

Letter to the Editor

Quantifying the growth of oncofertility[†]

Dear Editor,

Teams of scientists are more productive and write higher impact papers than individuals, especially in intrinsically interdisciplinary fields like oncofertility. Oncofertility, a field that merges oncology with fertility, inherently requires cross-disciplinary interaction between physicians, basic scientists, clinical researchers, ethicists, lawyers, educators, and religious leaders. Due to the unique interdisciplinary nature of the field, we therefore predicted that oncofertility would exceed other disciplines in terms of growth rate over time and here we quantify that endpoint using a PubMed analysis of papers published in this field. Our analysis of data on multiple fields of medicine and science shows that oncofertility outpaces traditional reproductive fields (published in similar journals) and palliative care, and is similar to nanotechnology and experienced exponential growth since its relative recent inception Figure 1. Taken together, the field of oncofertility supports the hypothesis that teams enable and empower high-impact science.

Teams from any discipline—in science and beyond—are more likely to outperform individuals [1, 2]. Moreover, work in the field of team-based science demonstrates that teams of particular compositions can assemble and succeed over durable periods of time with teams of atypical combinations creating the highest impact science [3]. Oncofertility is an example of an interdisciplinary field that merges oncology with fertility to explore, expand, and provide reproductive options for patients with fertility-threatening conditions. The field has moved rapidly from the purview of individual champions to an integrated field that has become standard of care in many academic institutions [4, 5]. The need for oncofertility services has accelerated in parallel to the many life-preserving advances in oncologic care, including earlier diagnostics and the emergence of targeted cancer therapies, methods to reduce radiation dose and field, and localized surgical procedures [6].

Many different organizations focused on fertility preservation have emerged recently, including the Oncofertility Consortium [6], the special emphasis group in fertility preservation at the American Association for Reproductive Medicine, and the International Society for Fertility Preservation. In the USA, the field of oncofertility was first funded as a Specialized Cooperative Center Program in Reproductive Research in 2003, and the Center for Reproductive Research focused on understanding structure–function relationships in reproductive science. This NIH-funded Center provided a mechanism to bring new perspectives to reproductive science from ancillary disciplines, like chemistry, bioengineering, and structural biology [7]. In 2007, this fundamental science transitioned to a NIH Roadmap Interdisciplinary Research Consortium—the Oncofertility Consortium—to specifically address the intractable problem of fertility preservation options for young female cancer patients. At this interval, the humanities including religion, ethics, and law; social

sciences; and broader inclusion of reproductive science and biomaterial innovation were engaged with a larger group of clinicians including reproductive endocrinology, urology, adult oncology (specialists in blood based and solid tumors and radiation oncology), nursing, patient navigation, survivorship services etc. In 2012, we broadened the scope of the Oncofertility Consortium to include the Center for Reproductive Health After Disease, whose mission is to protect and preserve the reproductive health—including fertility, endocrine health, sexuality, or the ability to carry an offspring to term—of women and men at reproductive risk after disease or treatment of disease. During the last 5 years, our team scope further expanded to include practitioners involved in pediatric oncology, pediatric gynecology, pediatric endocrinology, and patients with fertility concerns beyond oncologic interventions to genetic and developmental disorders, and transgender individuals. Clinical programs expanded from five domestic sites in 2007 to over 150 sites around the globe representing academic medical centers, stand-alone cancer centers, pediatric hospitals, and community hospitals [8].

Because oncofertility as a discipline includes a broad notion of interdisciplinarity/team-based science (from humanities to social science to biological and engineering sciences to clinical medicine), we were interested in the magnitude of growth of the discipline. Previously, we performed a network analysis and showed that networks of coauthors coalesced in 2012, demonstrating that the field has an organizing effect on individuals who previously did not identify as coauthors [7]. To further quantify the growth of the oncofertility field, we measured the number of papers published in the field and compared the publication rates over time with other fields. We identified five fields as comparator groups: reproductive-related research fields (fibroids, endometriosis, and Polycystic ovary syndrome (PCOS)), a more recently emerged interdiscipline, palliative care, and a powerhouse basic science field, nanotechnology. The number of papers in each field was mined from PubMed since 1941. Oncofertility as a field has grown at a statistically higher rate than reproductive research fields and palliative care, and is similar in growth rate to nanotechnology. This growth in oncofertility relative to nanotechnology is impressive, given the differences in these two fields in terms of number of journals with high-impact factors (chemistry vs. reproduction) [9].

The Oncofertility Consortium was created to assimilate oncology and fertility practices into a single entity that would enable young males and females to protect their reproductive health. It has rapidly grown in both the number and diversity of professionals involved in the work (humanities, social science, STEM sciences, and clinicians) and in the kind of patient/individuals engaged in fertility protective strategies (iatrogenic, genetic, developmental, and social). To our knowledge, no other field has integrated science and clinical disciplines in the same seamless way or had as powerful an impact on

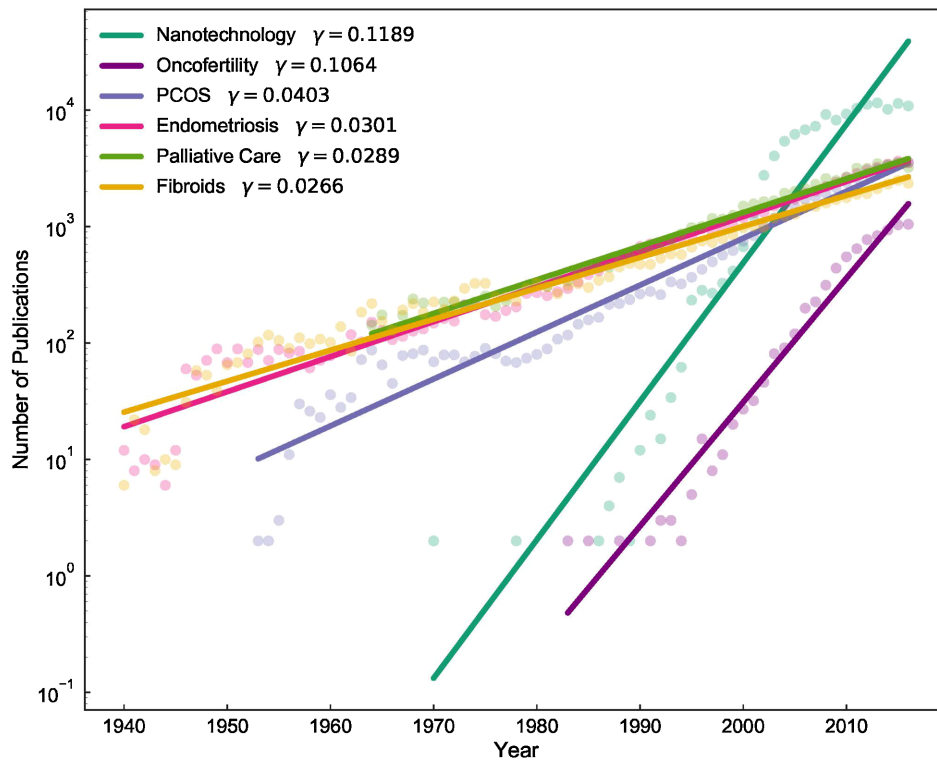


Figure 1. Field-wide comparisons of oncofertility publications to female diseases that have basic and clinical components (endometriosis, fibroids, PCOS), a field of science and medicine that emerged at the same time as oncofertility (palliative care) and a rapidly growing basic science field (nanotechnology). The dots represent the yearly publication number in each discipline, and the lines show the exponential growth fitting with the growth rates shown in the caption. This figure is available in color at *Biology of Reproduction* online.

research and quality of care in such a short time. To this point, the original Roadmap grant called upon the biomedical community to identify “the most intractable problems of our time, and provide methods for solving them using teams.” Through analytical tools that assess author networks, impact factors, and publication rates, we believe the Consortium has succeeded in creating teams and laying the groundwork for converting a once intractable problem into a clinical field.

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