Countries, parental occupation, and girls' interest in science

Although women have made substantial progress in the uptake of undergraduate and graduate study in science, technology, engineering, and mathematics (STEM) fields, they remain under-represented overall.[1] The gender gap in STEM enrolment is related to differences in attitudes toward science rather than differences in mathematical and scientific ability.[2] We explored the factors influencing adolescent girls' interest in science, with a focus on the interplay between cultural factors and parental occupation.

Gender differences in STEM interest are responsive to family influences. Parents influence children's interest via their own aspirations, values, and beliefs, providing role models through their own occupations and connections from their work and social networks.[3,4] Same-sex role modelling plays a particularly important role in socialising children's gender-relevant behaviours.[5] Parent modelling of STEM interests enables girls to envision themselves in counter-stereotypical STEM roles.[1,4] Nonetheless, girls' interest in science is also influenced by the broader sociocultural environment that can enhance or thwart parent modelling.[1] Exposure to gender-science stereotypes is pervasive and is associated with reduced STEM interest for girls.[3,6] Remarkably, studies have also reported that countries with greater socioeconomic development and gender equality have larger gender differences favouring boys in STEM interest.[7,8] However, little attention has been paid to the interaction of both micro (family) and macro (sociocultural milieu) factors in influencing girls' interest in STEM subjects (appendix).

To address this research gap, we used data from the 2015 Programme for International Students Assessment (PISA) to examine how maternal and paternal occupations influence girls' science interest and how this mechanism is moderated by three macro sociocultural factors (ie, gender-science stereotypes, socioeconomic development, and gender equality).

PISA 2015 was a large-scale international survey focusing on students' (aged 15 years) science-related motivation (eg, interest in learning science), performance, and demographics from 72 countries or regions.[9] Given our focus on parental occupation, we selected countries in which at least 10% of parents were employed in a STEM field. We relied on the implicit association test (IAT) from a large-scale international internet sample (2003–15) to create a national-level measure of gender-science stereotypes. The Human Development Index (HDI) and the Gender Gap Index (GGI) were used to assess socioeconomic

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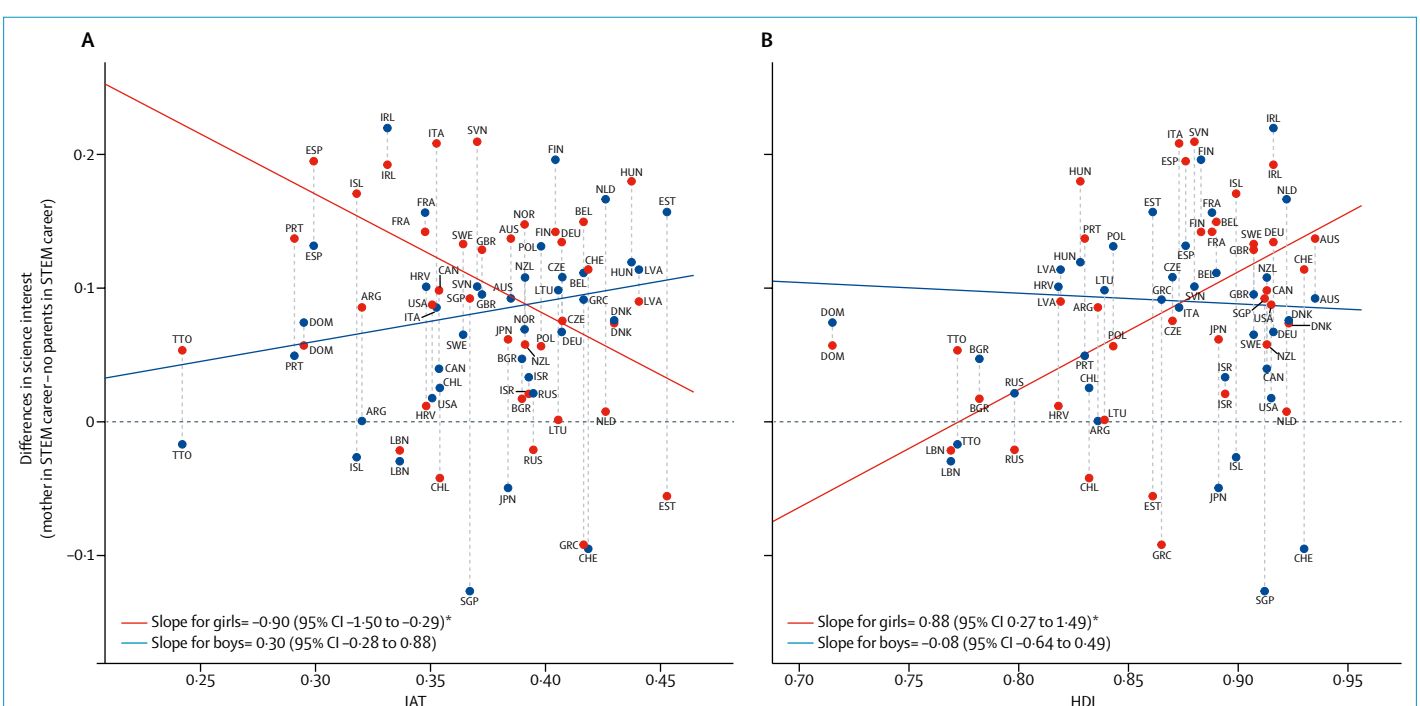

Figure: **Interaction between maternal role-model effect and IAT or HDI**
Data are shown for the 38 participating countries, by ISO 3 country code. High HDI scores indicate that countries have higher socioeconomic development; high IAT scores indicate that countries have more negative female-science implicit stereotypes. The effect of having a mother in a STEM career on girls' science interest varies significantly across different countries, in connection with implicit gender stereotypes in science (A) and socioeconomic development (B). The effect of parental occupation is represented by the difference in average science interest between youths with mother and without mother or father in a STEM career. Red points indicate the relative difference for girls whereas blue ones indicate it for boys. HDI=Human Development Index. IAT=implicit association test. *p<0·01.

development and gender equality. Merging these measures with the PISA data at the country level left us with 38 participating countries, comprising 256 968 participants (appendix).

We applied random-intercept multilevel regression and began with a baseline model that included only the independent variable and both individual-level covariates (science test scores, year grades, and parents' educational level) and national-level covariates to assess the effect of parental occupation on children's science interest. The results showed that girls with either parent employed in STEM had significantly higher science interest compared with those without parents employed in STEM careers (appendix).

Next, we added cross-level interactions between gender, parental occupation, and the national measures to test how the parental role-model effect varied by national-level IAT gender stereotypes, HDI development, and GGI gender equality scores (appendix). We found a significant interaction between parental occupation and national-level IAT scores for girls (figure). The simple slope shows that for girls, the difference in science interest between those whose mothers were in a STEM career versus those with no parents in a STEM career was smaller when IAT scores were greater. Thus, the positive maternal role-model effect on girls' science interest was weaker in societies with more negative female-science implicit stereotypes. Mothers' occupation also interacted with HDI (but not GGI) to predict girls' science interest. Results suggested that the maternal role-model effect on girls' science interest was strongest in more socioeconomically developed societies (figure; appendix).

Our findings show the power of the interaction between family and cultural context in shaping gendered interest in science. As expected, maternal role models can help protect girls against the negative effects of gender–science stereotypes; however, pervasive stereotypes within the broad cultural environment undermine positive role-model effects. Despite the ubiquity of gender-science stereotypes across all nations, we found considerable cultural variability and thus potential for change. Integrating many examples of female scientists as part of teachers' normal classroom instruction would be effective to reduce or neutralise gendered science stereotypes.[1] Emphasising gender similarities in science performance and ability to succeed, and helping girls to cultivate a wider perspective on science, are also imperative[2] (see appendix for further discussion).

The parental role-model effect was stronger in more socioeconomically developed countries. A possible explanation is that the economies of developing countries are geared towards advancing industry and economic growth, whereas the greater economic prosperity seen in developed countries has allowed the growth and flourishing of service sector industries (eg, counsellors, social workers, or childcare workers).[10] These jobs have been primarily filled by women because they are more congruent with traditional gender-role stereotypes. As such, in affluent societies, STEM careers might be less appealing for girls, and the gender gap in science interest favouring boys is also larger (appendix). Therefore, in these countries, parental beliefs regarding science-related values might have a stronger influence on girls' interest in STEM because they are based on informed experience of STEM careers and tend to support girls' exploration of STEM opportunities. Another possibility is that in developing countries that are less economically prosperous, girls might be more motivated to pursue STEM careers because they pay more than careers in other non-STEM fields. Fewer mothers occupying professional STEM roles in developing countries might also account for the parental role-model effect being weaker in countries with low socioeconomic development (see further discussion in the appendix).

This study has several limitations. First, given our correlational design, we cannot firmly establish causal associations between gender disparities in scientific achievement, interest in STEM, and broad sociocultural environment. Second, PISA 2015 only focuses on science motivation and thus we cannot investigate the effects of parental role models on girls' interest in mathematics, which might also contribute to girls' STEM attainment. Finally, the IAT scores used in this study relied on internet samples and thus might be biased by selection effects.

In conclusion, both implicit gender stereotypes and socioeconomic development appear to influence the effect of parental role models on girls' interest in science. This result suggests that efforts to increase female representation in STEM fields should pay more attention to understanding how sociocultural environment, at the familial and societal levels, directs girls towards—or away from—STEM fields.

We declare no competing interests. HWM and PDP received the grants from the Australian Research Council (DP130102713); PDP received the grants from the Australian Research Council (DE140100080). PISA 2015 data can be obtained from http://www.oecd.org/pisa/data/2015database. All macro-level national measures used in the present study are presented in the appendix.

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