

# Analysing funding patterns and their evolution for two medical research topics

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## Introduction

In this paper we analyse funding patterns and their evolution in two medical research topics: breast and ovarian cancer. Through the bibliometric analysis of 355,463 papers from *PubMed* (273,526 for breast and 81,937 for ovarian) and the use of the software *VantagePoint*, we have found 91 funding agencies for the breast topic and 65 for the ovarian case. Number of coincidences in agencies is 63. Furthermore, the first year in which every agency appears varies between the two medical topics. Analysis of patterns in funding, co-funding and their evolution, has been made through Social Network Analysis methodology and the use of *Ucinet6* software. Results show that agencies co-fund the research in both topics, although the number of agencies is higher in the case of breast cancer. Moreover, in the last ten years, the number of agencies which participate in research funding has increased.

## Data and Method

The two topics were analysed separately, in order to find similarities and differences. Table 1 shows a summary of the records utilised in our analysis. Data for funding agencies were obtained through the acknowledgment included in the papers. To obtain the names of agencies, the numbers of grants were cleaned. The cleaning and preparation of the data were made through the software *VantagePoint* (Porter & Cunningham, 2005), while Social Network Analysis was elaborated with the software *Ucinet6* (Suominen, 2014; Swar & Khan, 2014; Kim et al., 2014). *PubMed* database allowed us to obtain all the papers available in every topic, using the queries made by the own database.

Search Query made by PubMed database:

a) Topic=("breast neoplasms"[MeSH Terms] OR ("breast"[All Fields] AND "neoplasms"[All Fields]) OR "breast neoplasms"[All Fields] OR ("breast"[All Fields] AND "cancer"[All Fields]) OR "breast cancer"[All Fields]) AND ("2009/04/21"[PDat] : "2014/04/19"[PDat] AND cancer[sb])

b) Topic=("ovarian neoplasms"[MeSH Terms] OR ("ovarian"[All Fields] AND "neoplasms"[All Fields]) OR "ovarian neoplasms"[All Fields] OR ("ovarian"[All Fields] AND "cancer"[All Fields]) OR "ovarian cancer"[All Fields]) AND cancer[sb]

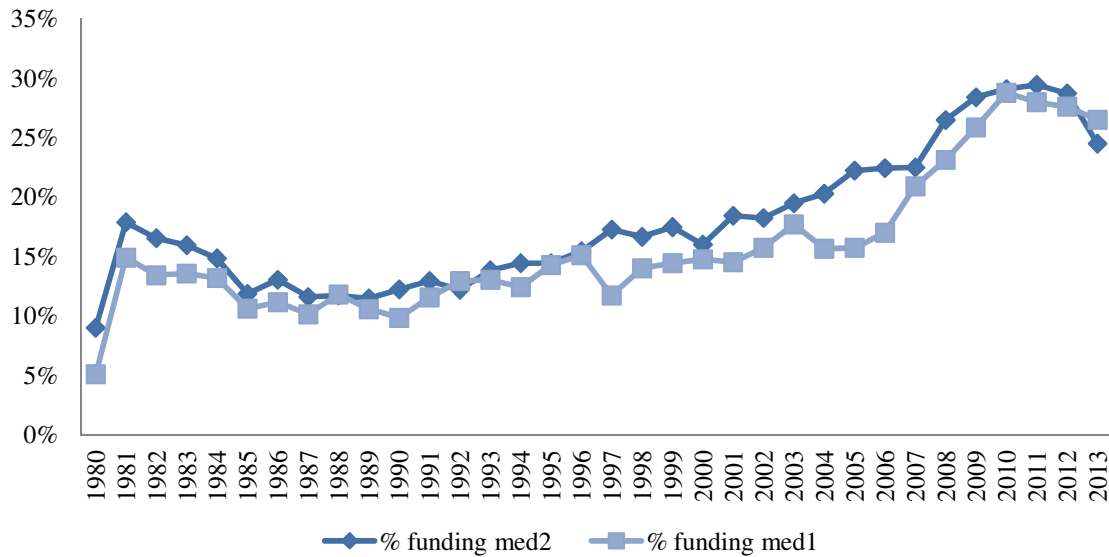
Although information about funding depends on the period analysed (Figure 1), the total database gives a quote of 18% of papers that include information about funding agencies (Table 1).

Table 1. Summary of data used in the analysis

|                                  | Med1 (ovarian cancer) | Med 2 (breast cancer) |
|----------------------------------|-----------------------|-----------------------|
| Total records                    | 81,937                | 273,526               |
| Records with founding            | 14,560 (17.77%)       | 48,948 (17.9%)        |
| Number of funding agencies       | 65                    | 91                    |
| Funding agencies coincide        | 63                    | 63                    |
| Funding agencies do not coincide | 28                    | 2                     |

Source: own elaboration

Fig. 1. Percentage of papers which give funding information by year



Source: own elaboration

## Results

The majority of funding agencies for the two topics are located in the United States (about 80%), and the other agencies appear in the United Kingdom, Canada, Austria, Italy, Ireland, and recently in other European countries represented by the European Research Council.

On the other hand, Figures 2 to 5 show that there is a tendency in the majority of the agencies to appear first in the funding of research about breast cancer. Moreover, the number of agencies that fund research in both topics has increased in the last ten years.

In Table 2 we include a summary with the most important results from the Social Networks Analysis. It is obvious that the National Cancer Institute appears like the most important funding agency for the two medical topics and the two periods analysed. Centrality degree also shows the importance of the National Centre for Research Resources for both topics, while the National Institute of General Medical Sciences is presented in ovarian cancer and the Public Health Service emerges in breast cancer. Betweenness of the NCRR, NIGMS and NIMH is important for the agencies that can access to the NCI only through the NCRR, as in the cases of the WHI and NCPDCID in Figure 2, for example. Therefore, we can identify in Figures 2 to 5 that the main differences between years 2003 and 2013 depend on a) the existence of cross-agency co-funding, and the appearance of the NIH as a co-funding agency, b) the existence of cross-national co-funding, and c) how many participants are not involved in co-funding.

Table 2. Summary of the Social Networks Analysis. Centrality measures

|                          | Med1 Y2003           | Med1 Y2013           | Med2 Y2003  | Med2 Y2013                  |
|--------------------------|----------------------|----------------------|-------------|-----------------------------|
| <b>Network Density</b>   | 21.57%               | 18.5%                | 16.9%       | 23.6%                       |
| <b>Degree Centrality</b> | NCI<br>NIGMS<br>NCRR | NCI<br>NCRR<br>NIGMS | NCI<br>NCRR | NCI<br>NCRR<br>PHS          |
| <b>Closeness</b>         | NCI<br>NIGMS<br>NCRR | NCI<br>NCRR<br>NIGMS | NCI<br>NCRR | NCI<br>NCRR<br>PHS<br>NIGMS |
| <b>Betweenness</b>       | NCI<br>NCRR          | NCI<br>NIGMS         | NCI<br>NCRR | NCI<br>NIMH<br>NIGMS        |

NCI: National Cancer Institute; NCRR: National Center for Research Resources; NIGMS: National Institute of General Medical Sciences; PHS: Public Health Service; NIMH: National Institute of Mental Health;



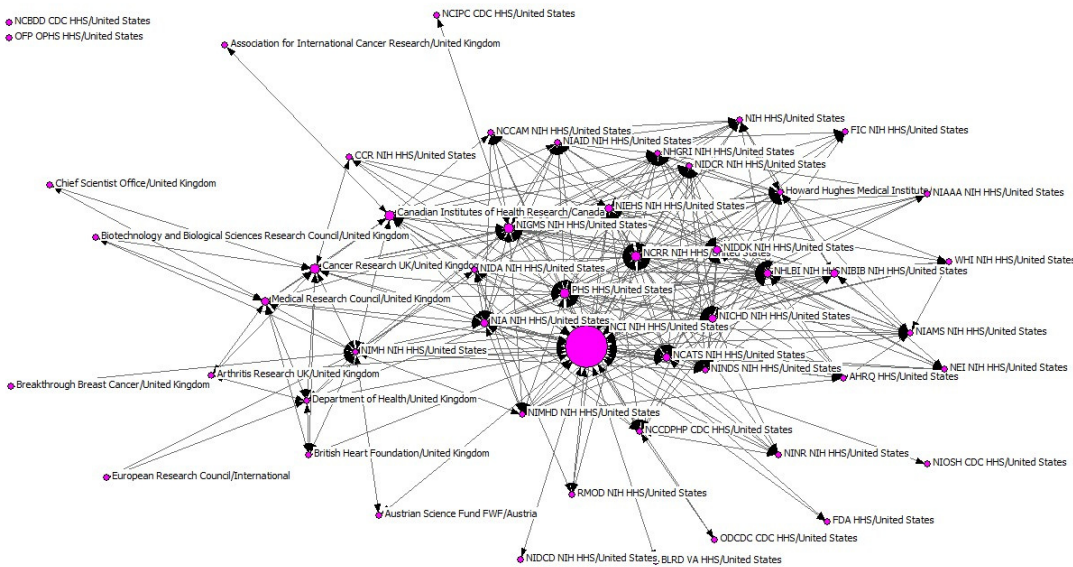
- C1. NCI NIH HHS/United States; NICHD NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States.
- C2. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; NHLBI NIH HHS/United States.
- C3. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; NHGRI NIH HHS/United States.
- C4. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NIAID NIH HHS/United States.
- C5. NCI NIH HHS/United States; NICHD NIH HHS/United States; NIGMS NIH HHS/United States; NIDDK NIH HHS/United States.
- C6. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States.
- C7. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NIEHS NIH HHS/United States.
- C8. NCI NIH HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; PHS HHS/United States.
- C9. NCI NIH HHS/United States; PHS HHS/United States; BHP HRSA HHS/United States.
- C10. NCI NIH HHS/United States; NIAID NIH HHS/United States; NIDCR NIH HHS/United States.

We use the term clique in a strong sense, which means that each participant in the clique has ties with the rest of nodes which form the clique. Comparing years 2003 and 2013 we can detect that agencies that are not directly connected in the network with the NCI in 2003 do not appear in any clique (WHI and NCPDCID). However, some agencies not connected directly with the NCI in 2013, they do appear in cliques (NINR, British Heart Foundation). In addition, in 2003 the NCI was involved in every clique, while in 2013 it appears in 35 cliques (92% of cliques). Moreover, in 2003 all the cliques were formed by United States agencies, while in 2013 we observe that 11 cliques incorporate cross-national co-funding (28.9% of cliques). Nations involved in these 11 cliques are United States, Canada and United Kingdom (the three nations in 4 cliques, United States and United Kingdom in 6 cliques, and United States and Canada in 1 clique).

- C1. NCI NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; NICHD NIH HHS/United States; NIGMS NIH HHS/United States; NCRR NIH HHS/United States; PHS HHS/United States; NIEHS NIH HHS/United States.
- C2. NCI NIH HHS/United States; NICHD NIH HHS/United States; NIGMS NIH HHS/United States; NCRR NIH HHS/United States; NCATS NIH HHS/United States; NHLBI NIH HHS/United States.
- C3. NCI NIH HHS/United States; NICHD NIH HHS/United States; NIGMS NIH HHS/United States; NCRR NIH HHS/United States; NIH HHS/United States.
- C4. NCI NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; Cancer Research UK/**United Kingdom**; NIGMS NIH HHS/United States; NCRR NIH HHS/United States; Medical Research Council/**United Kingdom**; PHS HHS/United States; Wellcome Trust/**United Kingdom**.
- C5. NCI NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; Cancer Research UK/**United Kingdom**; NIGMS NIH HHS/United States; NCRR NIH HHS/United States; PHS HHS/United States; NIEHS NIH HHS/United States.
- C6. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NCRR NIH HHS/United States; NHLBI NIH HHS/United States; NIAID NIH HHS/United States.
- C7. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NCRR NIH HHS/United States; NHLBI NIH HHS/United States; NHGRI NIH HHS/United States.
- C8. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NCRR NIH HHS/United States; NHLBI NIH HHS/United States; NLM NIH HHS/United States.
- C9. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NCATS NIH HHS/United States; NHLBI NIH HHS/United States; NIDDK NIH HHS/United States.
- C10. NCI NIH HHS/United States; Cancer Research UK/**United Kingdom**; NIGMS NIH HHS/United States; NIDDK NIH HHS/United States.
- C11. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NHLBI NIH HHS/United States; Howard Hughes Medical Institute/United States.
- C12. NCI NIH HHS/United States; NIGMS NIH HHS/United States; NIMHD NIH HHS/United States.
- C13. NCI NIH HHS/United States; Cancer Research UK/**United Kingdom**; Medical Research Council/**United Kingdom**; Department of Health/**United Kingdom**; Arthritis Research UK/**United Kingdom**.
- C14. NCI NIH HHS/United States; NCRR NIH HHS/United States; NHLBI NIH HHS/United States; NIAID NIH HHS/United States; NIBIB NIH HHS/United States.
- C15. NCI NIH HHS/United States; NICHD NIH HHS/United States; NCRR NIH HHS/United States; NHLBI NIH HHS/United States; NIBIB NIH HHS/United States.
- C16. NCI NIH HHS/United States; NICHD NIH HHS/United States; NCRR NIH HHS/United States; NIBIB NIH HHS/United States; NIH HHS/United States.
- C17. NCI NIH HHS/United States; NHLBI NIH HHS/United States; NIBIB NIH HHS/United States; Howard Hughes Medical Institute/United States.
- C18. NCI NIH HHS/United States; NIBIB NIH HHS/United States; Howard Hughes Medical Institute/United States; NCCDPHP CDC HHS/United States.
- C19. NCI NIH HHS/United States; NICHD NIH HHS/United States; NIBIB NIH HHS/United States; NIDCR NIH HHS/United States; NIH HHS/United States.
- C20. NCI NIH HHS/United States; NICHD NIH HHS/United States; NIEHS NIH HHS/United States; NIA NIH HHS/United States.
- C21. NCI NIH HHS/United States; NICHD NIH HHS/United States; NCATS NIH HHS/United States; NIA NIH HHS/United States.
- C22. NCI NIH HHS/United States; NICHD NIH HHS/United States; NIA NIH HHS/United States; NIMH NIH HHS/United States.
- C23. NCI NIH HHS/United States; NCATS NIH HHS/United States; NIDDK NIH HHS/United States; NIA NIH HHS/United States.
- C24. NCI NIH HHS/United States; NCATS NIH HHS/United States; NIDDK NIH HHS/United States; NIAMS NIH HHS/United States.
- C25. NCI NIH HHS/United States; NCRR NIH HHS/United States; NCATS NIH HHS/United States; NIAMS NIH HHS/United States.
- C26. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIAID NIH HHS/United States; NIAMS NIH HHS/United States.



Fig.5. Research Co-funding for breast cancer, year 2013



With respect to breast cancer, the cliques where there were more than three funding organisations are 32 for the year 2003 and 70 in the year 2013:

- C1. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [NIEHS NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NICHD NIH HHS/United States](#).
- C2. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [NIEHS NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NIA NIH HHS/United States](#).
- C3. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [NIEHS NIH HHS/United States](#); [PHS HHS/United States](#).
- C4. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [NIEHS NIH HHS/United States](#); [NCCAM NIH HHS/United States](#).
- C5. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NHLBI NIH HHS/United States](#).
- C6. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [NHLBI NIH HHS/United States](#); [PHS HHS/United States](#).
- C7. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NHLBI NIH HHS/United States](#); [NIAMS NIH HHS/United States](#).
- C8. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NIA NIH HHS/United States](#); [NIAMS NIH HHS/United States](#).
- C9. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NHLBI NIH HHS/United States](#); [PHS HHS/United States](#); [NIAMS NIH HHS/United States](#).
- C10. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NIAMS NIH HHS/United States](#); [NCCAM NIH HHS/United States](#).
- C11. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NEI NIH HHS/United States](#).
- C12. [NCI NIH HHS/United States](#); [NIDDK NIH HHS/United States](#); [NCCAM NIH HHS/United States](#); [BHP HRSA HHS/United States](#).
- C13. [NCI NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NICHD NIH HHS/United States](#); [NIAID NIH HHS/United States](#).
- C14. [NCI NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NIA NIH HHS/United States](#); [NIAID NIH HHS/United States](#).
- C15. [NCI NIH HHS/United States](#); [PHS HHS/United States](#); [NIAID NIH HHS/United States](#).
- C16. [NCI NIH HHS/United States](#); [NIA NIH HHS/United States](#); [NIAID NIH HHS/United States](#); [NIMH NIH HHS/United States](#).
- C17. [NCI NIH HHS/United States](#); [NICHD NIH HHS/United States](#); [NIAID NIH HHS/United States](#); [FIC NIH HHS/United States](#).
- C18. [NCI NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [NIA NIH HHS/United States](#); [AHRQ HHS/United States](#).
- C19. [NCI NIH HHS/United States](#); [NIA NIH HHS/United States](#); [AHRQ HHS/United States](#); [NIMH NIH HHS/United States](#).
- C20. [NCI NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [PHS HHS/United States](#); [AHRQ HHS/United States](#).
- C21. [NCI NIH HHS/United States](#); [NIEHS NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [ODCDC CDC HHS/United States](#).
- C22. [NCI NIH HHS/United States](#); [ODCDC CDC HHS/United States](#); [NIDCD NIH HHS/United States](#).
- C23. [NCI NIH HHS/United States](#); [NCRR NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NHGRI NIH HHS/United States](#).
- C24. [NCI NIH HHS/United States](#); [NIMH NIH HHS/United States](#); [NIDA NIH HHS/United States](#).
- C25. [NCI NIH HHS/United States](#); [NIMH NIH HHS/United States](#); [NINDS NIH HHS/United States](#).
- C26. [NCI NIH HHS/United States](#); [NIGMS NIH HHS/United States](#); [NIAMS NIH HHS/United States](#); [NINDS NIH HHS/United States](#).

- C27. NCI NIH HHS/United States; NHLBI NIH HHS/United States; PHS HHS/United States; NIAMS NIH HHS/United States; NIDCR NIH HHS/United States.
- C28. NCI NIH HHS/United States; NIA NIH HHS/United States; NIAMS NIH HHS/United States; NIDCR NIH HHS/United States.
- C29. NCI NIH HHS/United States; NIEHS NIH HHS/United States; NICHD NIH HHS/United States; FIC NIH HHS/United States.
- C30. NCI NIH HHS/United States; NIA NIH HHS/United States; NINR NIH HHS/United States.
- C31. NCI NIH HHS/United States; NICHD NIH HHS/United States; NIDA NIH HHS/United States.
- C32. NIA NIH HHS/United States; NIAMS NIH HHS/United States; NIADDK NIH HHS/United States.

Comparing years 2003 and 2013 we can also detect the importance of the NCI, which appears in 31 cliques in 2003 and in 67 in 2013. Moreover, in 2003 all the cliques were formed by United States agencies, while in 2013 we observe that 25 cliques incorporate cross-national co-funding (36% of cliques). Nations involved in these 25 cliques are United States, Canada, United Kingdom, Austria and the European Research Council (United States and Canada appear in 12 cliques; United States and United Kingdom in 7 cliques; United States, United Kingdom and Canada in 4 cliques; United States and Austria in 1 clique; United States, United Kingdom and the European Research Council in 1 clique).

- C1. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NCATS NIH HHS/United States; NIA NIH HHS/United States; NICHD NIH HHS/United States; NIMHD NIH HHS/United States.
- C2. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NCATS NIH HHS/United States; NIA NIH HHS/United States; NICHD NIH HHS/United States; NIDCR NIH HHS/United States.
- C3. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIEHS NIH HHS/United States; NCATS NIH HHS/United States; NIBIB NIH HHS/United States; NICHD NIH HHS/United States.
- C4. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIEHS NIH HHS/United States; NICHD NIH HHS/United States; NHGRI NIH HHS/United States.
- C5. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIEHS NIH HHS/United States; NIBIB NIH HHS/United States; NICHD NIH HHS/United States; NINDS NIH HHS/United States.
- C6. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIA NIH HHS/United States; NICHD NIH HHS/United States; NIDCR NIH HHS/United States; NINDS NIH HHS/United States.
- C7. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NHGRI NIH HHS/United States; NIAID NIH HHS/United States; Howard Hughes Medical Institute/United States.
- C8. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIA NIH HHS/United States; NIAID NIH HHS/United States.
- C9. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NCATS NIH HHS/United States; NIBIB NIH HHS/United States; Howard Hughes Medical Institute/United States.
- C10. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIBIB NIH HHS/United States; NINDS NIH HHS/United States; Howard Hughes Medical Institute/United States.
- C11. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; PHS HHS/United States; NIDDK NIH HHS/United States; NIA NIH HHS/United States; NIAID NIH HHS/United States.
- C12. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; PHS HHS/United States; NIDDK NIH HHS/United States; NIA NIH HHS/United States; NIDCR NIH HHS/United States.
- C13. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; PHS HHS/United States; NIDDK NIH HHS/United States; NIA NIH HHS/United States; NCCAM NIH HHS/United States.
- C14. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; PHS HHS/United States; NIDDK NIH HHS/United States; NIEHS NIH HHS/United States; NHGRI NIH HHS/United States.
- C15. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; PHS HHS/United States; NIDDK NIH HHS/United States; NIEHS NIH HHS/United States; NCCAM NIH HHS/United States.
- C16. NCI NIH HHS/United States; NCRR NIH HHS/United States; NIGMS NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; PHS HHS/United States; NIDDK NIH HHS/United States; NHGRI NIH HHS/United States; NIAID NIH HHS/United States.
- C17. NCI NIH HHS/United States; NCRR NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIBIB NIH HHS/United States; NINDS NIH HHS/United States; NIAMS NIH HHS/United States; Howard Hughes Medical Institute/United States.
- C18. NCI NIH HHS/United States; NCRR NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIA NIH HHS/United States; NINDS NIH HHS/United States; NIAMS NIH HHS/United States.
- C19. NCI NIH HHS/United States; NCRR NIH HHS/United States; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIAMS NIH HHS/United States; AHRQ HHS/United States.





- C53. **NCI NIH HHS/United States**; NIGMS NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; NIA NIH HHS/United States; NIMH NIH HHS/United States; NIDA NIH HHS/United States.
- C54. **NCI NIH HHS/United States**; NIGMS NIH HHS/United States; NIBIB NIH HHS/United States; NICHD NIH HHS/United States; NIMH NIH HHS/United States; NINDS NIH HHS/United States; NIDA NIH HHS/United States.
- C55. **NCI NIH HHS/United States**; NIGMS NIH HHS/United States; NCATS NIH HHS/United States; NIBIB NIH HHS/United States; NICHD NIH HHS/United States; NIMH NIH HHS/United States.
- C56. **NCI NIH HHS/United States**; NIGMS NIH HHS/United States; NICHD NIH HHS/United States; NIMH NIH HHS/United States; NHGRI NIH HHS/United States.
- C57. **NCI NIH HHS/United States**; NIGMS NIH HHS/United States; Canadian Institutes of Health Research/**Canada**; NIMH NIH HHS/United States; NHGRI NIH HHS/United States.
- C58. **NCI NIH HHS/United States**; NIMH NIH HHS/United States; Austrian Science Fund FWF/**Austria**.
- C59. **NCI NIH HHS/United States**; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIA NIH HHS/United States; NICHD NIH HHS/United States; NCCDPHP CDC HHS/United States.
- C60. **NCI NIH HHS/United States**; PHS HHS/United States; NIA NIH HHS/United States; NICHD NIH HHS/United States; NCCDPHP CDC HHS/United States; NINR NIH HHS/United States.
- C61. **NCI NIH HHS/United States**; Canadian Institutes of Health Research/**Canada**; PHS HHS/United States; NIDDK NIH HHS/United States; NIA NIH HHS/United States; NCCDPHP CDC HHS/United States.
- C62. **NCI NIH HHS/United States**; PHS HHS/United States; NIDDK NIH HHS/United States; NHLBI NIH HHS/United States; NIEHS NIH HHS/United States; NICHD NIH HHS/United States; NCCDPHP CDC HHS/United States.
- C63. **NCI NIH HHS/United States**; Canadian Institutes of Health Research/**Canada**; PHS HHS/United States; NIDDK NIH HHS/United States; NIEHS NIH HHS/United States; NCCDPHP CDC HHS/United States.
- C64. **NCI NIH HHS/United States**; NCCDPHP CDC HHS/United States; ODCDC CDC HHS/United States.
- C65. **NCI NIH HHS/United States**; PHS HHS/United States; NHLBI NIH HHS/United States; NIEHS NIH HHS/United States; NICHD NIH HHS/United States; NHGRI NIH HHS/United States; WHI NIH HHS/United States.
- C66. **NCI NIH HHS/United States**; PHS HHS/United States; NHLBI NIH HHS/United States; NIAMS NIH HHS/United States; WHI NIH HHS/United States.
- C67. **NCI NIH HHS/United States**; PHS HHS/United States; FDA HHS/United States.
- C68. Cancer Research UK/**United Kingdom**; Medical Research Council/**United Kingdom**; NIMH NIH HHS/United States; Biotechnology and Biological Sciences Research Council/**United Kingdom**.
- C69. Cancer Research UK/**United Kingdom**; Medical Research Council/**United Kingdom**; Chief Scientist Office/**United Kingdom**.
- C70. NIMH NIH HHS/United States; Department of Health/**United Kingdom**; **European Research Council**/International.

Table 3 summarises the main results for both types of cancer, indicating that the NCI is the most important agency in both cases, as has been demonstrated with cliques. An important difference found between ovarian and breast cancer research is that in ovarian research prevail cross-national co-funding between the United States and United Kingdom (6 cliques), while in breast research the dominant linkage occurs between United States and Canada (12 cliques).

Table 3. Summary of patterns in co-funding research

|  | Med1 Y2003 | Med1 Y2013   | Med2 Y2003 | Med2 Y2013   |
|--|------------|--|------------|--|
| <b>Non co-funding agencies (isolate in network)</b>  | 3          | 2  | 4          | 2  |
| <b>Cross-agency with NCI (number of cliques)</b>     | 10/10      | 35/38  | 31/32      | 67/70  |
| <b>Cross-agency without NCI (number of cliques)</b>  | 0          | 3  | 1          | 3  |
| <b>Cross-national co-funding (number of cliques)</b> | 0          | 11/38 (29%)<br>United States,<br>Canada,<br>United Kingdom | 0          | 25/70 (36%)<br>United States,<br>Canada,<br>United Kingdom,<br>Austria,<br>European Research Council |

Source: own elaboration

## Conclusions

Co-funding research analysis allows researchers to detect which are the most important institutions in supporting research in a topic, but also shows which are the mediator agencies to be contacted when it is difficult to manage a direct link with the funding star, which in our analysis is the NCI. Moreover, we can also observe which countries are linked more directly and in a higher rank to the United States depending on the topic. If we were trying to look for a mediator in ovarian cancer, we could find more opportunities in United Kingdom; if the topic were breast cancer, we would find our mediator in Canada.

Analysing medical bibliography evolve difficulties, as we have encountered through our data processing. For example, although *PubMed* database allowed us to download all the data in a fast way, cleaning the acknowledge data implied a lot of time. Because data included jointly the number of the project granted, the funding agency and other information, we needed to delete those unnecessary data project by project. Another important difficulty was related to the limitation for working with a high amount of data with VantagePoint and Windows, but fortunately we were able to solve it.

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