Women’s mobility networks enable efficient travel

Keywords: smartphone data, human mobility, gender, mobility networks, travel efficiency

Extended Abstract

Gender differences in mobility are well established: women travel shorter distances [1] and engage in lower physical activity [2]. However, contrasting perspectives remain on the organisation of travel. Surveys report more complex mobility for women, with mixed trip purposes and frequent trip chaining [3], whereas large-scale digital-trace studies conclude that women visit fewer locations, exhibit less diversity, and are more regular [1].

We address this contradiction using a 10-country smartphone dataset of 543,155 individuals with self-reported gender. Monthly trajectories are represented as networks of sequential visits: nodes represent unique locations (repertoire size) and weighted edges capture visit frequency (activity). We evaluate (i) repertoire size and activity, (ii) clustering and cycles as indicators of network interconnectedness, and (iii) degree centrality of top-ranked nodes (home, work, third place [4]). To isolate structure from baseline mobility, we apply nearest-neighbor matching on activity and repertoire size [5] and stratify individuals into inactive, moderate, and active groups.

We find four key findings: (1) Men are more active and heterogeneous, with broader variability in activity and repertoire size. (2) Women’s networks are denser, cycle-rich, and strongly home-anchored. (3) Women more often form two-stop tours, men rely on back-and-forth trips; this persists up to 150 km. (4) Women achieve higher *tour efficiency*, defined as distance saved by chaining stops relative to independent round-trips.

These findings reconcile prior discrepancies. Survey evidence of complex, multi-stop travel corresponds to the cycle-rich, interconnected networks of women, while digital-trace evidence of lower diversity reflects stronger home anchoring. Structural perspectives therefore reveal women’s mobility as simultaneously more interconnected and more efficient, advancing the study of gendered mobility and its inequalities.

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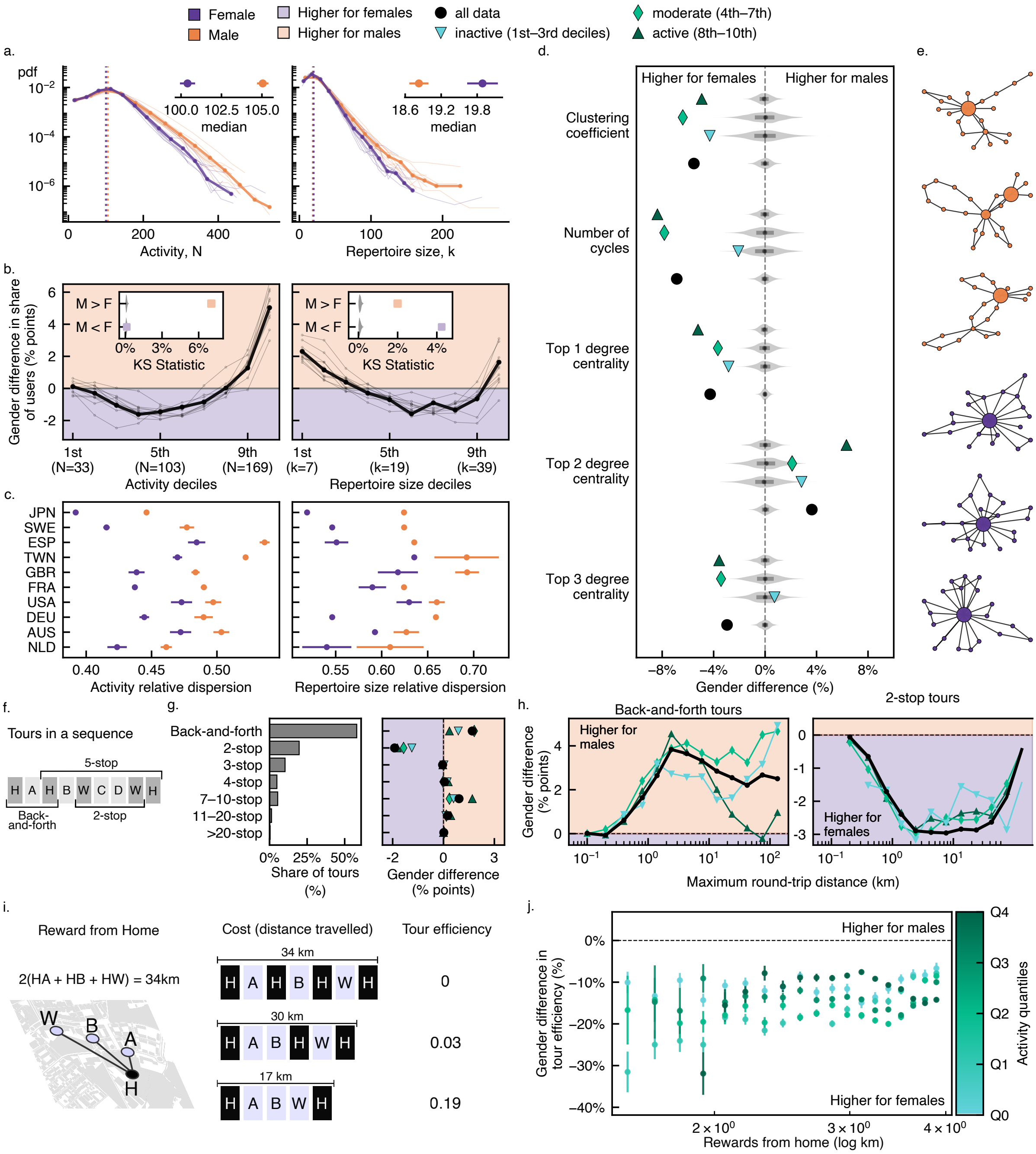

Figure 1: **Structural differences in gendered mobility networks. a.** Activity and repertoire size distributions (females: purple, males: orange); dashed lines: bootstrapped medians; thin: country-level, bold: country-balanced. **b.** Gender gaps across deciles of activity (right) and repertoire (left); insets: one-sided Kolmogorov–Smirnov (KS) statistics, compared to to random gender-label permutations in gray. **c.** Relative dispersion measured as the robust coefficient of variation (RCV) by country; error bars: mean and standard error. **d.** Relative gender differences across network metrics; matched by activity and repertoire; across activity groups. Gray violins: shuffled reference. **e.** Example networks for moderately active males (orange) and females (purple), showcasing differences reported in (d). **f.** Tour identification in a monthly visit sequence (anchors: dark gray). **g.** Tour length distribution (right) and gender differences (left), averaged across countries. **h.** Gender differences in back-and-forth (top) and two-stop tours (bottom) by maximum round-trip distance. **i.** Illustration of tour efficiency: proportion of distance saved by sequencing visits vs. independent round-trips from home **j.** Relative gender differences in tour efficiency by reward (log distance) and activity quantiles.