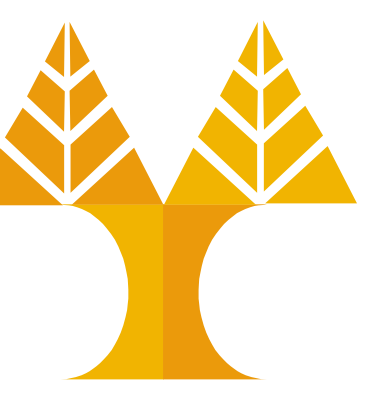


Beyond statistics: Network epidemiology to investigate contact tracing



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The potential of network analysis for infectious outbreak management was investigated. Network analysis showed infection transmission patterns between: elder individuals and healthcare professionals; young individuals; families (e.g. generational gap with age difference 30 years); districts that are closer geographically; and occupations related to healthcare, education and public administration.

Background

- Representing contact tracing data in the form of a network can provide insights and assist with pandemic management in the future.
- Using network analysis tools, can help assess interconnections and transmission heterogeneity, in multiple age and location population segments [1], enabling appropriate and expeditious intervention strategies [2].

Methods

- Anonymized transmission data of 21,084 infected individuals, from the first 4 COVID-19 waves, were provided by the Cyprus Ministry of Health. Data included gender, age, occupation (NACE) and residency information.
- Nodes in the network represented infected individuals and each edge was a confirmed transmission link between two infected individuals.
- District-to-district, age-group-to-age-group and occupation-to-occupation occurrences were used to construct district, age-group and occupation adjacency matrices.
- Centrality metrics e.g. outdegree, were used to identify super spreaders and assess vaccination campaigns.

Results

- Outdegree analysis:** Decreased outdegree values in older age groups and increased values in younger groups during the third and fourth waves were observed. This trend may be linked to targeted vaccination campaigns that prioritized older age groups.

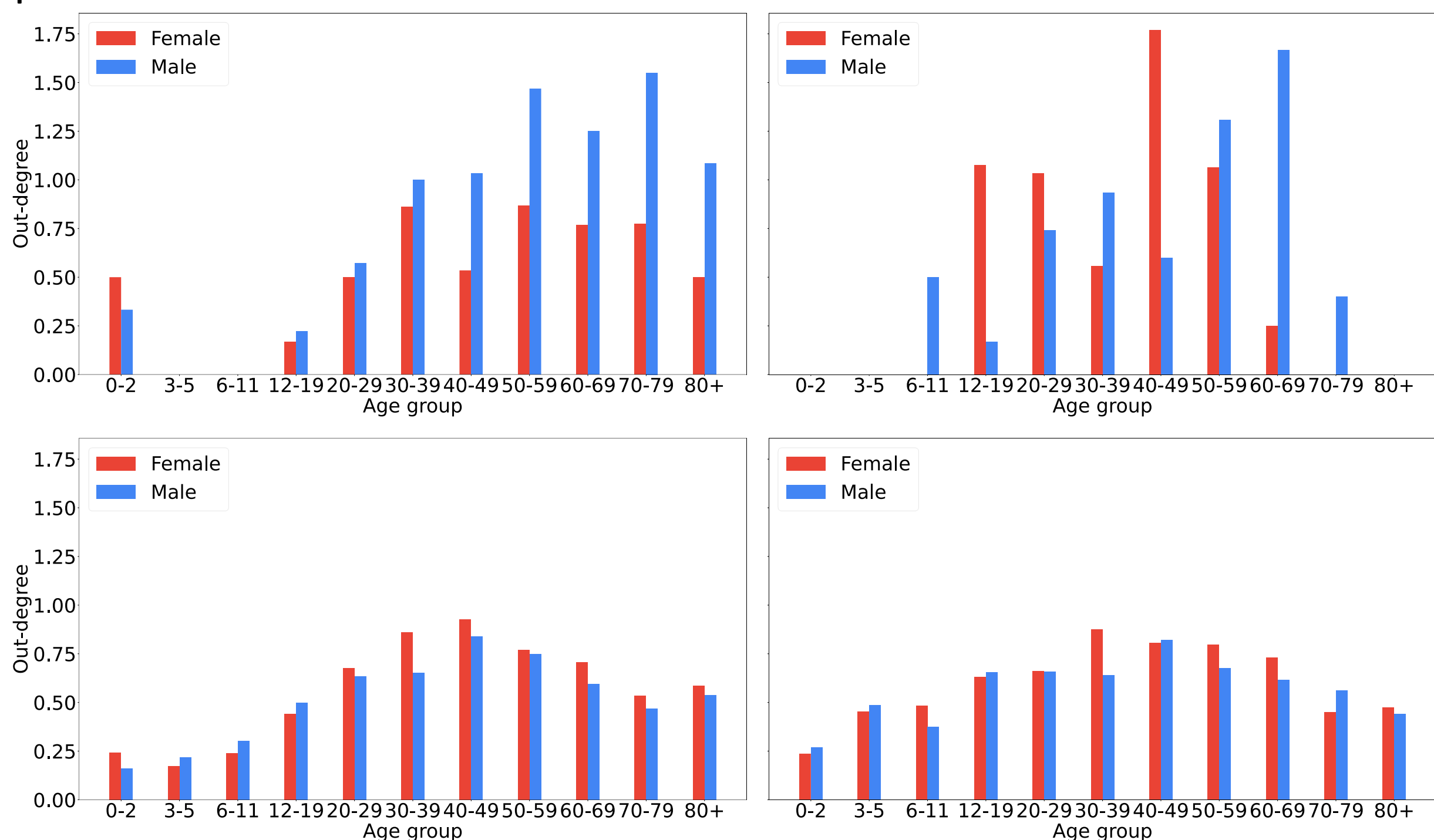


Figure 1: Average outdegree of individuals per age group. Outdegree centrality measures the number of transmissions to other nodes.

- District transmission patterns:** In general, revealed a tendency of transmission between locations that are closer geographically and major cities.

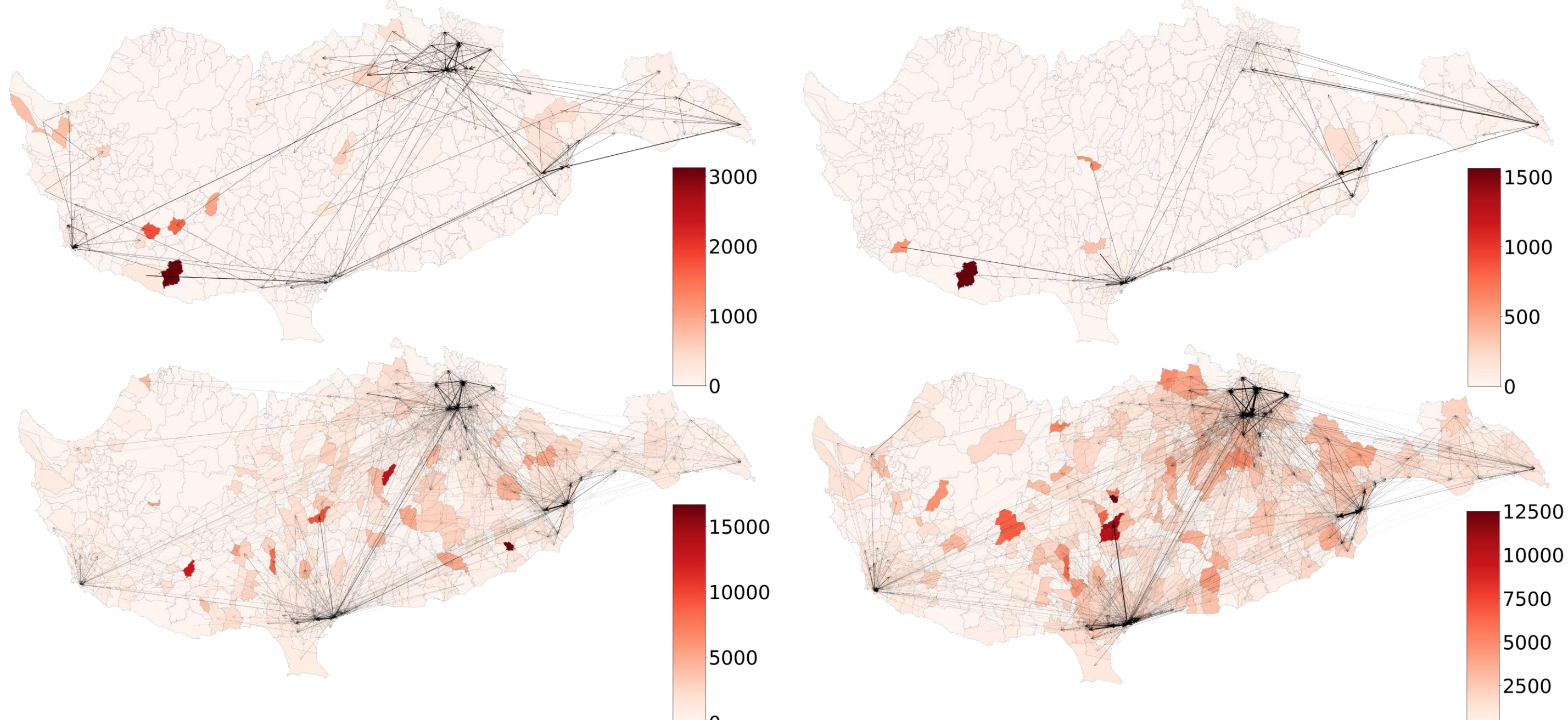


Figure 2: The postcode-to-postcode transmission network for the first 4th waves of pandemic. The thickness of the edges represents the number of transmissions and the colour the number of cases, normalized to the population.

Conclusions

- Network analysis was proven to be a valuable tool in understanding COVID-19 transmission dynamics. The findings provide epidemiologists and policymakers crucial information for guiding interventions, prioritizing resources, and making informed decisions to control and prevent the spread of the virus.

References

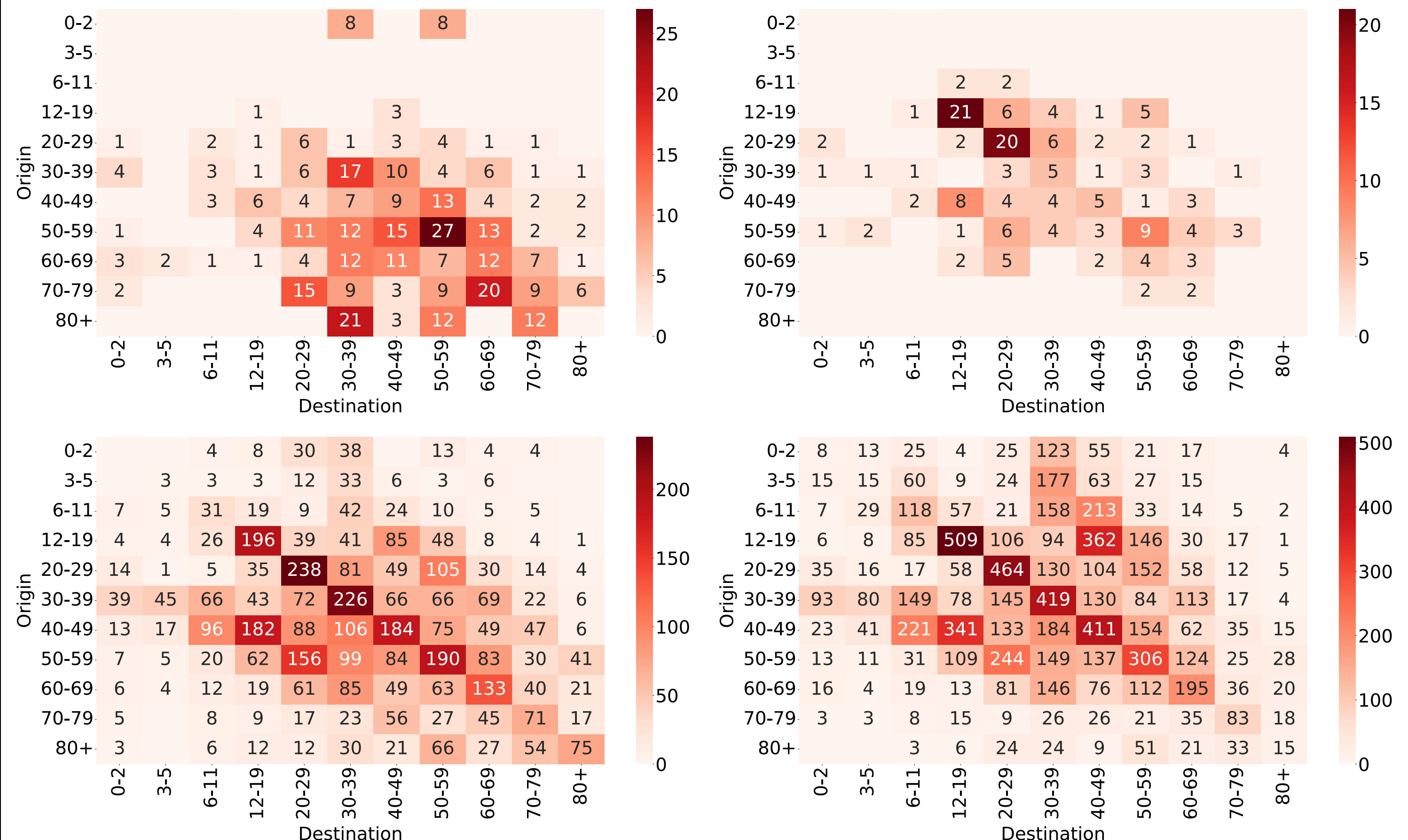
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Results Continued

- Age-group transmission patterns:**

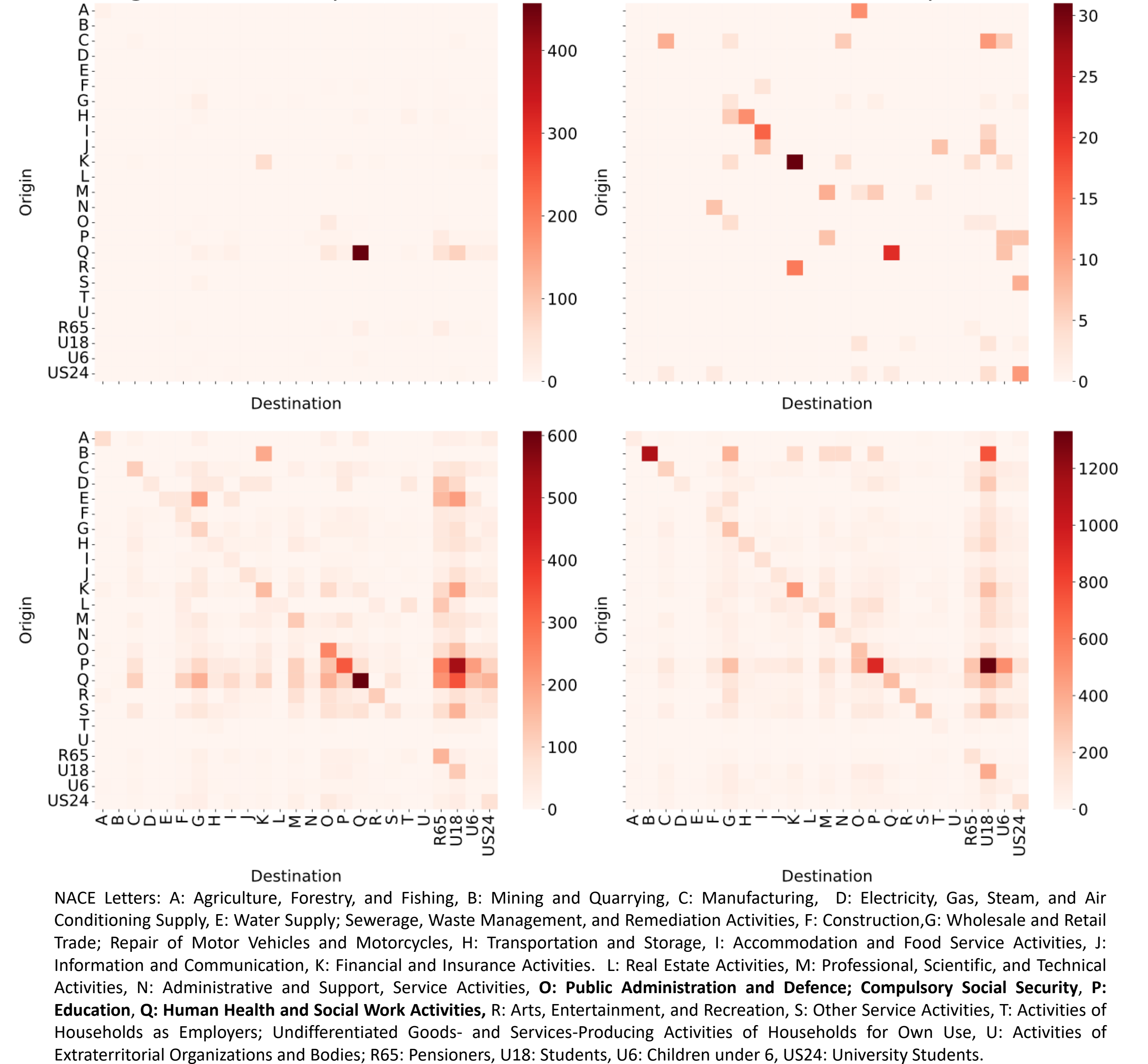
- First wave:** A pattern of transmission from elderly (70+) to young individuals (20-39) (Fig. B, red outline) → Seniors were admitted to the hospital where they infected healthcare professionals (doctors, nurses)
- Second wave (summer period):** Most of the cases involved teenagers (12-19) and young individuals (20-29) (Fig. C, red outlines) → Active social life and the re-opening of clubs and bars were probably the cause of the high transmission.
- Third and fourth wave:** A different pattern of transmission, between individuals with an age difference of ~ 30 years (Fig. D) → Transmission within families, i.e. parents infecting their children and vice versa.

Figure 3: Heatmaps visualization of transmission between age-groups.



- Occupation transmission patterns:**

Figure 4: Heatmaps visualization of transmission between occupations.



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