

Department of Human Geography and **Spatial Planning**



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Short-term exposure sequences and anxiety symptoms: a time series clustering of smartphone-based mobility trajectories

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1. Background

The evidence of the environment-health association is limited to aggregated exposure estimates (e.g., daily considering without exposure averages per person), spatiotemporal variabilities in exposures. Using mean exposures along individuals' daily mobility paths to represent their exposures is possibly an oversimplified approach.

2. Methods

> Based on GPS tracking data, we determined individuals' space-time exposure series according to Fig 2.



Fig 1. Graphic abstract

This study aims to :

1) characterize individuals' daily sequential exposure patterns of green space, noise, and PM2.5 along their mobility paths.

2) examine how different daily sequential exposure patterns were associated with anxiety symptoms.

- > Multivariate time series clustering was used to characterize environmental exposure patterns.
- > Regression models were developed to test the associations between anxiety and sequential exposure patterns.



Four days of exposure time series for each participant with length of 576 exposure assessments in total

Fig 2. Assessment of exposure time series based on the GPS tracking data

3. Results

The multivariate time series clustering resulted in four clusters. Participants in each cluster were exposed to different ambient environments, which revealed distinctive daily exposure variations (Fig 3).







Fig 4. Regression coefficients and 95% CIs for the associations between the anxiety scores and the exposure patterns.

 \succ On average, participants in cluster 2, cluster 3, and cluster 4 tended to be associated with lower anxiety scores than participants in the reference cluster (i.e., cluster 1).

 \succ Only cluster 2 (i.e., the "moderately healththreatening") reached statistical significance.

4. Conclusions

The series clustering-based time sequential exposure patterns consider both the magnitude and variation of exposures (Fig 6), which is impossible traditional aggregation-based with approaches (Fig 5).



Our findings support the previously neglected notion that people's daily sequential exposure patterns may play a role in mental health.

Individuals Individuals Fig 5. Preprocessing of mobility-based exposure data using aggregationbased approach.



Individuals with the same color were assigned in the same cluster.

Contact: Yuliang Lan

06:00

09:00

- Green space

12:00

Fig 3. Sequential environmental exposure pattern of each cluster

Time (h)

15:00

- Noise

18:00

21:00

← PM_{2.5}

24:00

Email: y.lan@uu.nl

03:00

Exposures

-1

-2-