 'purposeful work' in green spaces comprised purposeful work in private backyards.

Code	Green	Blue	Theme	Green	Blue	Domain	Green	Blue
Relaxation	25	32	Physical restoration	31	44	Physical	86 (22)	63 (16)
Chill out	5	9						
Eat	1	3						
Exercise	29	9	Physical pursuits	55	19			
Sport	17	0						
A walk	8	6						
Passing through	1	4						
Purposeful work	51*	8	Mental pursuits	53	11	Cognitive	55 (15)	12 (3)
Religious use	1	1						
Think	1	1						
Photography	0	1						
Get away	1	0	Attention restoration	2	1			
Relax my mind	0	1						
Reflection	1	0						
Fresh air	6	13	Nature	20	22	Space qualities	37 (10)	27 (7)
See nature	5	2						
Trees, plants, flowers	6	0						
Get outside	0	2						
See ocean	0	3						
Sunrise/set	1	1						
Nature sounds	1	0						
Proximity	4	1	Feature	16	3			
View	4	1						
Zoo animals	4	0						
Peace and quiet	2	1						
Atmosphere	2	0						
Beauty	1	0						
Monument	0	1						
Emotional attachment	1	1	Place attachment	1	1			
Distinct identity	0	1	Place identity	0	1			
Recreation	26	15	Passing time	37	19	Unstructured time	37 (9)	19 (5)
Unstructured time	6	1						
Sight-seeing	1	3						
Pets	4	0						
Family outing	12	5	Socialising	21	18	Social	21 (5)	18 (5)
Meet friends	6	5						
Hang out	0	7						
Romantic	3	1						
Depression	0	2	Health	1	3	Global wellbeing	1 (0)	3 (1)
Health	1	0						
Therapy	0	1						

Table 5
Motivations for visiting green and blue spaces in Georgetown, Guyana, in the past seven days, in response to the question '*What was the main reason for visiting?*'. Table displays the number of responses in each domain, per category of visit frequency, for each space type (all, green, blue). The percentage of each total (all, n = 375; green, n = 235; blue, n = 140) in shown in brackets.

Space type	Frequency	Domain				
		Physical	Cognitive	Space qualities	Unstructured time	Social
All visits ($n = 375$)	Once	72 (19)	22 (6)	33 (9)	32 (8)	24 (6)
	2–3 visits	49 (13)	18 (5)	10 (3)	11 (3)	10 (3)
	4–6 visits	14 (4)	8 (2)	9 (2)	6 (2)	1 (0)
	7 or more visits	14 (4)	22 (6)	9 (2)	7 (2)	4 (1)
Green ($n = 235$)	Once	37 (16)	14 (6)	20 (8)	19 (8)	12 (5)
	2–3 visits	35 (15)	13 (5)	3 (1)	5 (2)	4 (2)
	4–6 visits	9 (4)	5 (2)	6 (3)	5 (2)	1 (0)
	7 or more visits	8 (3)	21 (9)	8 (3)	6 (3)	4 (2)
Blue ($n = 140$)	Once	35 (25)	8 (6)	13 (9)	13 (9)	12 (8)
	2–3 visits	14 (10)	5 (4)	7 (5)	6 (4)	6 (4)
	4–6 visits	5 (4)	3 (2)	3 (2)	1 (1)	0 (0)
	7 or more visits	6 (4)	1 (1)	1 (1)	1 (1)	0 (0)

with the outcomes of research conducted in Singapore (Saw et al., 2015). The authors argue that while people in temperate regions are drawn to urban green spaces for the cooling benefits these spaces offer (Lafortezza et al., 2009), the extreme temperature and humidity posed by the tropical climate in Singapore tends to drive people into air-conditioned buildings. Moreover, Saw et al. (2015) contend that as greenery is so abundant throughout Singapore, it is difficult to detect how urban green spaces *per se* might be affecting human wellbeing. In Georgetown, air conditioning is less common, but the city has a wealth of biodiversity (Hayes et al., 2019; Hunte et al., 2019) and participants may therefore gain incidental exposure to nature during, for example, a commute to work (Keniger et al., 2013). Balconies, porches, and private

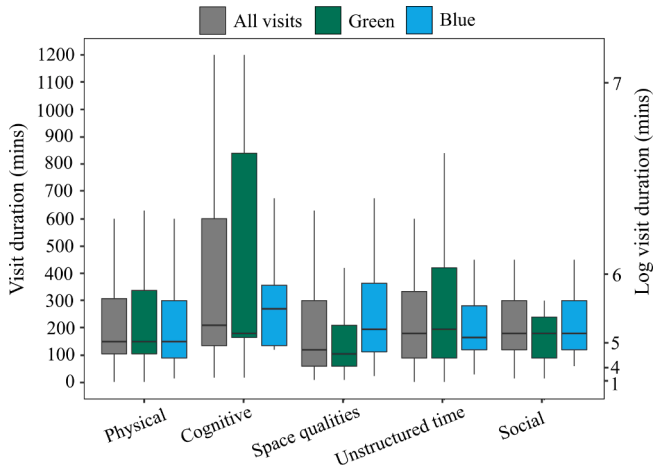

Fig. 2. Responses to the open question '*What was the main reason for visiting*?' green and blue spaces in Georgetown, Guyana. Visit motivations were clustered into codes before being grouped into themes and domains, with the domains presented here (Supplementary Material Table S2). Plots present all visits (grey), visits to green spaces only (green) and visits to blue spaces only (blue). Visit duration (mins) of time spent visiting green and blue spaces in the last seven days per visit motivation domain of visit, where boxplots depict the median (central horizontal line), with the coloured box showing the interquartile range. Log visit duration (mins) displayed on the z axis for comparison to Table 3, Figs. 3 and 4. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

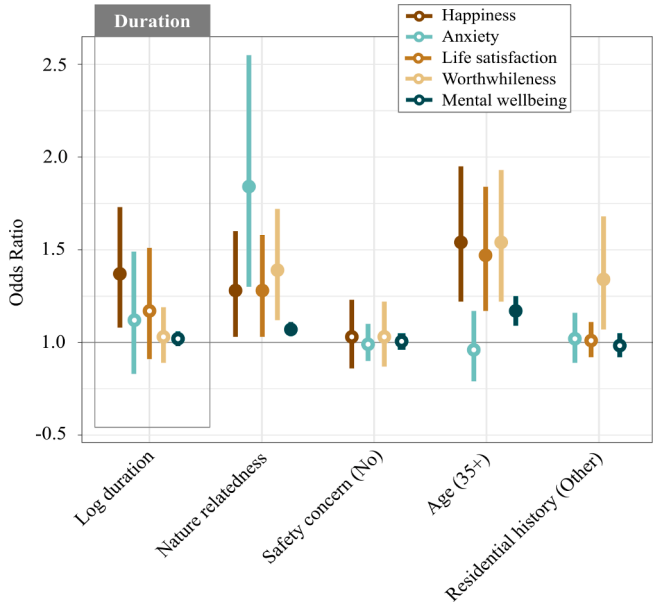

Fig. 3. Model-averaged (ΔAICc < 2 model set) odds ratios and 95% confidence intervals for five models investigating whether log visit duration (mins) predicts each of five measures of wellbeing (happiness = dark brown, anxiety = blue, life satisfaction = light brown, worthwhileness = yellow, mental wellbeing = dark green) of participants who visited green and blue spaces in Georgetown (n = 431). The centre circle is the odds ratio (filled = significant). 95% confidence intervals are determined to be significant if they do not cross one, with those above one positively related, and those below one negatively related, to wellbeing. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

backyards allow residents to spend time outside without leaving the safety of their properties, and are present in most of Georgetown's neighbourhoods regardless of socioeconomic status. Indeed, we found the majority of visits to green spaces for cognitive visit motivations were for purposeful work (e.g. *'kitchen garden', 'picking fruit', 'maintenance'*), predominately in backyards. Further investigation is necessary to disaggregate the importance of public and private green spaces in Georgetown, to build on our understanding of the positive contribution of private backyards to wellbeing in the Global North (de Bell et al., 2020; Young et al., 2020). However, our results do emphasise the need to incorporate backyards into future land-use planning, which may be particularly valuable for the sociodemographic groups that do not visit the public green or blue spaces.

Higher nature-relatedness was strongly associated with increased visit frequency and log visit duration (mins), as well as higher life satisfaction, worthwhileness, mental wellbeing and, although unintuitive, higher anxiety. While the latter finding for anxiety directly opposes existing evidence (Martyn & Brymer, 2014), the wide confidence intervals indicate substantial levels of uncertainty. Yet, it is possible that people were seeking respite from feelings of anxiety by spending more time visiting green and blue spaces, which merits further examination. Nonetheless, this study is the first to use the nature-relatedness scale in Guyana, and supports findings from the Global North that feeling connected with the natural world is associated with increased visit frequency and visit duration (Cox et al., 2018; Lin et al., 2014), and that nature-relatedness is positively associated with higher wellbeing (Cox et al., 2017; Cox et al., 2018; Nisbet et al., 2011; Zelenski & Nisbet, 2014). However, visits to green and blue space in the past week have also been shown to enhance nature-relatedness itself (Shanahan et al., 2017). Nature-relatedness is further associated with a number of pro-environmental behaviours and attitudes (Mayer & Frantz, 2004; Nisbet et al., 2009), although recreational and physical visits to green and blue spaces have also been associated with pro-environmental attitudes, mediated by increased wellbeing (Dean et al., 2019). While debates ensue about what it means to be 'connected' to nature, and whether people need to 'experience' nature to exhibit pro-environmental behaviours and attitudes (Clayton et al., 2017; Ives et al., 2017), it is clear that all these factors are cyclically interconnected. Furthermore, although attempts have been made to use the 'Connectedness with Nature' scale amongst farmers elsewhere in the Amazon (Mikołajczak et al., 2019), more work is needed to ascertain how attitudes toward the natural environment interact with pro-environmental behaviours, such as urban green and blue space use, to improve human wellbeing in Guyana.

Concern for personal safety was a key determinant of whether participants visited Georgetown's green and blue spaces. Studies in the Global South have shown that perceptions of safety strongly influence use of green space (Ambrey & Shahni, 2017; Hong et al., 2018), and in South America specifically (Parra et al., 2010; Wright Wendel et al., 2012). In Georgetown, crime and illegal activity is rife, compared with the country at large (Cummings et al., 2018), although there are no resolved data on crime within urban green or blue spaces. Understanding what attributes of these spaces influence personal safety concerns is necessary to identify how their design and management can be altered to encourage use. For instance, Pitt (2019) recommends improvements in cleanliness, lighting, and surveillance will influence perceptions of safety in urban waterways. Indeed, further study might also elicit whether people spend more time in private backyards rather than public spaces due to their concerns for personal safety. Concerns may be pertinent for certain age groups in particular, such as the elderly or those with children (Harris et al., 2018; Valentine & McKendrick, 1997).

Before now, the wellbeing of the population of Guyana has not been examined, as the country has never been included in international assessments of human wellbeing, such as the Gallup World Poll (Graham et al., 2018; Helliwell et al., 2016, 2020). This is despite the high prevalence of psychological health disorders amongst the population (Arora & Persaud, 2019). All four positive dimensions of wellbeing (happiness, life satisfaction, worthwhileness, mental wellbeing) were higher for participants aged above 35 years. This may be explained by

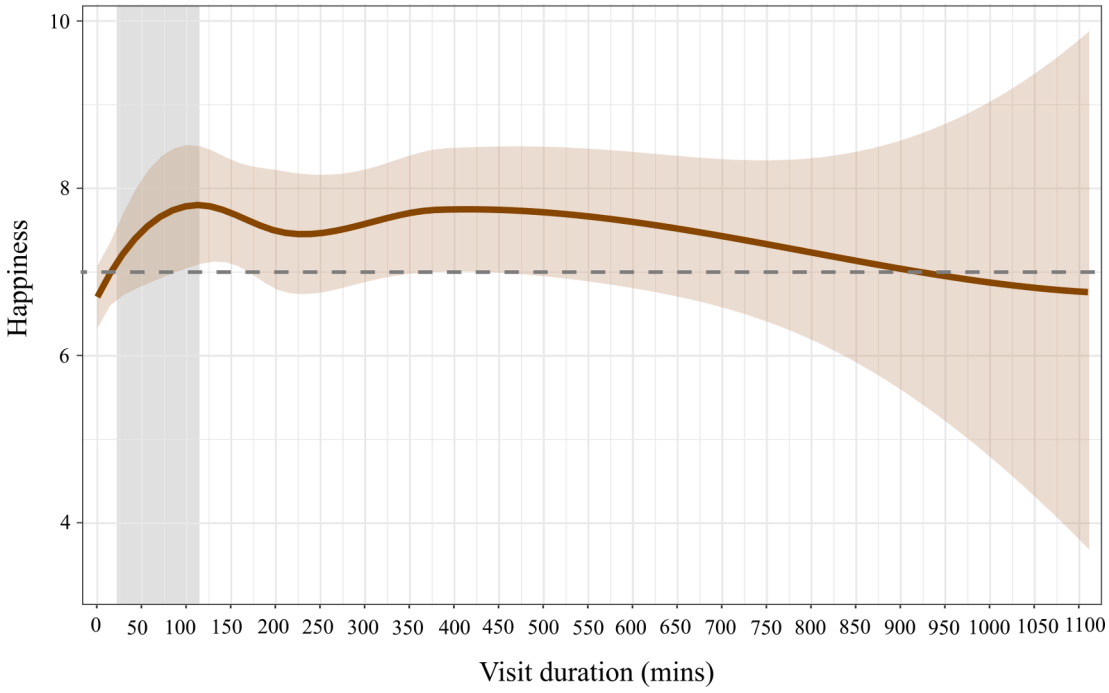

Fig. 4. Measures of happiness as a function of visit duration untransformed (mins) for green and blue spaces in Georgetown ($n = 407$), plotted using an unadjusted bivariate smoothing (LOESS) curve (with 95% confidence intervals). Horizontal dashed line represents the median wellbeing value for non-users (happiness = 7). The grey box therefore represents the period of time (~25–120 min) where wellbeing values that fall above this median increase. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

the fact that ageing is associated with an increased ability to process and regulate emotional experiences and prioritise emotional goals, regardless of the fact that ageing is concomitant with decreased physical, mental, and social health ('the paradox of ageing') (Mackenzie et al., 2018). Moreover, we found that participants who had spent time growing up outside of Georgetown (either in rural areas or abroad) felt their life was more worthwhile than those that had only lived in Georgetown. This is of particular interest given the magnitude of emigration out of Guyana, which has kept the population constant since the 1980s (Mycoo, 2017). High levels of emigration are thought to be the result of lack of employment, low salaries, and political insecurity (Khonje, 2015), all of which are factors known to contribute to subjective human wellbeing (Helliwell et al., 2020). Therefore, time spent outside of Georgetown and abroad may have enabled people to experience alternative lifestyles and opportunities which could have led them to feel like their lives were more worthwhile.

5. Conclusion

Accelerating urbanisation and population growth will place growing pressure on urban green and blue spaces, particularly in the Global South (Pauchard et al., 2006; Richards et al., 2017). These spaces offer both habitat for biodiversity and benefits for human wellbeing (WHO & CBD 2015). Guyana is a biodiversity-rich country with a rapidly emerging economy (Panelli, 2019) and a national mental-health crisis (Arora & Persaud, 2019). As a nation, policy-makers are looking to minimise trade-offs between ecological and public health demands in their land-use planning. Our results suggest that decision-makers could improve human wellbeing through the provision of urban green and blue spaces across the city, including ensuring that private backyards are associated with dwellings. Public health campaigns could be targeted at specific sociodemographic groups, although further work is needed to identify any existing barriers to urban green or blue space use. It is important to guarantee that wellbeing benefits are available to all sectors of society, minimising the risk of gentrification and any subsequent health inequalities (Cole et al., 2017; Haase et al., 2017). Moreover, public health officials should seek to understand what nature-relatedness means for people living in Georgetown, given its clear link with improved wellbeing.

CRediT authorship contribution statement

Jessica Claris Fisher: Conceptualization, Methodology, Formal analysis, Visualization, Writing - original draft. **Jake Emmerson Bicknell:** Methodology, Writing - review & editing. **Katherine Nesbitt Irvine:** Methodology, Validation, Writing - review & editing. **Damian Fernandes:** Resources, Supervision. **Jayalaxshmi Mistry:** Methodology, Supervision, Writing - review & editing. **Zoe Georgina Davies:** Conceptualization, Methodology, Supervision, Writing - review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.

org/10.1016/j.landurbplan.2021.104119.

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