Urban green space brings happiness when money can't buy it anymore
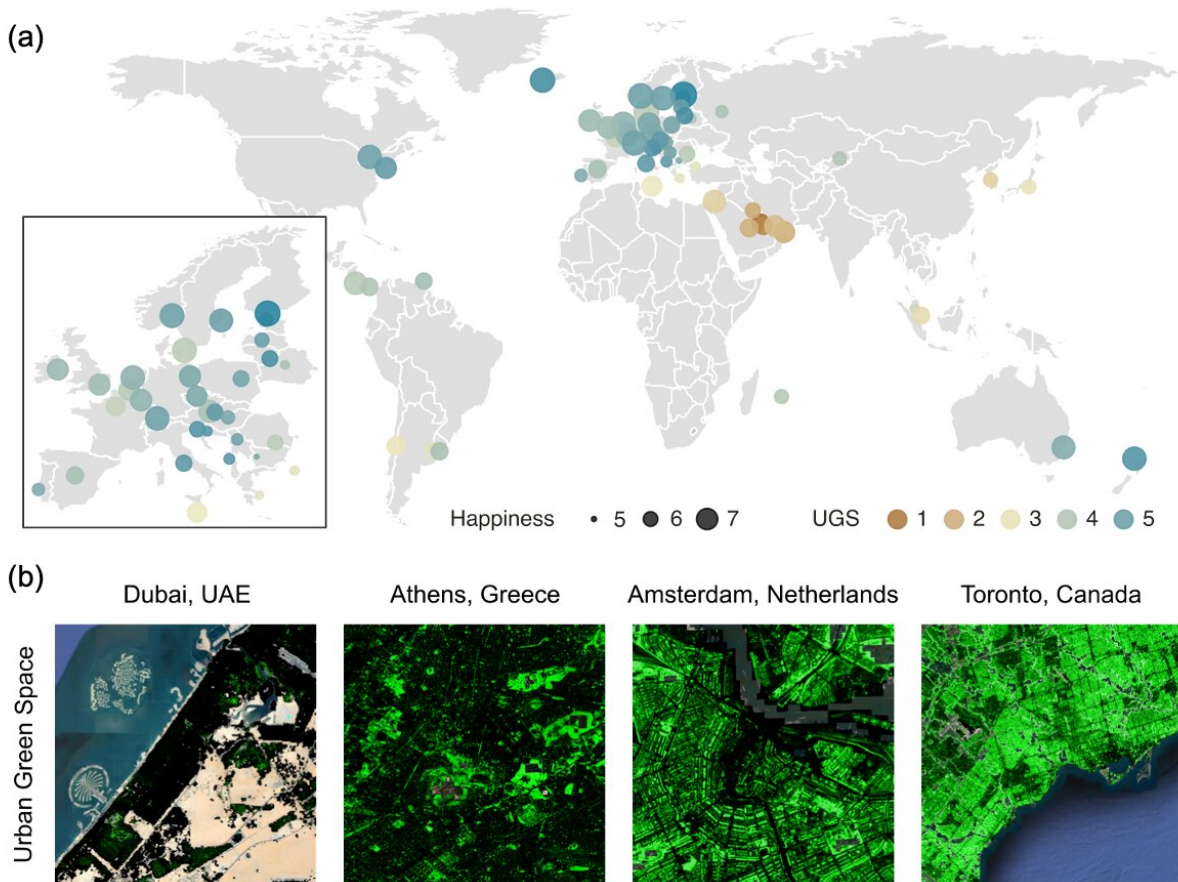
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Figure 1. (a) The map of urban green space and happiness in 60 developed countries. The size and color of circles represent the level of happiness and urban green space in a country, respectively. The markers are placed on the most populated cities of each country. (b) Urban green space is measured by the UGS in four world cities. The green areas indicate the adjusted NDVI per capita (i.e., UGS) for every 10m by 10m pixel. Credit: Institute for Basic Science

Urban green spaces, such as parks, backyards, riverbanks, and urban farmlands, are thought to contribute to citizen happiness by promoting physical and mental health. While a number of previous studies have reported the mental benefits of green space, most had been conducted in the affluent parts of the world like the United States and Europe, and only a few involved a multi-country setting.

Lack of data had been the main limitation in carrying out these studies because there is no global medical dataset that can provide reliable and standardized mental health surveys from different countries. Another challenge involves a systematic method to measure the amount of green space across countries. Various methods of measuring green space—questionnaires, qualitative interviews, satellite images, Google Street View images, and even smartphone technology still rely on individual-level measurements and hence are not scalable to the global level. These challenges left the question of the association between the positive effect of green space on mental health open and unanswered for many countries with different socioeconomic conditions.

Led by the Chief Investigator and an Associate Professor Cha Meeyoung at the Institute for Basic Science (IBS) and Korea Advanced Institute of Science and Technology (KAIST) in Daejeon, South Korea, an international collaboration of researchers from POSTECH, Max Planck Institute, New Jersey Institute of Technology, and the National University of Singapore set out to tackle the issue. The new study which was published in the journal *EPJ Data Science* identified the global correlation between urban green space and happiness in 60 countries using a satellite imagery dataset.

Using the Sentinel-2 satellite imagery dataset, the team measured each country's urban green space score as the total vegetation index per

population in the most populated cities. A total of ninety cities in sixty countries were chosen to represent at least 10% of the population in the studied countries. For a clear view, only the satellite imagery data from summertime were used for analysis, which is June to September for the Northern Hemisphere and December to February for the Southern Hemisphere. The happiness score was taken from the *World Happiness Report* published by the United Nations.
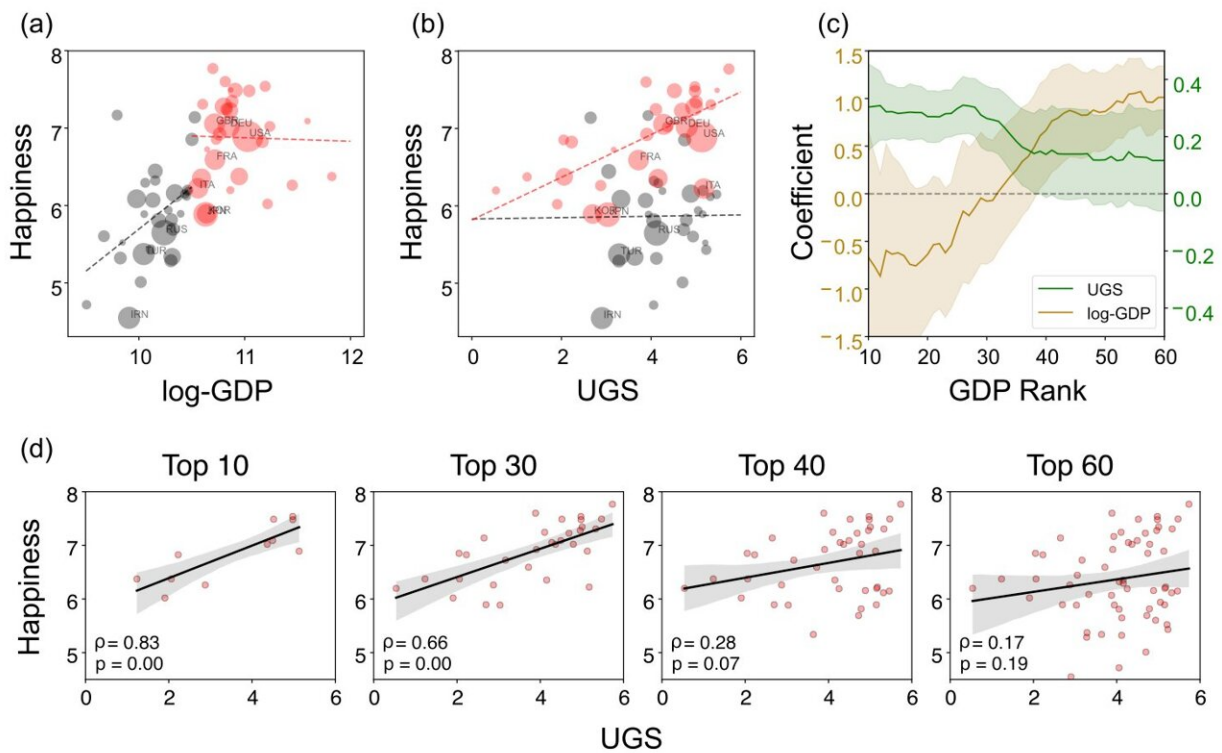

Figure 2. The relations of (a) log-GDP and happiness, and (b) urban green space (i.e., UGS) and happiness across 60 developed countries. The top 30 and the lowest 30 countries ranked by GDP are sized by the population size and colored by red and black. The dotted lines are the linear fit for each GDP group. (c) Changes of coefficients between urban green space and happiness for different sets of GDP rank with increasing window size from top 10 to 60. (d) The rank correlations between UGS and happiness for the groups of countries in the increasing GDP rank order. Credit: Institute for Basic Science

The team found a significant positive correlation between urban green space and happiness across all countries. Urban green space adds increased happiness compared to the baseline happiness value determined by the wealth of a nation. This relationship was robust for other socioeconomic conditions, including life expectancy, health expenditure, unemployment, gender inequality, and education.

The team also examined whether this association was uniform across all countries. Happiness in the top 30 wealthiest countries (i.e., GDP per capita of 38,000 USD or above) is strongly affected by the amount of urban green space, whereas the GDP per capita is a more critical factor of happiness in the bottom 30 countries. This finding corroborates the conventional wisdom that economic prosperity is crucial for happiness up to a certain level, after which urban green space is a better indicator of happiness. This finding coincides with a concept known as the Easterlin paradox, which tells us that increases in happiness through wealth reach a saturation point, after which the factors that improve happiness are unknown.

The team also identified a direct positive relationship between social support to urban green space. This indicates that the variable of social support can serve as a mediator between green space and happiness. This finding underlines the importance of maintaining urban green space as a place for social cohesion in support of people's happiness.

The authors point out their work has several policy-level implications. First, public green space should be made accessible to urban dwellers to enhance social support. If public safety in urban parks is not guaranteed, its positive role in social support and happiness may diminish. Also, the meaning of public safety may change; for example, ensuring biological safety will be a priority in keeping urban parks accessible during the
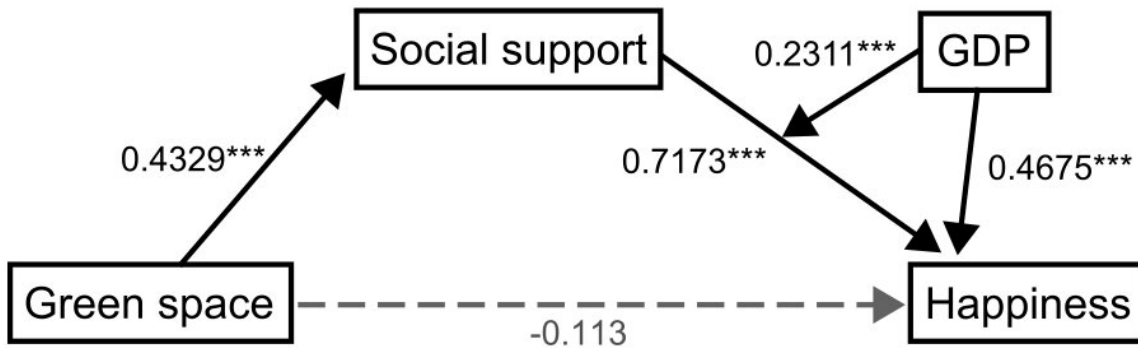
COVID-19 pandemic.

Figure 3. Diagram for the moderated mediation model between social support and green space. The boxes denote the model variables. Solid black arrows denote a statistically significant relationship between a pair of variables with the regression coefficient and the p-value (i.e., ***p

Second, urban planning for public green space is needed for both developed and developing countries. As it is challenging or nearly impossible to secure land for green space after the area is developed, urban planning for parks and green space should be considered in developing economies where new cities and suburban areas are rapidly expanding.

Third, recent climate changes can present substantial difficulty in sustaining urban green space. Extreme events such as wildfires, floods, droughts, and cold waves could endanger urban forests while global warming could conversely accelerate tree growth in cities due to the urban heat island effect. Thus, more attention must be paid to predict climate changes and discovering their impact on the maintenance of urban green space.

The authors also highlight the increasing demand for data-driven policy-making for citizens. "Big data from satellite imagery can provide great opportunities to

answer a variety of social issues. Our method can be used to quantify blue space at shores, and we may further study the relationship between blue space and happiness," says Dr. Cha.

Provided by Institute for Basic Science

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