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The motherhood penalty in mobility

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Extended Abstract

Becoming a parent alters nearly every aspect of peoples' lives, but women typically experience deeper lifestyle changes than men [7]. Academics have coined the phrase 'motherhood penalty' to describe the percentage by which women tend to fall behind men in terms of career advancement as a result of having children [6]. Although the motherhood penalty has been widely studied in labor market research, other behavioral aspects have yet to be fully understood. This is in part due to the scarcity of detailed behavioural data that captures the transition into parenthood.

Mobility and physical activity are key behavioural aspects affected by gender gaps [4, 2, 1]. Survey studies suggest that women have more complex travel behavior, are more likely to chain trips than men, and their trips are more influenced by domestic and care-related tasks [3, 7]. Using passively collected data, it has been shown that women are less physically active, travel shorter distances than men, and that higher fertility rates are associated with a larger gender mobility gap [4, 2, 1]. The mechanisms driving these differences are yet to be fully unveiled.

In this study, we analyze the role of parenthood in travel and physical activity. First, we address how individuals' mobility changes for mothers and fathers when becoming parents. Second, we compare results across countries and examine if the differences can be explained through differences in parental policies or gender norms.

The data used in this study was collected by a global smartphone company between 2015 to 2019 and contains demographic attributes, location, and app usage for 21,050 individuals across ten countries (United Kingdom, Germany, France, Spain, Sweden, Turkey, Japan, Taiwan, Russia, and Brazil) [1]. The users under study are between 18 to 50 years old and self-reported their gender. To study the effect of parenthood on the gender gap, we identify users as parents if they download an app related to parenthood or pregnancy on their smartphone. We use the day that the app was used for the first time as a proxy for the day of childbirth.

How does parenthood transform an individual's mobility? Here, we look at how mobility changes by measuring the within-individual variations and comparing the activity levels after childbirth to a baseline period before pregnancy. Our results are adjusted for potentially confounding factors (age, time, weight, height) through an event study approach [6].

To get a broad understanding of the different dimensions of mobility, we measure: (i) the activity levels captured by the number of steps, (ii) the typical distance traveled, captured by the radius of gyration, (iii) the distribution of time spent per location, captured by the time allocation entropy (low time allocation entropy is associated with spending a large fraction of time at home), (iii) the predictability of user visitation patterns, captured by the visitation entropy (low visitation entropy is associated with few locations visited) [4].

Our preliminary results indicate that females' mobility significantly changes after childbirth in all dimensions. We find that females' mobility reduces by $17.5 \pm 3.0\%$ in terms of the number of steps and $15.7 \pm 3.7\%$ in terms of typical distance traveled, see (Fig.1.a-b). At the same time, males experience reductions in their typical distance traveled by $7.2 \pm 1.5\%$, while they experience no visible effects on activity levels. The observed decline in female activity is maintained up to two years after childbirth. These results are troubling, especially considering

the health benefits resulting from physical activity. In terms of places visited, we observe that the visitation entropy reduces by $4.4 \pm 1.1\%$ for females, and it is not significantly altered as a result of parenthood for males (Fig.1.c). In terms of allocation of time, we find that the time allocation entropy significantly drops for females, but recovers after the one-year mark (Fig.1.d), suggesting that females start spending more time outside home one year after the parenthood cut-off.

Mapping the effect of parenthood across countries, parental policies, and gender norms. We find that motherhood penalties in activity levels exist in all countries under study. We measure the gender gap in activity level between males and females and find a significant gender gap in most of the countries studied. To investigate whether gender differences in parenthood gaps are associated with factors such as parental policies or gender norms, we retrieved data from the Social Institutions and Gender Index (SIGI) developed by OECD and the International Social Survey Programme (ISSP) [5]. We focus on questions concerning family and changing gender roles. Overall, our results indicate a correlation between the country's gender norms and the gender gap in the number of steps (Fig.1.e-g). Interestingly, Sweden, the country with the highest public expenditure on parenthood leaves and the lowest discrimination rates, reports the smallest gender gap, where females experience larger positive effects compared to males in the years after the parenthood cut-off.

Our results reveal that motherhood penalties exist across mobility dimensions, implying that parenthood is a key mechanism underlying the gender gap in human travel behaviour. However, we detect substantial differences between countries. While the effect of parental policies and gender norms is yet to be further investigated, we reveal that the division of household and familial responsibilities might play a key role in human mobility.

References

[1] Laura Alessandretti, Ulf Aslak, and Sune Lehmann. The scales of human mobility. 587(7834):402–407. Number: 7834 Publisher: Nature Publishing Group.

[2] Tim Althoff, Rok Sosič, Jennifer L. Hicks, Abby C. King, Scott L. Delp, and Jure Leskovec. Large-scale physical activity data reveal worldwide activity inequality. 547(7663):336–339. Number: 7663 Publisher: Nature Publishing Group.

[3] Inés Sánchez de Madariaga and Elena Zucchini. Measuring mobilities of care, a challenge for transport agendas. In Christina Lindkvist Scholten and Tanja Joelsson, editors, *Integrating Gender into Transport Planning: From One to Many Tracks*, pages 145–173. Springer International Publishing.

[4] Laetitia Gauvin, Michele Tizzoni, Simone Piaggesi, Andrew Young, Natalia Adler, Stefaan Verhulst, Leo Ferres, and Ciro Cattuto. Gender gaps in urban mobility. 7(1):1–13. Number: 1 Publisher: Palgrave.

[5] Max Haller, Roger Jowell, and Tom W Smith. The international social survey programme, 1984–2009. *Charting the Globe*, 2009.

[6] Henrik Kleven, Camille Landais, and Jakob Egholt Søgaard. Children and gender inequality: Evidence from denmark. *American Economic Journal: Applied Economics*, 11(4):181–209, 2019.

[7] Tanu Priya Uteng and Tim Cresswell. *Gendered Mobilities*. Ashgate Pubilishing.

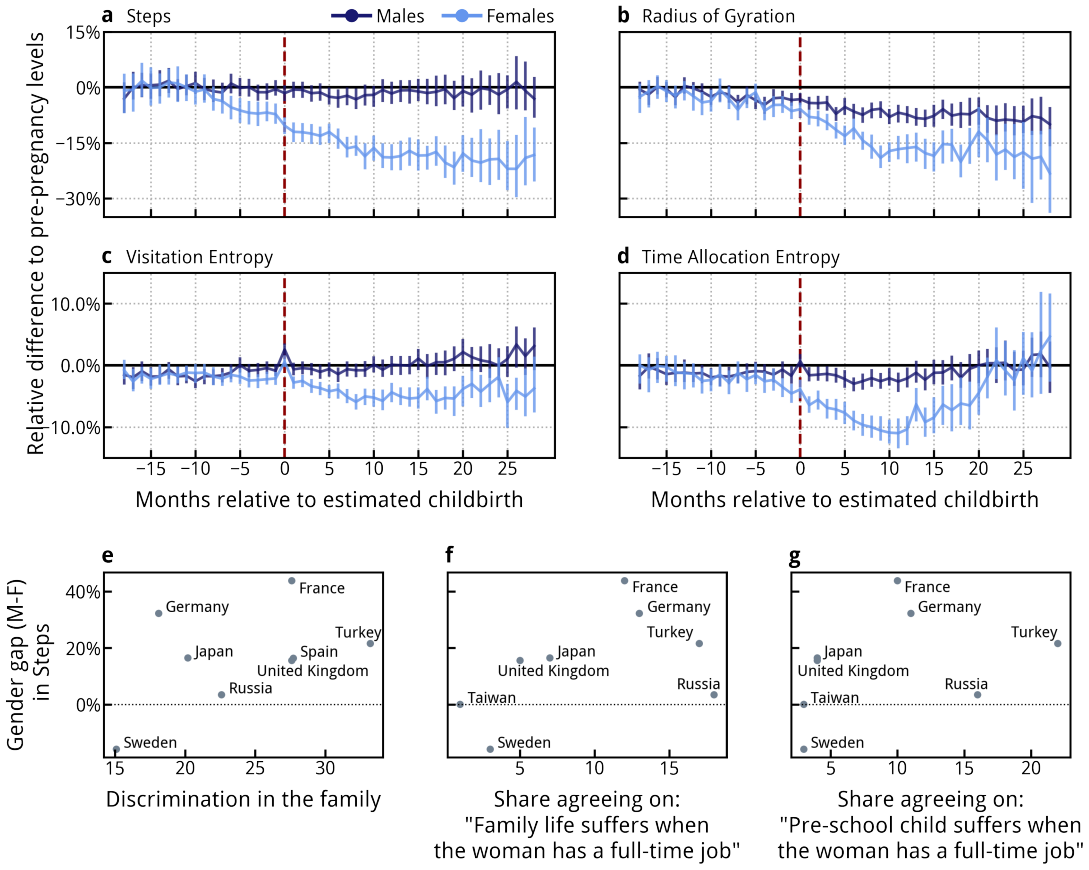

Figure 1: a-d. Relative difference to pre-pregnancy levels for males (dark blue) and females (light blue), per mobility metric. The red line indicates the estimated childbirth and all measures are the monthly estimates in reference to childbirth. e-g. The gender gap as the difference between males (M) and females (F) in number of steps per question. Plot (e) displays the discrimination dimension from the Social Institutions and Gender Index (SIGI) developed by OECD, while plot (f) and (g) represent questions from the International Social Survey Programme (ISSP)[5].