Critical masses for academic research groups

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The notion of critical mass in research is one that has been around for a long time without proper definition. It has been described as some kind of minimum threshold group size above which research standards significantly improve. However no evidence for such a threshold has been found and critical mass has never been measured – until now. We present a simple, sociophysical model which explains how research quality depends on research-group structure and in particular on size. Our model predicts that there are, in fact, two critical masses in research, the values of which are discipline dependent. Research quality tends to be linearly dependent on group size, but only up to a limit termed the "upper critical mass". This is interpreted as the average maximum number of colleagues with whom a given individual in a research group can meaningfully interact. Once the group exceeds this size, it tends to fragment into sub-groups and research quality no longer improves significantly with increasing size. There is also a lower critical mass, which small research groups should strive to achieve for stability.

Our theory is tested using empirical data on the quantity and quality of research groups in the UK, for which critical masses are determined. For theoretical physics the lower critical mass is about 6. For pure mathematics it is about 2 and for experimental physics it is 13. The upper critical mass, beyond which research quality does not significantly improve with increasing group size, is about twice the lower value.

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