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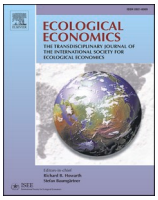

Surveys

Human-nature interactions in the Afrotropics: Experiential and cognitive connections among urban residents in southern Nigeria

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ABSTRACT

Many people are losing direct contact with nature, a phenomenon termed as the extinction of experience. Urban dwellers are particularly affected by this process that influences public health and habitat conservation. We explored the extinction of experience among the urban populace in Nigeria, a clear Global South representative with rapidly increasing human population. We interviewed 600 adults from several cities and performed statistical tests. Results show that most respondents have no contact nor connection with nature, revealing an important distancing from the natural world. The reasons respondents gave for not experiencing nature more often are mainly related to material terms (e.g., lack of time, money and nearby natural areas). We found that respondents with higher nature contact are also more connected to nature, which is promoted by the perception of neighborhood safety. Respondents living in Lagos, and those with lower levels of income and education show greater dissociation from nature. The relationships between real and perceived neighborhood naturalness and bird species are decoupled, but the perception of naturalness and bird species richness correlates. Our study provides novel information on the loss of human-nature interactions and its determinants in the Afrotropics. We recommend different actions necessary to ameliorate this problem.

1. Introduction

In recent decades, an increasing number of people are losing direct contact with nature, a phenomenon termed as the "extinction of experience" (Pyle, 1993). This process of continued isolation and alienation of humans from nature is commonly reported across the world (Miller, 2005), and constitutes a challenge for public health and for curbing environmental degradation (Soga and Gaston, 2016). On the one hand, the extinction of experience undermines the multiple benefits that interactions with nature have for people's physical and mental health (reviewed by Keniger et al., 2013). On the other hand, it also has a negative indirect effect on the environment through changes in people's behaviors and attitudes, as contact with nature can facilitate the appreciation of the natural world (Soga et al., 2016), and encourage pro-environmental behaviors and practices (Alcock et al., 2020; Prévot et al., 2018).

According to Soga and Gaston (2016), the extinction of experience is primarily a result of the loss of opportunities to experience nature and the loss of positive orientation towards it. Both loss of opportunity and orientation can be exacerbated as societies grow and develop economically. Specifically, the decline in opportunities is often associated with environmental degradation, increasing urbanization of the human population, over-scheduling, and technological advancements that put television, videogames and internet as the main leisure activities (Hartig et al., 2014; Hartig and Kahn, 2016; Soga and Gaston, 2016). While recreational activities, such as hiking, camping, insect catching, fishing and birdwatching, attract people to nature (Gao et al., 2019; Kurnia et al., 2021; Szczytko et al., 2020), natural areas that support these activities are quickly disappearing due to anthropogenic activities (e.g., Newbold et al., 2015; OECD/SWAC, 2020). The fragmentation of natural areas and the rural-to-urban migration of humans (United Nations, 2019b) create large isolation distances that disconnect people from nature (Miller, 2005). In fact, long distances and transportation costs affect visitation rates to natural areas across age groups, gender, and

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educational levels (Okello et al., 2012; S. Zhang and Zhou, 2018).

While these opportunity-related factors may be important in explaining the loss of interactions with nature, loss of orientation, understood as the feeling of connection or affinity with nature, may be an even more relevant factor (Cox et al., 2018; Lin et al., 2014). Interpretations and measures of the concept of nature connectedness are diverse in the literature, ranging from affective and cognitive aspects to facets of engagement and identity (Tam, 2013). Regardless of the indicator used, the literature suggests that nature connection is strongly associated with nature contact (Cheng and Monroe, 2012; Colléony et al., 2017; Nisbet et al., 2009; Tam, 2013), making it a key element in understanding physical detachment from the natural world. Some authors (e.g., Pyle, 2003), associate the feeling of disconnection from the natural world with the change of values in our societies and the predominance of materialism and consumerism. More recently, Riechers et al. (2020) suggested that landscape simplification induced by economic growth and dietary changes could have a negative impact on various relational values and impair human-nature connectedness.

The interplay of human-nature interactions, opportunities to experience nature, and orientation towards it is neither linear nor unidirectional, marring an understanding of the causes and consequences of the loss of nature experiences (Soga and Gaston, 2016). A clear example of this is the relationship between nature contact (i.e., interactions with nature) and connectedness (i.e., feelings or affection for nature), two concepts that appear to be interdependent. Although connectedness is sometimes considered as a predictor of nature contact (e.g., Cheng and Monroe, 2012; Colléony et al., 2017), there are also several studies showing that a greater nature contact enhances connectedness (e.g., Braun and Dierkes, 2017; Lumber et al., 2017; Mayer et al., 2009). In addition, the intensity of nature contact during childhood has been reported as a strong predictor of later visits to natural areas during adulthood (Colléony et al., 2017), as well as nature connectedness and involvement in environmental actions as an adult (van Heel et al., 2023). In fact, Hosaka et al. (2018) noted, based on a study conducted in Japan, that these early nature experiences may be more important than socio-demographic factors for explaining participation in nature-based activities.

The characteristics of the environment also have an impact in the extinction of experience. For instance, the extent of urban vegetation is known to be positively associated with fascinating animal groups like birds, butterflies, and beetles (see Arjona et al., 2023; Beninde et al., 2015; Ibáñez-Álamo et al., 2020), invariably influencing nature awareness and connectedness (Lim et al., 2022; White et al., 2023). Another important factor affecting visitation rate and duration of stay in natural areas is the perception of safety in many protected and unprotected wilderness areas (e.g., Lapham et al., 2016; Mata et al., 2022), consequently shaping nature connectedness (Adams and Savahl, 2015; Sedawi et al., 2020).

Although there is a large body of literature investigating the various components and mechanisms driving the extinction of experience, such investigations are strongly biased towards countries in the Global North (Barragan-Jason et al., 2022; Bashan et al., 2021; Pett et al., 2016), leaving important knowledge gaps in our understanding of human-nature interactions in regions of the Global South. The Global South consists of underdeveloped and developing countries, many of which are in the southern hemisphere, including Africa, Latin America, Asia, and Oceania (Dados and Connell, 2012; Shackleton et al., 2021). It presents biophysical and socioeconomic contextual characteristics that differentiate it from the Global North (Shackleton et al., 2021), which could influence nature connectedness in the area. For instance, most countries in the Global South experience higher urbanization rates, and socioeconomic crises (e.g., unemployment, poverty, health, and safety) than those from the Global North (World Cities Report, 2020), which could reduce investments (e.g., time and money) in nature visitation. Furthermore, people's responses and preferences for nature vary across cultures and countries (Colléony et al., 2019). These factors justify the importance of performing studies on the extinction of experience in the Global South. However, few studies have been conducted there in this respect, and they are focused mainly on touristic aspects like analyzing visits to natural areas such as national parks or protected areas (Kruger et al., 2017; Martinez-Harms et al., 2018; Wambani et al., 2021), and the consequences (mainly in terms of knowledge impacts) of distancing from nature (e.g., Binoy et al., 2021; Muslim et al., 2018; da Silva et al., 2022). Among specific regions of the Global South, Africa has received the least scientific attention in terms of human-nature connectedness research (Barragan-Jason et al., 2022) that is directly related to the extinction of experience concept. In fact, a recent systematic review of African urban ecology revealed that human dimension studies in the continent during the last century mainly focused on ecosystem services approaches rather than other topics such as the extinction of experience (Awoyemi and Ibáñez-Álamo, n.d.), suggesting that additional studies are needed from this discipline. This is particularly important given the declining state of the continent's huge biodiversity, and that outdoor activities have positive effects on human wellbeing (Lumber et al., 2017).

In the present study, we set out to determine the applicability of the extinction of experience in the Global South, specifically in an African context, by analyzing data collected from 600 respondents from four cities in southern Nigeria (Auchi, Calabar, Ibadan, and Lagos), one of the most densely populated, yet understudied regions in Africa (e.g., Awoyemi and Ibáñez-Álamo, n.d.; Seto et al., 2012). Our study's motivation was to determine the drivers of disconnection between the urban population and nature, given that previous studies have already shown that rural people in the area are more connected to nature than urban dwellers (e.g., Pam et al., 2021a, 2021b). While those studies were conducted in the rural-urban gradient in central Nigeria, the rural areas of the southern part of Nigeria are relatively insecure due to ongoing social unrest and kidnapping activities in the area (see Ojukwu, 2011; Otu et al., 2018), further explaining why we focused on urban centers. Therefore, we set the following objectives for our study: (1) To explore the extinction of experience in Nigeria, identifying patterns of contact with nature across socio-demographic groups; (2) To find out the self-reported reasons why people do not interact more frequently with nature; and (3) To investigate the cognitive dimension of human-nature connection, exploring possible associations with the identified tendencies of contact with nature. As a cognitive measure of nature connectedness, we used the Inclusion of Nature in Self scale proposed by Schultz (2002), which captures "the extent to which an individual includes nature within his/her cognitive representation of self" (p. 67). We also considered awareness of the environment by comparing perceptions with objective indicators of vegetation and birds. To achieve the proposed objectives, we adopted a two-stage empirical strategy: a first stage of descriptive and latent class analysis (to investigate the first two stated objectives); and a second stage of regression analyses (to address the third objective).

In this way, this study aims to make several contributions to the scientific literature. On the one hand, it examines human-nature relationships in a largely unexplored context. On the other hand, to our knowledge, this is the first study that attempts to identify and characterize segments of the population according to their patterns of contact with nature. An additional strength of the present research is the simultaneous investigation of experiential and cognitive dimensions of connection with nature. Through the results of this research, we intend to contribute to the proper channeling of resources aimed at improving experiences of nature in Afrotropical environments. Identifying factors underlying low levels of nature contact can inspire the design of interventions that favor intentional contact with nature and, ultimately, counteract the negative implications of the extinction of experience.

2. Methods

2.1. Study area and design

The study was carried out in four Nigerian cities, including Auchi, Calabar, Ibadan and Lagos (Fig. 1). In terms of landmass, Nigeria is the 14th largest country in Africa, covering about 923,768 km^2, and supporting several parks, natural areas, biodiversity hotspots and scenic sites (Ezealor, 2001). However, by mid-2023, Nigeria has an estimated human population of 223.8 million, translating to *c*.242 humans/km^2 (United Nations Population Fund, 2023), and suggesting an increasing need for awareness creation about nature conservation, particularly in highly urbanized areas.

Nigeria has two vegetation zones: rainforest and savannah (Ezealor, 2001). The studied cities fall within the rainforest zone characterized by dense evergreen forests of tall trees with thick undergrowth (Ola-Adams and Iyamabo, 1977). Additional information on population density and Gross Domestic Product of the study area is provided in Table 1.

Before choosing the studied cities, we first ensured that each of them qualified to be considered an urban center by having a contiguous patch of built-up land >1 km^2, and dominated by human-constructed features like buildings (>10 buildings/ha), high human density (>1600 inhabitants/km^2), roads, and vehicles (Marzluff, 2001; Niemelä, 1999; C. H. Nilon et al., 2003; Schneider et al., 2010). In addition, two of our studied cities (Lagos and Ibadan) are among the most densely populated in the entire African continent (World Cities Report, 2020). Thus, our selection of cities followed the criterion used by Taylor et al. (2018), who performed a similar survey in the two most-populous cities in each of Australia and New Zealand. Second, we ensured the widespread geographic distribution of our studied cities to cover the diverse cultural or ethnic groups (e.g., Yoruba, Igbo, Ibibio, etc.) in southern Nigeria (Oladipo et al., 2007). Third, our studied cities share similar biotic and abiotic conditions (Ezealor, 2001). By meeting these criteria, our sample could be considered a fair representation of urban southern Nigeria (cf. Table S1).

We used the "create random points tool" in ArcGIS (https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/create-random-points.htm) to stratify each city into five compartments stationed at the city center and its four cardinal points (i.e., west, east, south and

Table 1
Human Population (2016), Gross Domestic Products (GDP Per Capita; 2007) and land area (2006) of the state the studied cities are located (https://nigeria.opendataforafrica.org/).

City	State	Land area (km^2)	Population	*Density (persons/ km^2)	GDP Per Capita $ (2007)
Lagos	Lagos	3671	12,550,598	9270	4333
Ibadan	Oyo	26,500	7,840,864	6116	2666
Auchi	Edo	19,187	4,235,595	3308	3623
Calabar	Cross River	21,787	3,866,269	9059	3150

Note: *The density of the cities is based on data from Africapolis (http://africapolis.org), allowing us to gauge the qualification of each city as an urban center (i.e., >1600 inhabitants/km^2 according to Marzluff, 2001). Other indicators in the table are only available at the state (regional) level.

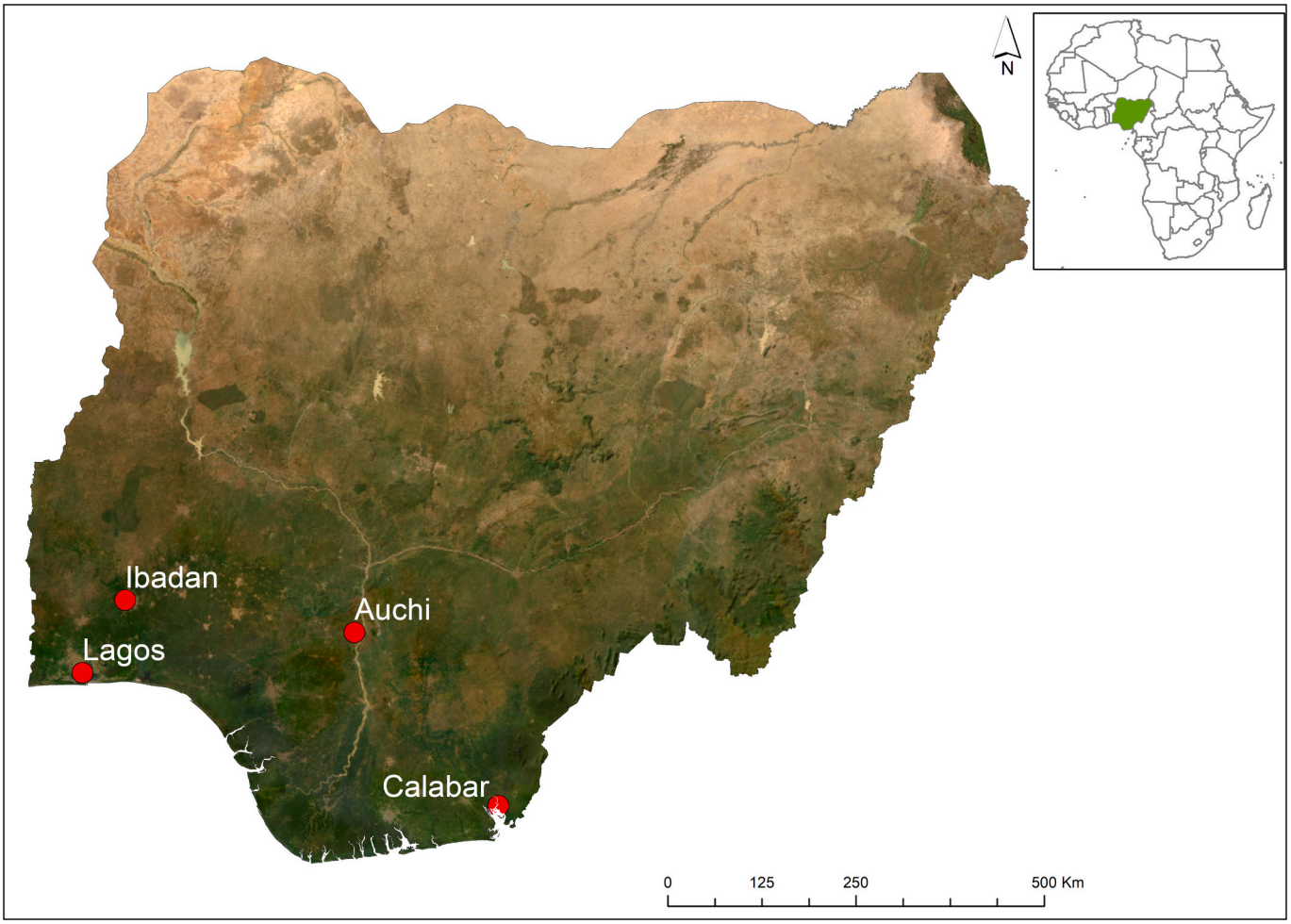

Fig. 1. Location of the study cities within Nigeria (highlighted box) and the African continent.

north of the city center) similar to Ciski et al. (2019). Each compartment measured 1 × 1 km, and separated from any other by at least 500 m, allowing us to capture information from respondents living in neighborhoods with different urbanization levels, vegetation cover and other socioeconomic characteristics following previous studies using a similar approach (e.g., Cox et al., 2018; Galbraith et al., 2015). Within each compartment, we also used the "create random points tool" in ArcGIS to randomly select five points (at least 200 m apart among them) as focal areas to perform the face-to-face interviews (see below), thus, securing a wide representation of inhabitants from each compartment. All points were marked with a Global Positioning System device (Garmin etrex 20×) to identify the exact geographic coordinates. Furthermore, the selection of these compartments and focal points was also needed to match the socioeconomic information obtained from the interviews with the remotely sensed vegetation data (i.e., Normalized Difference Vegetation Index) and bird data (i.e., bird species richness) that require a similar methodological approximation to grant its independence from point to point (e.g., Kubiszewski et al., 2019). This standardization of compartments and points across the studied cities matches the methodology followed by other studies (e.g., Cox and Gaston, 2015; Ibáñez-Álamo et al., 2020).

We purposively used questionnaires to interview six respondents from each point, totaling 150 people from each city and 600 respondents across the four cities. The total sample of 600 people consisted of an equal number of men and women as gender quotas were established to ensure equal representation. The surveys were conducted face-to-face (led by A.G. Awoyemi) between August and November 2021. At each point, six potential respondents (3 women and 3 men) were approached and asked if they lived within the 200-m radius of each point before interviewing them on a voluntary basis as no payments were made (otherwise they were not interviewed). This was relevant as it reflects respondents' experience and contact with nature on a daily basis (Taylor et al., 2018). Participants that agreed to answer the survey questions were then introduced to the purpose and objectives of the research, guaranteed anonymity and confidentiality of their responses, and were informed of their right to withdraw from the survey at any time. In addition, they were given the option to leave blank any questions they preferred not to answer. Each participant was interviewed independently of any other to ensure the uniqueness of the responses received. We conducted the interviews at different hours (mornings and evenings) of the day (week days and weekends) across the studied cities similar to other previous studies (e.g., Cox and Gaston, 2015). This procedure allowed us to cover a broad segment of the society with different sociodemographic and economic characteristics (Table S1).

2.2. Structured questionnaire and variables

2.2.1. Current experience of nature

To assess experiences of nature, we relied on direct and intentional contact with nature. We opted for a broad definition of nature, including neighborhood greenspaces, parks and managed settings, because they can play a crucial role in reversing the extinction of experience, especially in urban centers. Previous evidence indicates that the benefits of interacting with nature are not limited to wilderness environments, but also to a broader definition of nature (Gaston and Soga, 2020).

We asked about the frequency of contact with nature adapting the measures used by Soga et al. (2016). Thus, respondents were asked the following questions: (1) "How frequently do you visit natural places (e.g., neighborhood green areas, parks with lots of trees, beach, mountain, orchards, forest reserves, woodlot)?" (*visits*); (2) "How frequently do you touch plants or flowers in natural places?" (*plants*); (3) "How frequently do you observe or touch animals (e.g., birds, insects) in natural places?" (*animals*), which could facilitate nature connection, particularly during childhood (Franco et al., 2017; Kahn, 1997; Lumber et al., 2017). In addition to the frequency of visits, we considered the frequency of interactions with animals and plants to capture interactions that involve a more conscious and meaningful engagement with nature. Participants responded to those questions using a 6-point Likert scale (with 1 = never, 2 = once yearly, 3 = once every season, 4 = every month, 5 = every week, and 6 = every day). Those respondents who did not report the maximum frequency for all nature interaction questions were asked why they did not experience nature more often. They could choose several of the following options to answer this question: 1 = "I don't have time", 2 = "I don't have money to visit them", 3 = "Lack of natural areas nearby (it is too far)", 4 = "I have a disability / Health problem", 5 = "I am not interested / I don't like nature", 6 = "Other reason". We also considered the duration of visits to natural places (*duration*). Respondents answered the question "How long do you normally stay in natural places?" on a 5-point Likert scale (1 = some minutes, 2 = some hours, 3 = half a day, 4 = whole a day, and 5 = several days).

2.2.2. Previous experiences and setting

Respondents also answered the three previous questions on the frequency of contact with nature (*visits, plants* and *animals*) during their childhood, classified here as when they were 6–12 years old. We created an aggregated indicator of the frequency of interactions with nature during childhood as the sum of the scores of the three questions (*childhood frequency of nature contact*). We also asked if they had ever lived outside their current city (yes or no) as a factor that could influence opportunities to interact with nature (*lived outside current city*).

2.2.3. Nature connectedness

We evaluated affinity with nature (*nature connectedness*) using the Inclusion of Nature in Self Scale (Schultz, 2002), which is an adaptation of the Inclusion of Other in Self Scale by Aron et al. (1992). Based on self-concept, this scale captures the cognitive dimension of connectedness with nature through a graphic question. Seven pairs of circles are shown overlapping to different degrees, one labeled "Self" and the other "Nature", and respondents were asked to choose the pair that best reflects their interconnectedness with the natural world (Fig. 2). Each pair of circles is assigned a score from 1 (separate circles) to 7 (completely overlapped circles).

2.2.4. Perception of nature

We assessed the opportunity to experience nature by asking about the participants' perception of the level of nature in their neighborhood (*perception of neighborhood naturalness*). Here, we described neighborhood naturalness to respondents as the coverage of vegetation (%) within the 200-m radius of each sampling point (i.e., where respondents live) following previous studies (e.g., Cox et al., 2018; Ugolini et al., 2020, 2021). We then asked them to rate (on a 5-point Likert scale) how natural the location they live in is (i.e., the 200-m radius), whereby 1 = very artificial (≤20% vegetation cover), 2 = artificial (≤40% vegetation cover), 3 = intermediate (≤60% vegetation cover), 4 = natural (≤80%

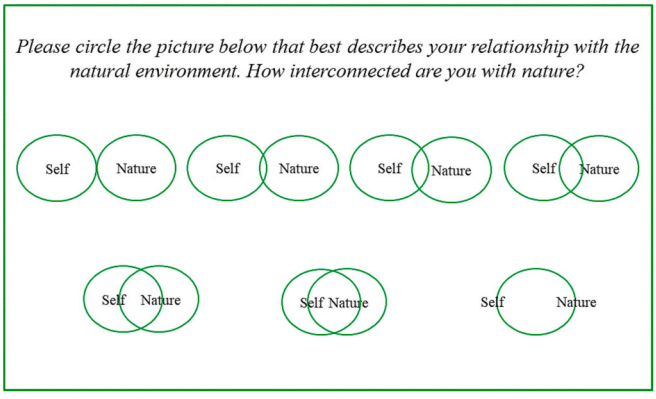

Fig. 2. Schematic representation of the level of nature connectedness adopted from Schultz (2002).

vegetation cover), 5 = very natural (100% vegetation cover). We also asked for the types (based on taxonomic families) of birds (e.g., sparrows, pigeons, kites, crows; *perception of bird types*) they usually found there (1 = very few (<3), 2 = few (3, 4), 3 = intermediate (5–7), 4 = many (8–18), 5 = very many (>18)) by showing them different images using the guide to the Birds of Western Africa (Borrow and Demey, 2014). We defined the number of bird types for each category based on the information on bird censuses (5 mins/point) carried out in the same sampled cities and points in November 2020–January 2021 as part of another study on the association of urbanization with avian diversity.

2.2.5. Measured indicators of nature (vegetation and birds)

The Normalized Difference Vegetation Index (NDVI) estimates the presence and photosynthetic vigor of vegetation, and is commonly used to investigate the relationships between nature and human well-being in urban areas (Pereira et al., 2012; Taylor et al., 2018). To estimate the NDVI, we downloaded Cloudless Sentinel 2 Level 1C Images to cover the survey period (November 2021), from the USGS Earth Explorer (https://earthexplorer.usgs.gov/). We then used the "spectralindices" function to estimate the mean NDVI using the R Statistical Software (Alabi et al., 2022; Leutner et al., 2019; Suab and Avtar, 2020).

Some months before the interviews (November 2020–January 2021), a single observer (A.G. Awoyemi, an expert ornithologist with >10 years of experience censusing birds in Nigeria) recorded the number of individuals of each bird species seen and/or heard within a 50-m radius (Ivande and Cresswell, 2016) of each point where respondents were interviewed (bird species richness). The bird censuses were done following general recommendations for quantifying birds (Bibby et al., 2000) and thus carried out only under good weather conditions and during the morning (up to 4 h after local sunrise; Manu et al., 2006).

2.2.6. Safety perception

We asked respondents to score how safe they felt in their neighborhood (*safety*), translating to a 200-m radius of each sampling point, where they could have direct and daily interaction with nature (Cox et al., 2018; Taylor et al., 2018). This was also scored on the following 5-point Likert scale, including not at all (1), a little (2), moderately (3), quite a bit (4) or extremely (5).

2.2.7. Socioeconomic characteristics

We obtained socio-demographic information from respondents, including age (continuous), gender (male or female) and marital status (single, married, divorced or widow); children (continuous). We also asked for their level of education (no formal education, primary, secondary, technical/polytechnic or university), employment status (self-employed, employed by someone or not employed); and level of monthly income, scaled based on the approved Nigerian minimum wage of 30,000 Naira (National Minimum Wage Act, 2019), and converted to USD ($) on 30 November 2021 (<$73, $73–$145, $145–$218, $218–$290, >$290).

2.3. Methods of data analysis

This study was conducted following a two-stage empirical strategy. Statistical analyses were conducted using the R Statistical Software (R Core Team, 2022).

2.3.1. Latent class analysis

To identify latent and unobserved groups, and to determine how the resulting subgroups differ in their pattern of human-nature interactions in the study area, we performed a Latent Class Analysis (LCA), which offers a probability-based classification (Scheier and Komarc, 2020; Song et al., 2021; Walsh et al., 2023). To achieve that, we used the "MixAll" package, which consists of algorithms and methods for model-based clustering and classification (Iovleff and Bathia, 2022). The MixAll package was relevant to our LCA because it supports different types of data (e.g., continuous, categorical/qualitative, count), missing values, and models (e.g., Gaussian, Gamma, Poisson), and is commonly deployed in clustering analysis (e.g., Ma et al., 2021; Nagode and Klemenc, 2021).

A total of 11 indicator variables (described above), including those related to socio-demography (*gender, age, education, marital status, children, employ* and *income*) and intentional contact with nature (*visits*, *plants*, *animals* and *duration*) were incorporated into the LCA to identify the groups. In MixAll, the number of classes must be ≥2 (Iovleff and Bathia, 2022). Thus, we ran models up to five classes following Song et al. (2021), and selected the best model (see Table 2) as the one with the lowest Bayesian Information Criterion (BIC) value (Burnham and Anderson, 2002; Nylund et al., 2007; Schwarz, 1978; Song et al., 2021). It is worthy of note that the incorporation of additional classes (i.e., > 5) increased BIC values, supporting our selection of five classes. The LCA generated an additional categorical variable, termed "Class" with two levels, including Class 1 (low nature contact) and Class 2 (high nature contact), which was included in further analyses. Thus, we first explored the distribution of the respondents across the identified latent classes, and how such variations influenced their self-reported reasons for not visiting nature more often.

2.3.2. Regression analysis

At the second stage, we performed regression analyses to determine differences in: (1) nature connectedness due to latent class membership (Class 1 vs Class 2) and the remaining variables not used to define the classes, including safety, childhood frequency of nature contact and living outside the current city, (2) NDVI due to subjective perception of neighborhood naturalness and latent class membership, and (3) bird species richness due to subjective perception of types of birds and latent class membership. We decided to use bird species richness since it positively correlated with the number of families of the sampled birds (r (598) = 0.98, $p < 0.001$).

We checked the assumptions of normal distribution of our response variables (Shapiro and Wilk, 1965) and use log-transformed data when it was possible to obtain a reasonably normal distribution (i.e. NDVI). When the normal distribution was not obtained even after transforming data, we fitted our models using Poisson distribution (i.e., bird species richness). However, for the nature connectedness response variable, which is ordinal with natural and ordered categories, we performed an Ordered Probit Analysis using the "ordinal" package and probit link (Christensen, 2023; Ferreira and Moro, 2013). To check for potential interactions between the latent classes and our predictors on these response variables, we included an interaction of the latent class membership with all the independent variables included in the models.

We then used a stepwise backward selection method to simplify the models (Crawley, 2013; Marhuenda et al., 2014). Thus, starting with interaction terms, variables with the highest p-values were first removed, and the procedure repeated until the best model (containing significant effects) was selected as the one with the lowest Akaike Information Criterion value (Burnham and Anderson, 2002). We set statistical significance at p-value <0.05.

Table 2
Goodness of fit of Latent Class Analysis of human-nature interaction in southern Nigeria (n = 600).

Class	Log Likelihood	Bayesian Information Criterion	NFP
2-class	**−8968.52**	**19,197.23**	**197**
3-class	−8742.85	19,379.18	296
4-class	−8521.19	19,569.16	395
5-class	−8368.98	19,898.05	494

Note: NFP = Number of Free Parameters of the Mixture Model. The best model (2-class) is highlighted in bold.

3. Results

3.1. Description of the sample

The study sample was balanced in terms of gender and the number of respondents from each city. Participants ranged in age from 14 to 72 years old (Mean ± SD = 34.89 ± 11.69 years). Approximately, 40% of the participants had a secondary school education, 30% technical school, and 20% university education. In terms of marital status, most of the participants were married (59.7%). In relation to income, 49% of the respondents who indicated their monthly income chose the lower range (<$73). This low-income level is very similar to that found by the Nigeria Poverty Map, which reveals that about 4 of 10 Nigerians (40%) are poor according to the 2018/19 national monetary poverty line (National Bureau of Statistics, 2023). In fact, when other factors, such as deprivations in cleaner cooking energy, sanitation, healthcare, food insecurity, housing, and education, were incorporated (termed multi-dimensional poverty), the poverty level increases to 63%. Given that the data also show that poverty level in northern Nigeria (65%) is higher than in the south (35%; our study area), and is also higher in rural (72%) than in the urban areas (42%) (National Bureau of Statistics, 2023), our data could be considered a fair representation of urban areas in southern Nigeria (cf. Table S1). The descriptive statistics of socioeconomic characteristics and other variables are given in Table 3.

Table 3
Descriptive statistics of the main variables of the questionnaire: current nature experience, previous experiences and setting, nature connectedness, perception of nature, safety perception and socioeconomic characteristics.

Variables	Obs	Mean / %	Std. dev.	Min	Max
Current experience of nature					
Duration	500	2.24	0.841	1	5
Visits	598	2.115	1.544	1	6
Plants	598	2.296	1.762	1	6
Animals	597	2.323	1.810	1	6
Previous experiences and setting					
Childhood frequency of nature contact	596	10.675	5.997	3	18
Living outside current city	599	0.841		0	1
Nature connectedness					
Nature connectedness (INS)	597	3.173	2.132	1	7
Perception of nature					
Perception of neighborhood naturalness	597	2.931	0.938	1	5
Perception of bird types	596	2.678	1.055	1	5
Safety perception					
Safety	596	3.5	1.134	1	5
Socioeconomic characteristics					
Age	572	34.886	11.686	14	72
Gender (female)	600	0.503		0	1
Marital status					
Single	598	0.383		0	1
Married	598	0.597		0	1
Divorced	598	0.012		0	1
Widow	598	0.008		0	1
Children	600	1.965	1.886	0	10
Education					
no formal education	583	0.012		0	1
Primary	583	0.098		0	1
Secondary	583	0.401		0	1
technical/polytechnic	583	0.290		0	1
University	583	0.199		0	1
Employment status					
self-employed	592	0.578		0	1
employed by someone	592	0.329		0	1
not employed	592	0.093		0	1
Income					
<$73	418	0.490		0	1
$73–$145	418	0.258		0	1
$145–$218	418	0.086		0	1
$218–$290	418	0.089		0	1
>$290	418	0.077		0	1

3.2. Latent class membership: patterns of nature experience

Through the LCA, we identify unobserved groups or classes of cases that explain associations between the indicator variables (contact with nature and socio-demographic characteristics). Overall, the LCA disaggregated the sampled respondents into two classes: Class 1 (low nature contact, $n = 323$) and Class 2 (high nature contact, $n = 277$) as shown in Figs. 3 and 4.

Regarding human-nature interaction, a large proportion of the respondents in Class 1 reported to never visit natural areas (Fig. 3a) nor observe animals (Fig. 3b) or plants (Fig. 3c), and spend little time in natural areas (Fig. 3d) in comparison with Class 2. The differences between the two groups were more pronounced in terms of frequency of contact, while they were less evident in terms of the time spent in nature. For both groups, spending a few hours in nature was most common, although people in Class 2 are more likely to spend longer periods than those in Class 1.

In terms of socio-demographic variables, there were similar levels of interactions with nature by females and males (Fig. 4a), though a higher level of nature contact was observed among younger respondents (Fig. 4b), and those with slightly lower number of children (Fig. 4c). While Class 1 with low nature contact was dominated by married respondents, Class 2 has a more balanced proportion of married and single respondents (Fig. 4d). We found lower levels of nature contact among respondents with lower educational levels (e.g., secondary/high school) than those with higher qualifications, such as university and technical degrees (Fig. 4e). Regarding the studied cities, respondents living in Lagos showed lower levels of nature contact (Class 1) relative to others, such as Ibadan, where respondents interacted with nature more often (Class 2; Fig. 4f). Occupational status also seems to exert some influences on nature interaction behavior as we found that the group with lower contact with nature was mainly comprised of self-employed people (Fig. 3g). Finally, results of income are noteworthy, with respondents earning less than $73 showing lesser likelihood of nature contact (Class 1).

As for the declared reasons for infrequent interactions, the lack of time, money, and nearby natural areas was commonly reported across the two class memberships (Fig. 5). All stated reasons were relatively higher in Class 1 (low nature contact) than Class 2 (high nature contact).

3.3. Cognitive connection to nature

The results of our regression analyses showed interesting trends that consolidate the results obtained in the LCA. As anticipated, the Class 2, with higher nature contact based on the LCA, also demonstrated a significantly higher nature connectedness than Class 1 (Table 4; Fig. 6). Furthermore, while nature connectedness (independently of class membership) increased as the perception of neighborhood safety improves, we found no significant correlation between nature connectedness and whether respondents ever lived outside their current city or not (Table 4). The only significant interaction effect shows a negative correlation between nature visitation during childhood and Class 2 (Table 4; Fig. 7).

We found a negative significant correlation between respondents' perception of neighborhood naturalness and the real (measured) naturalness estimated through NDVI irrespective of class membership ($t = -2.600$, $p = 0.010$; Fig. 8a; Table S2). In addition, we found no significant association between the respondents' perception of types of birds (independently of class membership) and the real (measured) bird species richness ($t = -1.080$, $p = 0.280$; Table S3). Exploring this dissociation further revealed that perception of neighborhood naturalness and types of birds significantly (positively) correlated (r (593) = 0.33, $p < 0.001$; Fig. 8b). Finally, the bird species detected in our censuses showed 35 different bird species of 22 families (Table S4). Of this

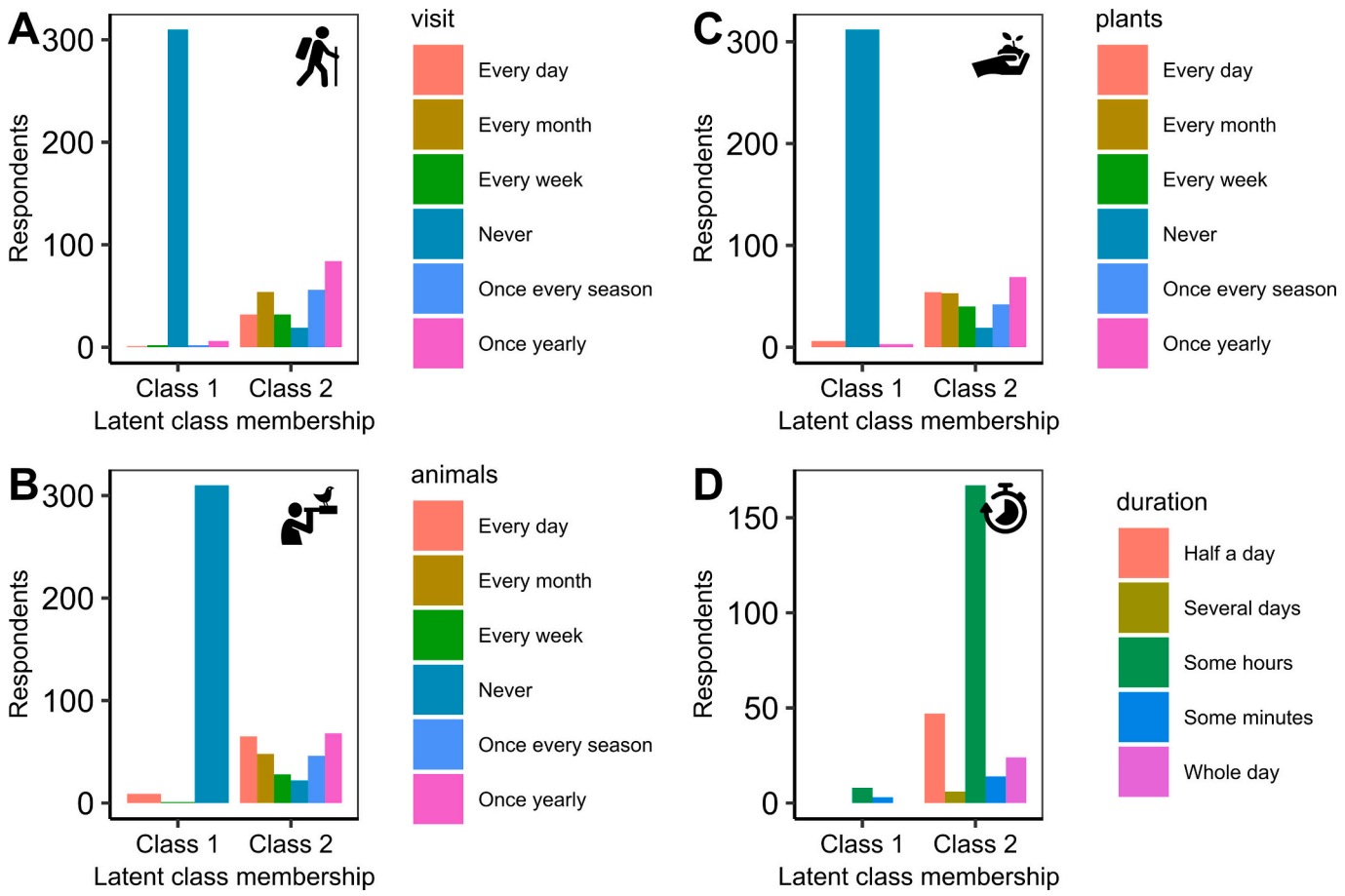

Fig. 3. Latent class membership of nature contact among sampled urban populations in Nigeria.

total bird species, 23, 19, 16 and 16, were recorded in Ibadan, Auchi, Calabar and Lagos, respectively.

4. Discussion

Many cities in the Global South are growing rapidly, leading to the loss of biodiversity (Seto et al., 2012; United Nations, 2019a). This urbanization process also has the potential to disconnect people from nature as supported by our findings. Our study analyzed the human-nature connection from a broad perspective, considering both the experiential and cognitive dimensions, as well as their interrelationships and shows a high level of extinction of experience in Nigeria. Thus, it fills an important knowledge gap by broadening our understanding of this crucial process from a Global South perspective (Barragan-Jason et al., 2022; Pett et al., 2016).

4.1. Relationships between experiential connection to nature and socioeconomic and demographic variables

Our study reveals a relatively large proportion of people with no nature experiences, corroborating the weakening of the relationship with nature reported by previous studies (Binoy et al., 2021; Cox et al., 2017; Imai et al., 2019; Soga et al., 2018). Despite this consistency of results, the proportion of people who never interacted with nature in this study (55%) was substantially higher than those reported from the Global North, where such proportion was ≤10%, whether considering only urban greenspaces (Ishibashi et al., 2020; Soga et al., 2015) or a wide variety of natural places (Colléony et al., 2017). The obtained low levels of contact with nature were particularly striking, especially given the temporal context of this study. We conducted our surveys in 2021 after the lock-down measures taken to curb the Covid-19 pandemic, when Lee et al. (2022) predicted a surge in nature experiences in Africa. Studies from other geographic areas have reported changes in preferences for contact with nature after the coronavirus crisis, favoring a higher frequency of visits to natural areas (Berdejo-Espinola et al., 2022; Lenaerts et al., 2021; Stankowska and Stankowska-Mazur, 2022).

However, distancing from nature did not occur homogeneously among the study participants. The performance of the LCA allowed us to disaggregate the respondents into two homogenous groups differing in their behavioral tendencies. Despite its potential benefits, this methodological approach is seldom used to investigate human-nature interactions so far (Batool et al., 2022; Huynh et al., 2022; Jorgensen and Meis-Harris, 2022). Based on the segmentation of the intensity of nature contact by the LCA, the socioeconomic and demographic variables investigated in this study reveal important patterns that could be useful to improve our understanding of human-nature interactions from an African perspective. Our result showing a lower level of nature contact among older respondents suggests the potential influence of ageing that could limit the ability of older people from visiting nature more often, a pattern revealed by previous studies (e.g., Freeman et al., 2019). In contrast, the higher nature contact among younger respondents could also be associated with the recent increasing environmental consciousness across the world (e.g., Urbański, and ul Haque, A., 2020). However, if that applies to the study area, we would have expected that respondents with a higher number of children (synchronizing with recent decades) to experience nature more often, which was not the case here. This contrasting result suggests the influence of other potential factors. For instance, a higher number of children could imply higher family responsibilities for our study participants, and consequently reducing investments (e.g., time) on nature contact. Supporting this position

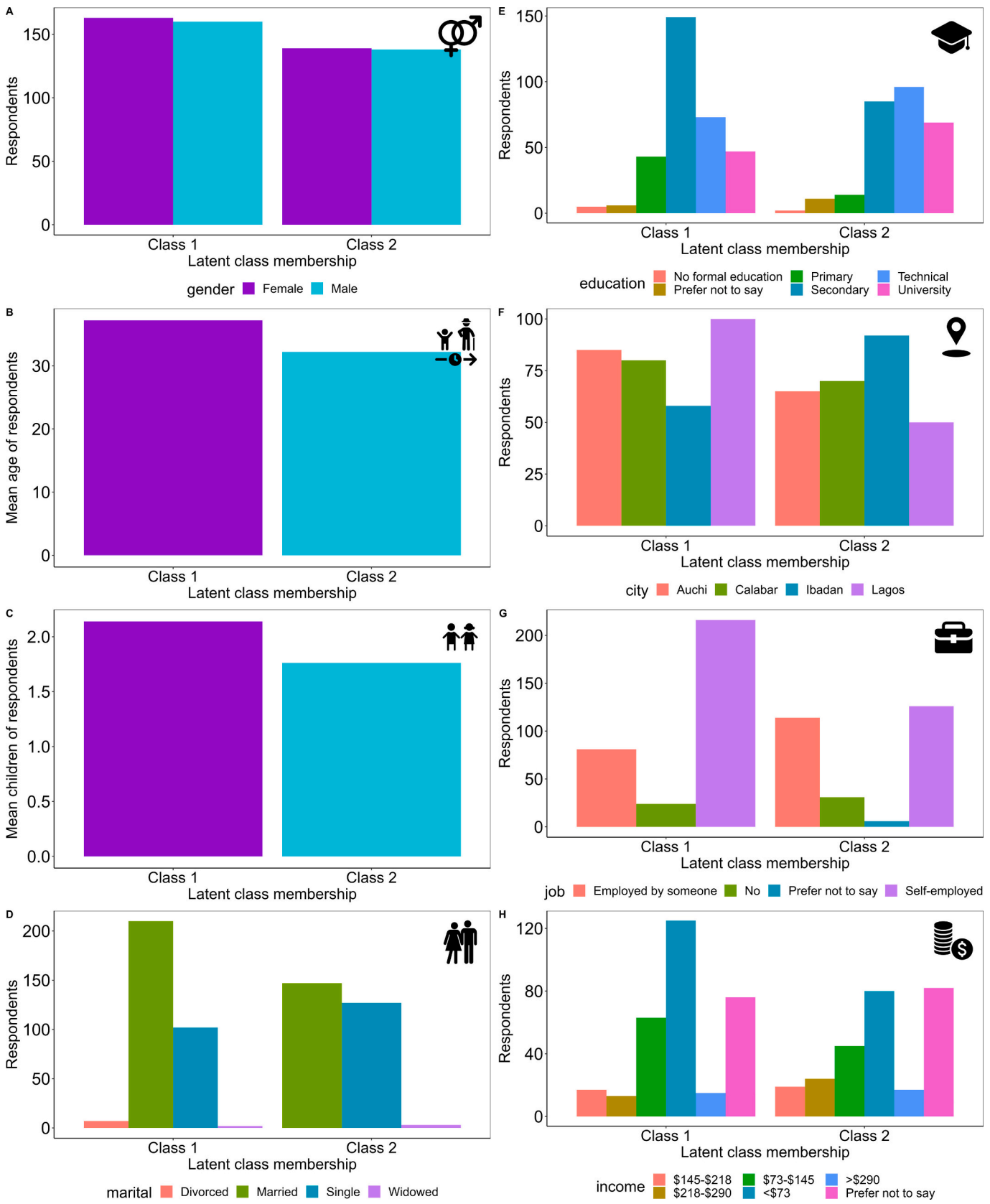

Fig. 4. Latent class membership of socio-demographic variables of sampled urban populations in Nigeria.

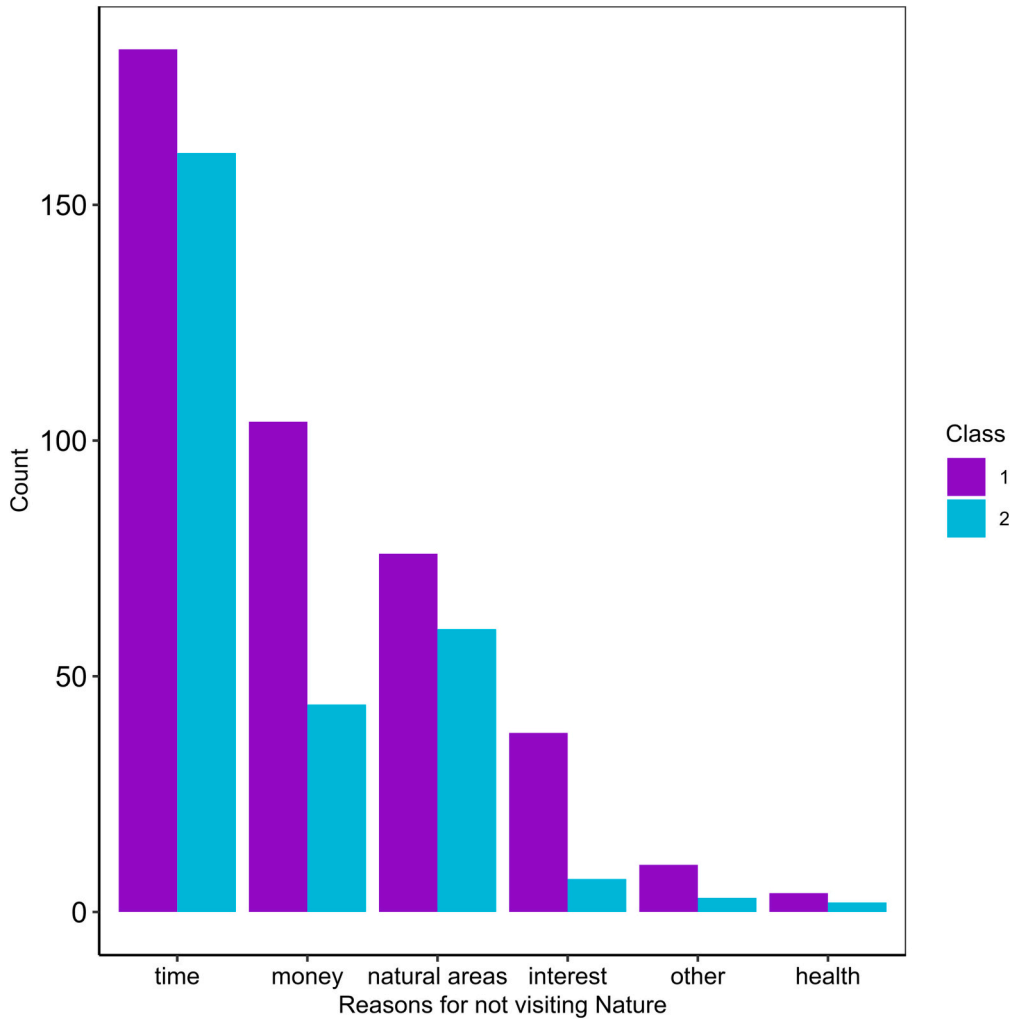

Fig. 5. Differences among latent classes of declared reasons for infrequent interactions with nature among sampled urban populations in Nigeria.

Table 4
Results of an Ordered Probit Model exploring the predictors of nature connectedness in Nigeria. It includes the best model (AIC = 1981.97), and the statistically non-significant and rejected interaction effects.

	Estimate (SE)	*p*-value
Class 2	1.438 (0.19)	< 0.001***
Safety	0.065 (0.04)	0.106
Childhood frequency of nature contact	0.025 (0.01)	0.016*
Lived outside current city	0.111 (0.12)	0.369
Class 2 * Childhood frequency of nature contact	−0.035 (0.02)	0.022*
Rejected variable		
Class 2 * Safety	−0.004 (0.08)	0.963
Class 2 * Lived outside current city	0.119 (0.246)	0.628

Note: Significant effects are indicated by * at *p* values <0.05, and *** at *p* value <0.005. Threshold Coefficients of the final model show estimate (se): 1|2 = 0.556 (0.22); 2|3 = 1.026 (0.22); 3|4 = 1.417 (0.22); 4|5 = 1.887 (0.22); 5|6 = 2.027 (0.22); 6|7 = 2.320 (0.23).

regarding higher responsibilities, we also show that low nature contact was more prominent among married participants in comparison with those identified as being single. Nevertheless, environmental education shows promise in mitigating the low level of nature contact in Nigeria as our result already shows that nature contact is higher among more educated respondents.

Meanwhile, Lagos holds the largest proportion of respondents with low nature contact, which is hardly surprising. On the one hand, Lagos is one of the most rapidly developing cities in the world (World Cities Report, 2020), which could have negative impacts on the associated biodiversity. This is supported by our study given that we recorded the lowest bird species richness in this city relative to others. Birds are an important animal group that promotes the interconnectedness of people with nature across different cities (e.g., Cox and Gaston, 2015). This could in part explain why Ibadan respondents experience nature more often relative to those sampled in each of the remaining studied cities. In addition to the highest bird species richness, the Ibadan Bird Club was established in 2014, growing in membership and meeting at monthly intervals, to promote birdwatching around the city of Ibadan, consequently reconnecting people with nature in the area (Awoyemi and Bown, 2019). On the other hand, Lagos is the center of economic activities in Nigeria (National Bureau of Statistics, 2023), which could partially restrict nature contact too. For instance, our result showing low nature contact among respondents that were self-employed than those employed by someone or had no job, suggests that people in the study area could prefer to invest more time in their businesses to boost their

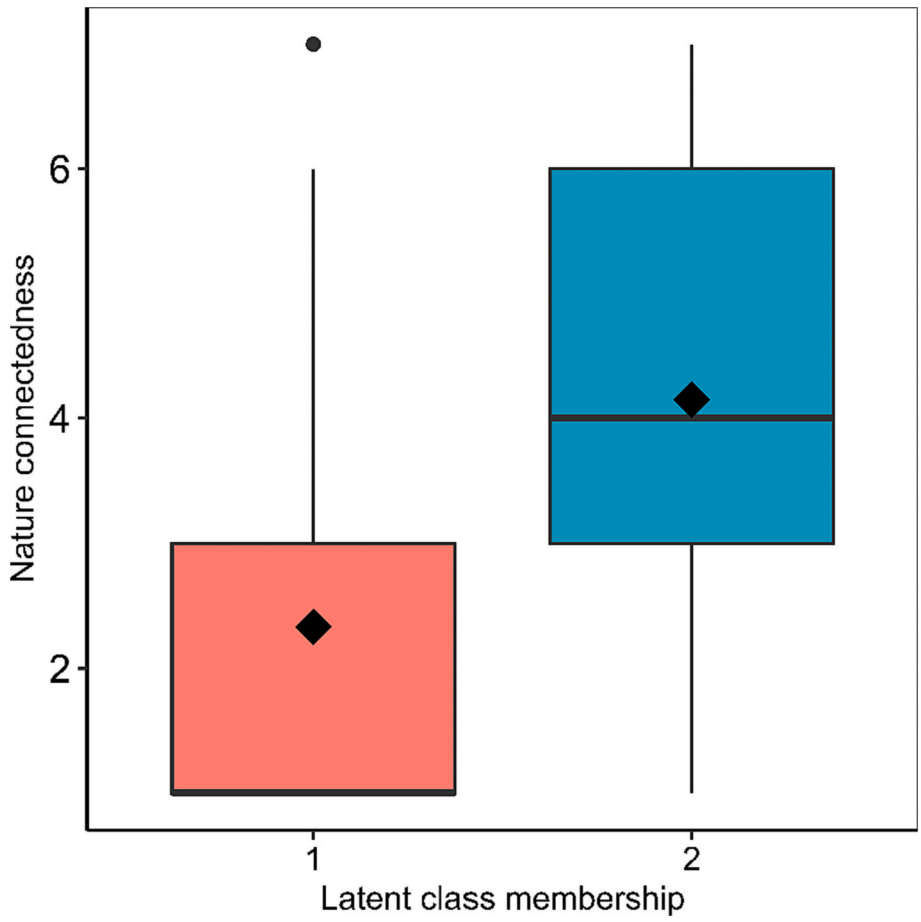

Fig. 6. Differences in nature connectedness between Class 1 (low nature contact) and Class 2 (high nature contact) of respondents sampled in Nigeria. The boxplots show the mean (black rhombus), median (bar across rectangles), upper and lower quartiles and extreme values.

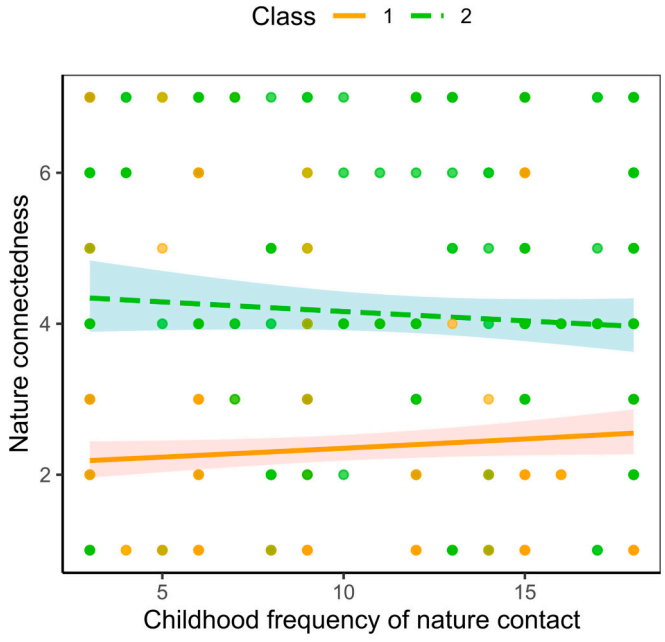

Fig. 7. Interaction between nature connectedness and visitation to natural areas during childhood between Class 1 (low nature contact) and Class 2 (high nature contact).

income and profit. This makes sense given that the majority of respondents earn less than $73 monthly, particularly those in the class with low nature contact. Our results are unique in this respect by allowing us to quantify the influence of socioeconomic and demographic variables on an additional facet of living standard (i.e., human-nature interaction), which is now recognized globally as an antidote against mental health issues (Keniger et al., 2013; Tillmann et al., 2018).

4.2. *Factors influencing cognitive connection to nature*

Our study supports the growing body of literature (e.g., Lumber et al., 2017; Tam, 2013) showing the positive associations between nature contact (i.e., experiential connection) and connectedness (i.e., cognitive connection). Here, the investigated nature connectedness based on the Inclusion of Nature in Self Scale (Schultz, 2001, 2002) reveals interesting findings. Overall, the perceived relationship between self and nature was very weak, with a third of the respondents perceiving themselves as completely separate from nature. This could be due to the low level of direct interaction with nature, as the different dimensions of nature connection may interact and influence each other (Ives et al., 2018). The results of the Ordered Probit Analysis support this idea, as Class 2 (high nature contact) shows a significantly higher connectedness too.

As expected, the perception of safety by respondents positively correlates with nature connectedness irrespective of class membership, reinforcing previous findings (e.g., Sedawi et al., 2020). This result is crucial for potential decision-making and actions. For instance, the non-urban sites (e.g., wilderness, national parks and forest reserves) where people could also connect with nature are riskier in Nigeria (Ojukwu,

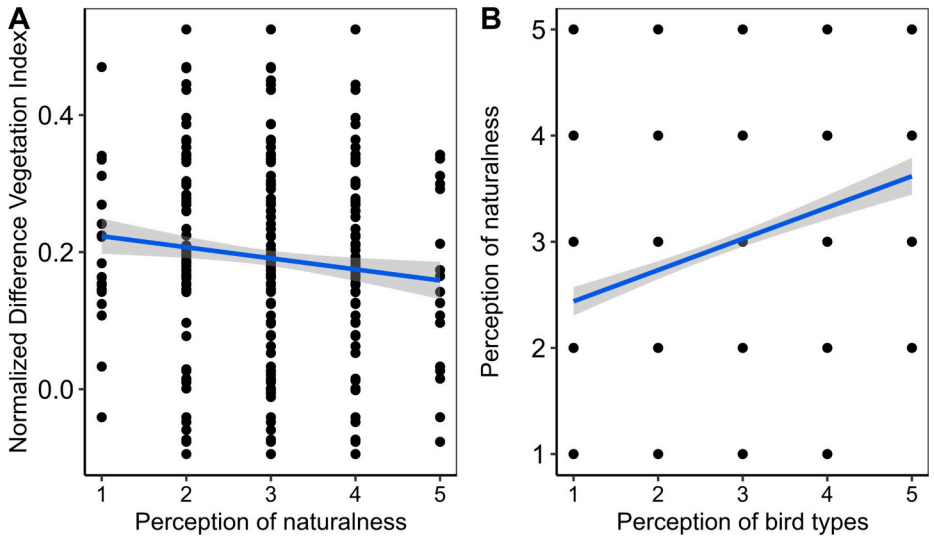

Fig. 8. (a) Association between perception and real (measured) neighborhood naturalness in Nigeria, (b) Correlation between perception of neighborhood naturalness and perceived number of bird types in Nigeria.

2011; Otu et al., 2018), suggesting that the perception of safety risks in the cities could further aggravate the low level of nature connectedness detected in our study. On this note, we call for the need to make urban greenspaces safer in Nigeria, and potentially in other areas of the Global South, where this peculiar situation exists.

Regarding the variables relating to participants' past, nature connectedness did not significantly correlate with whether respondents had lived outside their current city, but significantly declined with increasing number of visits to natural areas during childhood (for the Class 2 with high nature contact). These results contradict the notion that earlier (childhood) experiences in nature are very important for developing a strong bond with nature during adulthood (Passmore et al., 2021; van Heel et al., 2023). Nevertheless, our results are encouraging as they suggest that strong nature connectedness could still be developed later in life regardless of the individual's background.

Perhaps, surprising were our results showing a dissociation between real (measured) and perceived neighborhood naturalness and bird species richness independently of class membership. Here, NDVI significantly (negatively) correlates with the perception of neighborhood naturalness by the respondents on the one hand. This result suggests that the study participants were probably not aware of, not interested in or even underestimate the amount of greenness in their neighborhood, which is plausible given the low nature contact and connectedness detected in this study. This is particularly concerning given that our research focused on the immediate vicinity, where respondents could interact with nature on a daily basis. It is also possible that the respondents were rather more interested in certain plant parts like flowers or fruits (see Shwartz et al., 2014) than the amount of green vegetation in their neighborhood, pinpointing the need to investigate further the items that attract people to nature in the area. On the other hand, we found no significant association between the real (measured) and perceived bird species richness of the neighborhood. Poor identification skills could make it difficult for the study participants to differentiate the different kinds of birds found in their neighborhood, potentially leading to an important underestimation. Our result showing a positive significant correlation between the perception of neighborhood naturalness and bird species richness supports this position, and in general could indicate the need for additional educational activities involving birds (like those performed in the area by the Ibadan Bird Club or the A.P. Leventis Ornithological Research Institute; https://www.aplori.org/) in order to improve the value of nearby urban nature.

In general, studies have shown a weak relationship between real and perceived biodiversity while recommending different ameliorative strategies (e.g., Belaire et al., 2015; Dallimer et al., 2012; Shwartz et al., 2014). In the UK for example, the deployment of bird feeders shows promise in mitigating the gap between perceived and actual bird species richness (Cox and Gaston, 2015). However, we did not record any act of feeding wild birds during our survey, an uncommon practice in Nigeria. Since respondents with higher levels of education experienced nature more often according to our results, environmental education could be more applicable in bridging the gap in biodiversity knowledge in the Nigerian context.

4.3. *Reasons for infrequent nature visitation*

The main reason participants gave for not interacting with nature more often was the lack of time. This finding is in line with that found by Boyd et al. (2018) that revealed "too busy at work" or "too busy at home" as the two main reasons for not visiting natural environments. As these authors pointed out, more research is needed to understand how people prioritize and allocate their time across different activities.

The lack of money was the second most important reason for not visiting natural areas more often given by respondents in Class 1 (low nature contact). Given the various economic crises experienced by Nigeria, particularly during the Covid-19 Pandemic (Ozili, 2021; Stanley et al., 2020), respondents might have to prioritize the items on which they expend their limited income, which was <$73 for almost half of the respondents (49%). This total monthly income will, for example, only cover a 2-day return travel for a person to visit the Okomu National Park from Lagos, suggesting why respondents in our study may not have enough money to visit natural areas amidst other demanding living expenses like feeding, housing, healthcare, and education. It is thus hardly surprising that people with higher incomes tend to visit greenspaces more frequently (Jones et al., 2009), spend more time in them (Soga and Akasaka, 2019) and participate more in nature-based activities (Hosaka et al., 2018). On the one hand, higher incomes could enhance mobility due to the availability of private vehicles and capacity to travel farther to explore more natural areas (Martinez-Harms et al., 2018). On the other hand, wealthier neighborhoods tend to have higher quality greenspaces that are relatively easier to explore (Cox et al., 2017; Hoffimann et al., 2017), a pattern known as the luxury effect that is present in various urban ecosystems and cities around the world including Africa (Chamberlain et al., 2019; Leong et al., 2018).

Another main reason why respondents did not increase their nature experience was the lack of natural areas nearby. This reason was particularly noticeable among members of Class 2 (high nature contact),

suggesting the existence of people who would like to interact more with nature but lack the opportunities to do so. This result could be explained from two dimensions. First, it could be due to the respondents' lack of knowledge/awareness of the urban nature associated with their immediate environment as we had found a no significant or even negative associations between the real and subjective perception of nature and birds. Second, it could have arisen from the lower levels of biodiversity associated with urban centers in our studied cities. For instance, the cities included in our investigation are located in southern Nigeria, a region in Africa that has experienced an exponential loss of forest cover stemmed from different factors (FAO, 2011; Popoola, 2016), particularly urbanization (Awoyemi and Ibáñez-Álamo, n.d.; Seto et al., 2012). This urban expansion seems to be an important predictor of people's affection for nature in the area (Bashan et al., 2021). For instance, Lagos is the most densely populated of the sampled cities (9270 people/km^2), but also holds the highest number of respondents who never visited natural areas as well as the lowest bird species richness. Although accounting for a small fraction, our study also reveals the lack of interest and health issues as reasons for not visiting nature more often.

4.4. Study limitations and future research directions

Before concluding, some limitations of the study should be highlighted, one of which lies in the cross-sectional nature of our data. Although we could identify relationships between variables, we were only able to interpret them in terms of associations and could not infer cause-effect relationships. Secondly, to assess interactions with nature (e.g., Soga et al., 2016; Yamanoi et al., 2021), we considered activities beyond mere exposure but involving experiencing nature through different senses (Colléony et al., 2020a, 2020b; Moss, 2012). However, some behaviors may constitute a negative form of engagement with nature if they involve unintentional harm to wild species and habitats (e.g., picking flowers or touching animals). Although this is beyond the scope of our paper, it would be valuable for future studies to examine the activities that people undertake in nature, distinguishing their effects on people, flora and fauna.

Another aspect of the present study that should be considered for future investigation is that most participants reported to have lived outside their current city (84%). However, we did not collect further information on where they actually lived in the past, preventing us from knowing whether the participants grew up in an urban or rural area, which may have important implications. Only direct and intentional contact with nature during childhood was considered, ignoring the possible influence of incidental exposure to natural areas during early life. Other potentially relevant information such as the type (wild or managed), quality and distances of natural environments or the motivation to visit them could also be important in this context (Clayton et al., 2017; Colléony et al., 2020a; Soga et al., 2015; Y. Zhang et al., 2017). We therefore encourage future studies to gain a deeper understanding of nature experiences by overcoming the limitations of our study. Despite these limitations, we hope that our study will help to outline a clearer picture of the relationship that residents of urban areas in Nigeria (and potentially inhabitants of other African countries) have with nature.

5. Conclusion

Expanding our knowledge of human disengagement from nature is necessary if we are to take measures to reverse it. Differences between countries and cultures demand regional studies, so that possible measures can be tailored to the specificities of each context (Bashan et al., 2021; Colléony et al., 2019). The bulk of research on human-nature interactions is based in Global North countries, but the extinction of experience is not a phenomenon unique to these countries. To our knowledge, this is the first study that assessed the extinction of experience by analyzing patterns of interaction with nature and its determinants in the Afrotropics.

Using a reasonably large sample of Nigerian adults, we found evidence of a strong distancing of people from the natural world, indicating an important level of extinction of experience that is even more pronounced than previous studies have found in other areas. A second conclusion of this study is that low nature contact was more prominent in Lagos, and among those respondents with lower educational and income levels. Interestingly, we found a positive significant association between experiential and cognitive nature experiences, and that neighborhood safety is a promoter of nature connectedness. On the one hand, our study reveals a strong dissociation between real (measured) and perceived neighborhood naturalness and bird species richness. On the other hand, the perception of neighborhood naturalness and bird types significantly (positively) correlated. Finally, we identified the lack of time, money and nearby natural areas as the main reasons for not visiting natural areas more often in the area and provided some useful recommendations to try to revert the observed disconnection with nature by Nigerians. We hope that the findings of this study will help in the design of interventions that favor direct and intentional contact with nature for urban residents, so that the benefits associated with this contact can reach broad segments of the population.

CRediT authorship contribution statement

Adewale G. Awoyemi: Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **Nazaret Ibáñez-Rueda:** Writing – original draft, Visualization, Methodology, Formal analysis. **Jorge Guardiola:** Writing – review & editing, Methodology, Formal analysis. **Juan Diego Ibáñez-Álamo:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no conflict of interest.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2024.108105.

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